Technical Specifications Index

Division 1 Specifications

Section 01000 – Summary of Work Section 01005 – Definitions & Terminology Section Section 01030 – Special Procedures Section 01039 – Coordination & Meetings Section 01300 - Submittals Section 01310 - Progress Schedules Section 01340 – Shop Drawings, Product Data & Samples, O&M Manuals Section 01400 – Quality Control Section 01420 – Geotechnical Engineering Study Section 01510 - Temporary Facilities Section 01563 - Groundwater Handling Section 01568 – Erosion and Sediment Control during Construction Section 01600 – Products Section 01601 – Job Conditions Section 01640 – Product Substitutions Section 01650 – Starting Systems Section 01700 - Contract Closeout Section 01730 – Operation and Maintenance Manuals Section 01732 – Demolition of Civil Site Improvements Section 01900 – References and Standards

Division 2 Specifications

Section 02110 – Site Clearing and Grubbing Section 02200 – Earthwork for Top Soil Requirements Section 02221 – Excavating, Backfilling and Compacting for Utilities Section Section 02300 – Structural Earthwork Section 02500 – Flexible Base Section 02515 – Wetwell and Manhole Structures Section 02556 – Water Transmission Lines and/or Pressure Sewer Lines Section 02570 – Sanitary Sewer Section 02572 – Combination Air Valves Section Section 02590 – Polyurethane Protective Coatings Section 02831 – Chain Link Fences and Gates

Division 3 Specifications

Section 03200 – Concrete Reinforcement Section 03300 – Cast-in-Place Concrete for Site Work Section 03301 – Cast-in-Place Concrete (Limited Applications)

Division 7 Specifications

Section 07900 - Joint Sealers

Division 9 Specifications

Section 09865 – Shop Coatings Section 09900 – Field Coatings

Division 11 Specifications

Section 11005 – Equipment: General Requirements Section 11060 – Pumping Equipment: General Requirements Section 11322 – Submersible Lift Station

Division 13 Specifications

Section 13443 – Lift Station Controls Section 13450 – Portable Hoist

Division 15 Specifications

Section 15076 – Tagging Section 15100 – Valves and Appurtenances

Division 16 Specifications

Section 16012 - Electrical Work Section 16111 - Conduit, Fittings, and Bodies Section 16126 – Instrumentation Cable Section 16131 – Device Pull and Junction Boxes Section 16135 – Cabinets, Boxes and Fittings Section 16140 – Wiring Devices Section 16150 – Electric Motors Section 16160 – Cabinets and Enclosures Section 16195– Electrical Identification Section 16452 - Grounding Section 16475 – Overcurrent Protective Devices Section 16476 – Disconnects and Circuit Breakers Section 16481 – Motor Controllers Section 16496 – Automatic Transfer Switch Section 16510 - Lighting Fixtures Section 16622 – Sound Attenuating Enclosure Section 16670 – Lighting Protection System Section 16903 - Remote Terminal Unit

Division 19 Specifications

Section 19000 – Trench Protection

1.00 PART 1 GENERAL 1.01 SECTION INCLUDES

Summary of the Work including any work by OWNER, OWNER furnished products, work sequence and future work.

1.02 DESCRIPTION OF WORK

- A. Location of Work: Hidalgo County, Texas, Edinburg, Texas
- B. Description of Work: Construction of a Sanitary Sewer Lift Station and Receiving Manhole.
 - 1. Under this Contract, CONTRACTOR shall furnish all materials, appliances, tools, equipment, transportation, services, and all labor and superintendence for the construction of the work as described in these TECHNICAL SPECIFICATIONS and as shown on the PLANS. The completed installation shall not lack any part which can be reasonably implied as necessary to its proper functioning or any subsidiary item which is customarily furnished, and CONTRACTOR shall deliver the installation to OWNER in operating condition.
 - 2. Work, in general, under this Contract consists of furnishing, installing and constructing a new lift station, a new receiving manhole, extending a 18" sanitary sewer line, and a 10" force main including all related appurtenances, as indicated on the PLANS. Major items of construction and services required are designed as follows:
 - a. Install a new lift station with two 30 HP submersible, non-clog pumps in a 8 feet diameter fiberglass wet well with a 10 inch discharge forcemain.
 - 3. Clean up project area upon completion including repair of staging area and other areas damaged as a result of the CONTRACTOR's activities.
 - 4. Sequence of Work: OWNER reserves the right to schedule sequence of construction; that is, which portion of the project will be constructed first. The contractor may perform construction operations during daylight hours only, unless written approval is given by the ENGINEER and the OWNER. All existing utilities to remain operational during all construction activities.
 - a. Demolition of existing lift station:
 - 1. Existing lift station to be in operation simultaneously with new lift station before it is taken out of service. Provide bypass pumping as required to maintain all sewer lines in service.
 - 2. Contractor to provide a construction sequence to ensure sanitary sewer flows do not overflow.
 - 5. Attend monthly progress meetings of project.
 - 6. Plans: Table of Contents listed below.

01000 - Page 1 of 2

1.03 CONTRACTOR RESPONSIBILITIES

- A. Under this Contract, CONTRACTOR shall furnish all materials, appliances, tools, equipment, transportation, services, and all labor and superintendence for the construction of the work as described in these TECHNICAL SPECIFICATIONS and as shown on the PLANS. The completed installation shall not lack any part which can be reasonably implied as necessary to its proper functioning or any subsidiary item which is customarily furnished, and CONTRACTOR shall deliver the installation to OWNER in operating condition.
- B. Contractor shall make provisions to host a monthly meeting at the site for the duration of the project.

1.04 PAYMENT – (Not Used)

END OF SECTION

01000 - Page 2 of 2

1.00 PART 1 - GENERAL

1.01 SPECIFICATION TERMINOLOGY

- A. "Certified" used in context with materials and equipment means the material and equipment has been tested and found by a nationally recognized testing laboratory to meet specification requirements, or nationally recognized standards if requirements are not specified, and is safe for use in the specified manner. A nationally recognized testing laboratory must periodically inspect production of the equipment and the equipment must bear a label, tag, or other record of certification.
- B. "Certified" used in context with labor performance or ability to install materials and equipment means that the abilities of the proposed installer have been tested by an representative of the specified testing agency authorized to issue certificates of competency and has met the prescribed standards for certification.
- C. "Certified" used in context with test reports, payment requests or other statements of fact means that the statements made on the document are a true statement as attested to by the certifying entity.
- D. "Engineer" refers to the Consulting Engineering Firm under contract with the City of Edinburg for this particular project, or its designated representative.
- E. "Furnish" means to supply, deliver and unload materials and equipment at the project site ready to install.
- F. "Indicated" means graphic representations, notes, or schedules on drawings, or other requirements in Contract Documents. Words such as "shown", "noted", "scheduled", are used to help locate the reference. No limitation on the location is intended unless specifically noted.
- G. "Install" means the operations at the project site including unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, training and similar operations required to prepare the materials and equipment for use, verify conformance with Contract Documents and prepare for acceptance and operation by the Owner.
- H. "Installer" means an entity engaged by Contractor, either as an employee, subcontractor, or sub-subcontractor to install materials and/or equipment. Installers are to have successfully completed a minimum of five projects similar in size and scope to this project, have a minimum of five years of experience in the installation of similar materials and equipment, and comply with the requirements of the authority having jurisdiction.
- I. "Labeled" means equipment that embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc. and production is periodically inspected in accordance with nationally recognized standards or tests to determine safe use in a specified manner.
- J. "Listed" means equipment is included in a list published by a nationally recognized laboratory which makes periodic inspection of production of such equipment and states that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
- K. "Manufacturer" means an entity engaged by Contractor, as a subcontractor, or subsubcontractor to furnish materials and/or equipment. Manufacturers are to have a minimum of

five years experience in the manufacture of materials and equipment similar in size, capacity and scope to the specified materials and equipment.

- L. "Perform" means to complete the operations necessary to comply with the Contract Documents.
- M. "Owner" means City of Edinburg.
- N. "Project site" means the space available to perform the work, either exclusively or in conjunction with others performing construction at the project site.
- O. "Provide" means to furnish and install materials and equipment.
- P. "Regulation" means laws, statutes, ordinances, and lawful orders issued by authorities having jurisdiction, as well as, rules, conventions, and agreements within the construction industry that control performance of work, whether they are lawfully imposed by authorities having jurisdiction or not.
- Q. "Specified" means written representations in the bid documents or the technical specifications.

1.02 SPECIFICATION SENTENCE STRUCTURE

- A. Specifications are written in modified brief style. Requirements apply to all work of the same kind, class, and type even though the word "all" is not stated.
- B. Simple imperative sentence structure is used which places a verb as the first word in the sentence. It is understood that the words "furnish", "install", "provide", or similar words include the meaning of the phrase "The Contractor shall." before these words.
- C. It is understood that the words "directed", "designated", "requested", "authorized", "approved", "selected", or similar words include the meaning of the phrase "by the Engineer" after these words unless otherwise stated. Use of these words does not extend the Engineer's responsibility for construction supervision or responsibilities beyond those defined in the General Conditions.
- D. "At no additional cost to Owner", "With no extra compensation to Contractor", "At Contractor's own expense", or similar words mean that the Contractor will perform or provide specified operation of work without any increase in the Contract Amount. It is understood that the cost for performing all work is included in the amount bid and will be performed at no additional cost to the Owner unless specifically stated otherwise.

1.03 DOCUMENT ORGANIZATION

- A. Organization of Contract Documents is not intended to control or to lessen the responsibility of the Contractor when dividing work among subcontractors, or to establish the extent of work to be performed by any trade, subcontractor or vendor. Specification or details do not need to be indicated or specified in each specification or drawing. Items shown in the contract documents are applicable regardless of location in the Contract Documents.
- B. Standard paragraph titles and other identifications of subject matter in the specifications are intended to aid in locating and recognizing various requirements of the specifications. Titles do not define, limit, or otherwise restrict specification text.

- C. Capitalizing words in the text does not mean that these words convey special or unique meanings or have precedence over other parts of the Contract Documents. Specification text governs over titling and it is understood that the specification is to be interpreted as a whole.
- D. Drawings and specifications do not indicate or describe all of the work required to complete the project. Additional details required for the correct installation of selected products are to be provided by the Contractor and coordinated with the Engineer. Provide any work, materials or equipment required for a complete and functional system even if they are not detailed or specified.

1.04 INTERPRETATIONS OF DOCUMENTS

- A. Comply with the most stringent requirements where compliance with two (2) or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, unless Contract Documents indicate otherwise.
 - 1. Quantity or quality level shown or indicated shall be minimum to be provided or performed in every instance.
 - 2. Actual installation may comply exactly with minimum quality indicated, or it may exceed that minimum within reasonable limits.
 - 3. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for context of requirements.
 - 4. Refer instances of uncertainty to the Engineer for a decision before proceeding.
- B. Provide materials and equipment comparable in quality to similar materials and equipment incorporated in the project or as required to meet the minimum requirements of the application if the materials and equipment are shown in the drawings but are not included in the specifications.

1.05 REFERENCE STANDARDS

- A. Comply with applicable construction industry standards as if bound or copied directly into the Contract Documents regardless of lack of reference in the Contract Documents. Apply provisions of the Contract Documents where Contract Documents include more stringent requirements than the referenced standards.
 - 1. Standards referenced directly in the Contract Documents take precedence over standards that are not referenced but recognized in the construction industry as applicable.
 - Comply with standards not referenced but recognized in the construction industry as applicable for performance of the work except as otherwise limited by the Contract Documents. The Engineer determines whether code or standard is applicable, or which of several are applicable.
- B. Consider a referenced standard to be the latest edition with supplements or amendments when a standard is referred to in an individual specification section but is not listed by title and date.
- C. Trade association names and title of general standards are frequently abbreviated. Acronyms or abbreviations used in the Contract Documents mean the recognized name of trade association, standards generating organization, authority having jurisdiction, or other entity applicable in the context of the Contract Documents. Refer to "Encyclopedia of Associations," published by Gale Research Company.

D. Make copies of reference standards available as requested by Engineer or Owner.

1.06 SUBSTITUTIONS AND EQUAL PRODUCTS

Provide materials and equipment manufactured by the entities specifically listed in each technical specification section. Submit a Contractor's Modification Request per Section 01300, SUBMITTALS for substitution of materials and equipment of manufacturers not specifically listed or for materials and equipment that does not strictly comply with the Contract Documents.

Contractor may provide "equal" products manufactured by manufacturers other than those specifically listed in the technical specification section unless it is specifically stated that only the materials and equipment of the specified manufacturers shall be provided. Provide a request for approval of proposed equals per Section 01300 SUBMITTALS for any materials or equipment not specifically listed. Submit a Contractor's Modification Request for substitution of materials and equipment of other manufacturers or for materials and equipment that does not strictly comply with the Contract Documents. A Field Order or Change Order will be issued if the contract modification is approved.

END OF SECTION

SECTION 01030 – SPECIAL PROCEDURES

1.00 PART 1 - GENERAL

- A. Consider the sequences, duration limitations, and governing factors outlined in this Section to prepare the schedule for the work.
- B. Perform the work not specifically described in this Section as required to complete the entire project within the contract time.

1.01 SHUT DOWNS AND PLANS OF ACTION

- A. Shut-downs of operations or equipment must be planned and scheduled.
 - 1. Submit a written plan of action for approval for shutting down essential services. These include:
 - a. Water or Wastewater service
 - b. Electrical power
 - c. Control power
 - d. Process piping
 - e. Treatment equipment
 - f. Communications equipment
 - g. Other designated functions
 - 2. Describe the following in the Plan of Action:
 - a. Construction necessary
 - b. Utilities, piping, or services affected
 - c. Length of time the service or utility will be disturbed
 - d. Procedures to be used to carry out the work
 - e. Plan of Action to handle emergencies
 - f. Contingency plan that will be used if the original schedule cannot be met
 - 3. Plan must be received by the Owner and the City two (2) weeks **prior** to beginning the work.
- B. The Owner has identified "Critical Operations" that must not be out of service longer than the designated maximum out of service time and/or must be performed only during the designated times.
 - 1. Work affecting "Critical Operations" is to be performed on a 24-hour a day basis until operations have been restored.
 - 2. Provide additional work force and equipment as required to complete the work affecting "Critical Operations" within the allotted time.
 - 3. Include the cost for work affecting "Critical Operations" in the contract proposal.

END OF SECTION 01030

SECTION 01030 – SPECIAL PROCEDURES

THIS SHEET INTENTIONALLY LEFT BLANK

01030 – Page 2 of 2

1.00 PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Coordination.
- B. Preconstruction Conference.
- C. Site Mobilization Conference.
- D. Progress Meetings.

1.03 COORDINATION

- A. The General Contractor shall have primary responsibility to coordinate and schedule the Work. However, the contractor shall be responsible for adhering to the schedule and coordinating submittals and installation of the Work of the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements. Accordingly, each Contractor shall, as applicable, perform the following tasks.
- 1. Verify that all utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- 2. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion and for portions of Work designated for Owner's occupancy.
- After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.04 PRECONSTRUCTION CONFERENCE

- A. Owner, City, and Engineer will schedule a preconstruction conference after Notice of Award.
- B. Attendance Required Owner, City, Engineer, and Contractor.
- C. Agenda:
 - 1. Execution of Owner-Contractor Agreement.
 - 2. Submission of executed bonds and insurance certificates.
 - 3. Distribution of Contract Documents.
 - 4. Submission of list of Subcontractors, list of products, unit prices and construction work schedule in accordance with the General Conditions of the Contract, Sections 01300 and Section 01310.
 - 5. Designation of personnel representing the parties in Contract and the Engineer.
 - 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.
 - 7. Scheduling.

1.05 SITE MOBILIZATION CONFERENCE

A. Engineer, City, and Owner will schedule a conference at the Project site prior to Contractor occupancy. Attendance Required - Owner, City, Engineer, Special Consultants, and Contractor, Contractor's Superintendent, and major Subcontractors. Agenda:

SECTION 01039 – COORDINATION AND MEETINGS

- 1. Use of premises by Owner, City and Contractor.
- 2. Owner's and City's requirements and partial occupancy.
- 3. Construction facilities and controls provided by the City.
- 4. Temporary utilities provided by Owner and/or City, if any, not by Contractor.
- 5. Survey layout.
- 6. Security and housekeeping procedures.
- 7. Schedules and sequence for construction and wastewater flow management.
- 8. Procedures for testing.
- 9. Procedures for maintaining Record Documents.

1.06 PROGRESS MEETINGS

- A. The Owner will schedule and administer meetings throughout progress of the Work.
- B. The Owner will make arrangements for meetings, preside at meetings, record minutes, and distribute copies to Owner, Contractor, participants, and those affected by decisions made.
- C. Attendance Required Job superintendent, major Subcontractors and suppliers, Owner, City, and Engineer, as appropriate to agenda topics for each meeting.
- D. Agenda:
- 1. Review minutes of previous meetings.
- 2. Review of Work progress.
- 3. Field observations, problems, and decisions.
- 4. Identification of problems which impede planned progress.
- 5. Review of submittals schedule and status of submittals.
- 6. Review of off-site fabrication and delivery schedules.
- 7. Maintenance of progress schedule.
- 8. Corrective measures to regain lost progress.
- 9. Planned progress during succeeding work period.
- 10. Coordination of projected progress.
- 11. Maintenance of quality and work standards.
- 12. Effect of proposed changes on progress schedule and coordination.
- 13. Other business relating to Work.

2.00 PART 2 – PRODUCTS [NOT USED]

3.00 PART 3 – EXECUTION [NOT USED]

END OF SECTION 01039 – Page 2 of 2

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Submit documentation as required by the Contract Documents and as reasonably requested by the Owner and Engineer to:
 - 1. Record the products incorporated into the Project for the Owner.
 - 2. Provide information for operation and maintenance of the Project.
 - 3. Provide information for the administration of the Contract.
 - 4. Allow the Engineer to advise the Owner if products proposed for the project by the Contractor conform, in general, with the design concepts of the Contract Documents.
- B. Contractor's responsibility for full compliance with the Contract Documents is not relieved by the Engineer's review of submittals. Contract modifications may only be approved by Change Order or Field Order.

1.02 CONTRACTOR'S RESPONSIBILITIES

- A. Review all submittals prior to submission.
- B. Determine and verify:
 - 1. Field measurements.
 - 2. Field construction requirements.
 - 3. Location of all existing structures, utilities and equipment related to the submittals.
 - 4. Submittals are complete for their intended purpose.
 - 5. Conflicts between the submittals related to the various subcontractors and suppliers have been resolved.
 - 6. Quantities and dimensions shown on the submittals.
- C. Submit information per the procedures described in this section and the detailed specifications.
- D. Furnish the following submittals:
 - 1. As specified in the attached Submittal Schedule.
 - 2. Schedules, data and other documentation as described in detail in this section or referenced in the General Conditions.
 - 3. Submittals as required in the detailed specifications.
 - 4. Submittals not required will be returned without Engineer's review.

- E. Submit a schedule indicating the date submittals will be sent to the Engineer and proposed dates that the product will be incorporated into the project. Make submittals promptly in accordance with the schedule so as to cause no delay in the project.
 - 1. Submittals shall be sent to Engineer allowing a reasonable time for delivery, review and marking submittals. Time for review is to include time for resubmission if necessary and to allow adequate time for the ordering, fabrication, and delivery of the product.
 - 2. Schedule submittal to provide all information for interrelated work at one time. No review will be performed on submittals requiring coordination with other submittals. Engineer will return submittals for resubmission as a complete package.
- F. Installation of any products prior to the approval of shop drawings is done at the Contractor's risk. Products not meeting the requirements of Contract Documents are defective and may be rejected at the Owner's option.
- G. Payment will not be made for products for which submittals are required until the submittals have been received. Payment will not be made for products for which shop drawings or samples are required until these are approved by the Engineer.

1.03 QUALITY ASSURANCE

- A. Submit legible, accurate, complete documents presented in a clear, easily understood manner. Submittals not meeting this criteria will be returned without review.
- B. Demonstrate that the proposed products are in full and complete compliance with the design criteria and requirements of the Contract Documents including drawings and specifications as modified by Addenda, Field Orders, and Change Orders.
- C. Furnish and install products that fully comply with the information included in the submittal.
- D. Review and approve submittals prior to submitting them to the Engineer for review. Submittals will not be accepted from subcontractors, suppliers, or anyone other than the Contractor.

1.04 SUBMITTAL PROCEDURES

- A. Deliver submittals to the Engineer.
- B. Assign a number to the documents originated to allow tracking of the submittal during the review process.
 - 1. Assign a number consisting of a prefix, a sequence number, and a letter suffix. Prefixes shall be as follows:

Prefix	Description	Originator
со	Change Order	Contractor
CTR	Certified Test Report	Contractor
EIR	Equipment Installation Report	Contractor

FO	Field Order	Engineer
NBC	Notification by Contractor	Contractor
O&M	Operation & Maintenance Manuals	Contractor
РСМ	Proposed Contract Modification	Engineer
PR	Payment Request	Contractor
PP	Project Photographs	Contractor
RD	Record Data	Contractor
RFI	Request for Information	Contractor
SAM	Sample	Contractor
SD	Shop Drawing	Contractor
SCH	Schedule of Progress	Contractor

- 2. Issue sequence numbers in chronological order for each type of submittal.
- 3. Issue numbers for re-submittals that have the same number as the original submittal followed by an alphabetical suffix indicating the number of times the same submittal has been sent to the Engineer for processing. For example: SD-025-A represents a shop drawing that is the twenty-fifth submittal of this type and is the second time this submittal has been sent for review.
- 4. Clearly note the submittal number on each page or sheet of the submittal.
- 5. Correct assignment of numbers is essential since different submittal types are processed in different ways.
- D. Submit documents with uniform markings and page sizes.
 - 1. Paper size shall allow for ease of reproduction.
 - a. Submit documents on 8-1/2" X 11" paper where practical.
 - b. Use 11" X 17" paper for larger drawings and schematics.
 - c. Use full size blueline sheets for fabrications and layout drawings. Reproducible drawings may be submitted in lieu of bluelines.
 - 2. Mark submittals to:
 - a. Indicate Contractor's corrections in green.

- b. Highlight items pertinent to the products being furnished in yellow and delete items that are not when the Manufacturer's standard drawings or information sheets are provided.
- c. Cloud items and highlight in yellow where selections by the Engineer or Owner are required.
- d. Mark dimensions with the prefix FD to indicate field verified dimensions on the drawings.
- e. Provide a blank space 8" x 3" for Contractor's and Engineer's stamp.
- E. Mark submittals to reference the drawing number and/or section of the specifications, detail designation, schedule or location that corresponds with the data submitted. Other identification may also be required, such as layout drawings or schedules to allow the reviewer to determine where a particular product is to be used.
- F. The number of copies of each submittal to be sent by the Contractor and the number of copies of each submittal to be returned are:

Prefix	Description	No. of Copies Sent	No. of Copies Returned
со	Change Order	4	1
CTR	Certified Test Report	4	0
EIR	Equipment Installation Report	2	0
NBC	Notification by Contractor	2	1
O&M	Preliminary O&M Manuals	2	1
O&M	Final O&M Manuals	4	0
PR	Payment Request	4	1
PP	Project Photographs (including videotapes)	2	0
RD	Record Data	2	0
RFI	Request for Information	2	1
SAM	Sample	2	0
SD	Shop Drawings	4	1

SCH Schedule of Progress 4 0	SCH	Schedule of Progress	4	0
------------------------------	-----	----------------------	---	---

1.05 REVIEW PROCEDURES

A. Priority submittals will be reviewed before other submittals for this project which have been received but not reviewed.

1.06 REQUIREMENTS

- A. Certifications, Warranties and Service Agreements include documents as specified in the detailed specifications, as shown in the submittal schedule or as follows:
 - Certified Test Reports (CTR) A report prepared by an approved testing agency giving results of tests performed on products to indicate their compliance with the specifications. (Refer to Section 01400, QUALITY CONTROL.)
 - Certification of Local Field Service (CLS) A certified letter stating that field service is available from a factory or supplier approved service organization located within a 300 mile radius of the project site. List names, addresses, and telephone numbers of approved service organizations on or attach to the certificate.
 - 3. Extended Warranty (EW) A guarantee of performance for the product or system beyond the normal one (1) year warranty described in the General Conditions. Issue the warranty certificate in the name of the Project Owner.
 - 4. Extended Service Agreement (ESA) A contract to provide maintenance beyond that required to fulfill requirements for warranty repairs, or to perform routine maintenance for a definite period of time beyond the warranty period. Issue the service agreement in the name of the Project Owner.
 - 5. Certification of Adequacy of Design (CAD) A certified letter from the manufacturer of the equipment stating that they have designed the equipment to be structurally stable and to withstand all imposed loads without deformation, failure, or adverse effects to the performance and operational requirements of the unit. The letter shall state that mechanical and electrical equipment is adequately sized to be fully operational for the conditions specified or normally encountered by the product's intended use.
 - 6. Certification of Applicator/Subcontractor (CSQ) A certified letter stating that the Applicator or Subcontractor proposed to perform a specified function is duly designated as factory authorized and trained for the application of the specified product.
- B. Submit record data to provide information to allow the Owner to adequately identify the products incorporated into the project and allow replacement or repair at some future date.
 - 1. Provide record data for all products. Record data is not required for items for which shop drawings and/or operations and maintenance manuals are required.
 - 2. Provide information only on the specified products. Submit a Contractor's Modification Request for approval of deviations or substitutions and obtain approval by Field Order or Change Order prior to submitting Record Data.

- 3. Record data will be received by the Engineer, logged, and provided to Owner for his/her record.
 - a. Record data may be reviewed to see that the information provided is adequate for the purpose intended. Inadequate drawings may be returned as unacceptable.
 - b. Record data is not reviewed for compliance with the Contract Documents. Comments may be returned if deviations from the Contract Documents are noted during the cursory review performed to see that the information is adequate.

1.07 REQUESTS FOR DEVIATION

- A. Submit requests for deviation from the Contract Documents for any product that does not fully comply with the specifications.
- B. Submit request by Contractor's Modification Request (CMR). Identify the deviations and the reason the change is requested.
- C. Deviations that result in a reduction in cost shall also include the amount of the reduction to the Owner.
- D. A Change Order or Field Order will be issued by the Engineer for deviations approved by the Owner. Deviations from the Contract Documents may only be approved by Change Order or Field Order.

1.08 SUBMITTALS FOR SUBSTITUTIONS

- A. Substitutions are defined as any product that the Contractor proposes to provide for the Project in lieu of the specified product.
- B. If the Contractor desires to submit a manufacturer or product which is not specified, the Contractor must submit the following for consideration of approval of the substitution:
 - 1. Contractor's Modification Request for deviation from the Contract Documents per Paragraph 1.07.
 - 2. Prove that the product is acceptable as a substitute. It is not the Engineer's responsibility to prove the product is not acceptable as a substitute.
 - a. Indicate on a point by point basis for each specified feature that the product is acceptable to meet the intent of the Contract Documents requirements.
 - b. Make a direct comparison with the specified manufacturer's published data sheets and available information. Provide this printed material with the submittal.
 - c. The decision of the Engineer regarding the acceptability of the proposed substituted product is final.
 - 3. Provide a typewritten certification that, in making the substitution request, the Contractor:
 - a. Has determined that the substituted product will perform in substantially the same manner and result in the same ability to meet the specified performance as the specified product.

- b. Will provide the same warranties and/or bonds for the substituted product as specified or as would be provided by the Manufacturer of the specified product.
- c. Will assume all responsibility to coordinate any modifications that may be necessary to incorporate the substituted product into the project and will waive all claims for additional work which may be necessary to incorporate the substituted product into the project which may subsequently become apparent.
- d. Will maintain the same time schedule as for the specified product.
- C. Engineering cost for review of substitutions will be paid by the Contractor.
 - 1. Cost for additional review time will be billed to the Owner by the Engineer for the actual hours required for the review and marking of shop drawings by Engineer and in accordance with the following rates:

Principal-in-Charge	\$150.00
Project Manager	\$125.00 Design
Engineer	\$ 90.00 Engineering
Technician	\$ 75.00
Clerk	\$ 50.00

2. Cost for the additional review shall be paid to the Owner by the Contractor on a monthly basis.

1.09 GUARANTEES

- A. Warranties and guarantees shall be submitted as required by the Contract Documents and submitted with the shop drawings or record data.
- 1.10 RESUBMISSION REQUIREMENTS
 - A. Make all corrections or changes in the submittals required by the Engineer and resubmit until approved.
 - B. Need for more than one resubmission or any other delay of obtaining Engineer's review of submittals, will not entitle the Contractor to an extension of Contract Time. All costs associated with such delays shall be at the Contractor's expense.

1.11 ENGINEER'S DUTIES

- A. Review the submittals and return with reasonable promptness.
- B. Affix stamp, indicate approval, rejection, and the need for re-submittal.
- C. Distribute documents.

SUBMITTAL SCHEDULE

Smaa		6	c	6	<u>^</u>	Е	E	<u>^</u>	~	D	0	E	Р
Spec.		Э	3	C	C			C C	C	к	0		۳
No.	Description	D	Α	Т	L	W	S	Α	S	D	Μ		Ρ
	•		М	R	s		Α	D	Q			R	в
					1				_				

						-	-	-					
01568	Erosion and Sediment Control during Construction									x			
01600	Products							х				х	
01650	Starting Systems										х	x	
01700	Contract Closeout									х			
01730	Operations and Maintenance Manual										х		
02221	Excavating, Backfilling and Compacting for Utilities									х			
02300	Structural Earthwork									х			
02515	Wetwell and Manhole Structures									х			
02555	Water Lines									х			
02556	Force Mains									х			
02570	Sanitary Sewer									х			
02572	Combination Air Valves	Х								х	х		
02590	Polyurthane Protective Coating									х			
02831	Chain Link Fence and Gates									х			
03300	Cast in Place Concrete									х			
07900	Joint Sealers									х			
11005	Equipment: General Requirements	х								х			
11060	Pumping Equipment: General Requirements	x								x			
												Ē	
Spec. No.	Description	S D	S A M	C T R	C L S	E W	E S A	C A D	C S Q	R D	O M	E I R	P P B
11322	Submersible Lift Station									Х	Х	Х	
13443	Lift Station Controls	x		x						x	х	х	
15076	Tagging									х			
15100	Valves and Appurtenances									х	х		

SECTION 01300 – SUBMITTALS

16010	General Requirements	х				х		
16073	Hangers and Supports for Electrical Systems	x				х		
16100	Basic Electrical Materials and Methods					х		
16120	Conductors and Cables					х		
16130	Raceways and Boxes					х		
16140	Wiring Devices	х				х		
16401	Overhead Electrical Service	х				х		
16450	Grounding	х				х		
19000	Trench Protection					х		

- SD Shop Drawing
- SAM Sample
- CTR Certified Test Report
- CLS Certification of Local Field Service
- EW Extended Warranty
- ESA Extended Service Agreement
- PPB Process Performance Bond

- CAD Certificate of Adequacy of Design
- CSQ Certification of Applicator/ Subcontractor Qualifications
- RD Record Data
 - OM Operation and Maintenance Manuals
- EIR Equipment Installation Report

END OF SECTION

SECTION 01310 – PROGRESS SCHEDULES

1.00 PART 1 - GENERAL

1.01 REQUIREMENTS

- A. Prepare and submit a progress schedule for the work and update the schedule on a monthly basis for the duration of the project.
- B. Provide schedule in adequate detail to allow Owner to monitor the work progress, to anticipate the time and amount of progress payments, and to relate submittal processing to sequential activities of the work.
- C. Incorporate and specifically designate the dates of anticipated submission of submittals and the dates when submittals must be returned to the Contractor into the schedule.
- D. Assume complete responsibility for maintaining the progress of the work per the schedule submitted.
- E. Take into consideration when preparing schedule all requirements of Section 01030, SPECIAL PROCEDURES.

1.02 SCHEDULE REVISIONS

- A. Revise the schedule if it appears that the schedule no longer represents the actual progress of the work.
 - 1. Submit a written report if the schedule indicates that the project is more than thirty (30) days behind schedule. The report is to include: a. Number of days behind schedule
 - b. Narrative description of the steps to be taken to bring the project back on schedule
 - c. Anticipated time required to bring the project back on schedule
 - 2. Submit a revised schedule indicating the action that the Contractor proposes to take to bring the project back on schedule.
- B. Revise the schedule to indicate any adjustments in contract time approved by change order.
 - 1. Revised schedule is to be included with Contract Modification Request and in response to Proposed Contract Modifications by the Owner and Engineer for which an extension of time is requested.
 - 2. Failure to submit a revised schedule indicates that the modification shall have no impact on the ability of the Contractor to complete the project on time and that the cost associated with the change of additional plant or work force have been included in the cost proposed for the modification.
- C. Updating the project schedule to reflect actual progress is not considered a revision to the project schedule.
- D. Payment estimates may not be recommended for payment without a revised schedule and if required, the report indicating the Contractor's plan for bringing the project back on schedule.

END OF SECTION 01310 - Page 1 of 2

SECTION 01310 – PROGRESS SCHEDULES

THIS SHEET INTENTIONALLY LEFT BLANK 01310 – Page 2 of 2

1.00 PART 1 - GENERAL

1.01 SUMMARY

A. General:

- 1. Section Addresses:
 - a. Mechanics and administration of the submittal process for shop drawings, product data, samples and operation and maintenance manuals.
- 2. Related Sections include but are not necessarily limited to:
 - a. Division 1 General Requirements.
 - b. Division 11 Equipment.
 - c. Division 13 Special Construction.
 - d. Division 15 Mechanical.
 - e. Division 16 Electrical.

1.02 DEFINITIONS

- A. Shop Drawings:
 - 1. See General Provisions.
 - 2. Product data and samples are Shop Drawing information.
- B. Miscellaneous Submittals:
 - 1. Submittals other than Shop Drawings:
 - 2. Representative types of miscellaneous submittal items include but are not limited to:
 - a) Construction schedule.
 - b) Concrete, soil compaction, and pressure test reports.
 - c) Installed equipment and systems performance test reports.
 - d) Manufacturer's installation certification letters.
 - e) Instrumentation and control commissioning reports.
 - f) Warranties.
 - g) Service agreements.
 - h) Survey data.
 - i) Cost breakdown (Schedule of Values).

1.03 TRANSMITTALS

- A. Shop Drawings, Operation and Maintenance Manuals, Manufacturers and Installers Quality Control and Quality Assurance documentation:
 - 1. Transmit 4 copies of all submittals to:

Attn: Luis Nava, P.E. Phone: (956) 329-5404 Fax: (361) 826-5806

- 2. Utilize a copy of attached Exhibit "A" to transmit all shop drawings, product data and samples.
- 3. Utilize a copy of attached Exhibit "B" to transmit all Operation and Maintenance Manuals.
- 4. All transmittals must be from Contractor and bear his approval stamp. Transmittals will not be received from or returned to subcontractors.
- 5. Shop drawing transmittal stamp shall read "(Contractor's Name) represents that we have determined and verified all field dimensions and measurements, field

construction criteria, materials, catalog numbers, and similar data, and that we have verified the requirements of the work and the Contract Documents."

- 6. Operation and Maintenance Manual transmittal stamp may be Contractor's standard approval stamp.
- 7. Provide submittal information defining specific equipment or materials utilized on the project. Generalized product information not clearly defining specific equipment or materials to be provided will be rejected.
- 8. Calculations required in individual specification sections are required as For Information Only-For-Future-Use submittals. Calculations and other submittals identified as For-Information-Only-For Future-Use submittals shall be transmitted directly to the Engineer.
- B. Submittal schedule:
 - 1. Schedule of shop drawings:
 - a. Submitted and approved within 20 days of receipt of Notice to Proceed.
 - 2. Operation and Maintenance Manuals and Equipment Record Sheets:
 - a. Initial submittal within 60 days after date shop drawings are approved.

1.04 PREPARATION OF SUBMITTALS

- A. Shop Drawings:
 - 1. Number transmittals consecutively beginning with 1.
 - 2. Number transmittals of resubmitted items with the original root number and a suffix letter starting with "A" on a new transmittal form.
 - 3. Restrict each letter of transmittal to only one Specification Section or portion thereof.
 - 4. Provide breakout of each transmittal contents on transmittal form. Each component thus defined will receive specific action by the Engineer. Define manufacturer, item, Contract Document tag number, and Contract Drawing/Specification reference.
 - 5. Do not change the scope of any resubmittal from the original transmittal scope. If some components of the original or previous resubmittal transmittal received "A" or "B" Action and others did not, list the "A" or "B" Action components in subsequent resubmittal packages and indicate "A" or "B" Action code previously received on the transmittal form.
 - 6. Action items are defined on page 01340-6, Section 1.05A.
 - 7. With prior approval of the Engineer, components of an original submittal or prior resubmittal that have not received an "A" or "B" Action may be withheld from a resubmittal. Such components shall be listed on the resubmittal transmittal form and indicated as "Outstanding To Be Resubmitted At a Later Date."
 - 8. For 8-1/2 x 11 IN size sheets, provide four copies of each page for Engineer plus the number required by the Contractor.
 - 9. The number of copies required by the Contractor will be defined at the Preconstruction Conference, but shall not exceed 10.
 - 10. For items not covered in paragraph 1.04-A.6 submit one reproducible transparency and one print of each drawing until approval is obtained. Utilize mailing tube; do not fold.
 - 11. The Engineer will mark and return the reproducible to the Contractor for his reproduction and distribution.
 - 12. Provide clear space (3 IN SQ) for Engineer stamping of each component defined in 1.04-A.4.
 - 13. Contractor shall not use red color for marks on transmittals.

SECTION 01340 - SHOP DRAWINGS, PRODUCT DATA & SAMPLES, O&M MANUALS

- 14. Duplicate all marks on all copies transmitted, and ensure marks are photocopy reproducible. Outline Contractor marks on reproducible transparencies with a rectangular box.
- 15. Transmittal contents:
 - a. Coordinate and identify shop drawing contents so that all items can be easily verified by the Engineer.
 - b. Identify equipment or material use, tag number, drawing detail reference, weight, and other project specific information.
 - c. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
 - Submit items like equipment brochures, cuts of fixtures, product data sheets or catalog sheets on 8-1/2 x 11 IN pages. Indicate exact item or model and all options proposed.
 - e. Include legible scale details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout drawings, parts catalogs, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data. Arrange data and performance information in format similar to that provided in Contract Documents. Provide, at minimum, the detail provided in the Contract Documents.
 - f. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet.
- B. Samples:
 - 1. Identification:
 - a. Identify sample referencing transmittal number, manufacturer, item, use, type, project designation, tag number, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.
 - b. If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
 - 2. Include application specific brochures, and installation instructions.
 - 3. Provide Contractor's stamp of approval on samples or transmittal form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
 - 4. Resubmit samples of rejected items.
- C. Operation and Maintenance Manuals:
 - 1. Number transmittals for Operation and Maintenance Manual with original root number of the approved shop drawing for the item.
 - 2. Submit one copy until approval is received.
 - 3. Identify resubmittals with the original number plus a suffix letter starting with "A."
 - 4. Submit Operation and Maintenance Manuals printed on 8-1/2 x 11 IN size heavy first quality paper with standard three-hole punching and bound in stiff metal hinged binder constructed as a three-ring style. Provide binders with titles on front and on spine of binder. Tab each section of manuals for easy reference with plastic-coated dividers. Provide index for each manual. Provide plastic sheet lifters prior to first page and following last page.
 - 5. Reduce drawings or diagrams bound in manuals to an 8-1/2 x 11 IN or 11 x 17 IN size. However, where reduction is not practical to ensure readability, fold larger

drawings separately and place in vinyl envelopes which are bound into the binder. Identify vinyl envelopes with drawing numbers.

- 6. Transmittal Content:
 - a. Submission of Operation and Maintenance Manuals is applicable but not necessarily limited to: 1) Major equipment. 2) Equipment used with electrical motor loads of 1/6 HP nameplate or greater. 3) Specialized equipment including valves and instrumentation and control system components for process systems.
 - b. Prepare Operation and Maintenance manuals to include, but not necessarily limited to, the following detailed information, as applicable:
 - a) Equipment function, normal operating characteristics, and limiting operations.
 - b) Assembly, disassembly, installation, alignment, adjustment, and checking instructions.
 - c) Operating instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
 - d) Lubrication and maintenance instructions.
 - e) Guide to "troubleshooting."
 - f) Parts list and predicted life of parts subject to wear.
 - g) Outline, cross-section, and assembly drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and

interconnection diagrams.

- h) Test data and performance curves.
- i) A list of recommended spare parts with a price list and a list of spare parts provided under these specifications.
- j) Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
- k) Instrumentation or tag numbers relating the equipment back to the Contract Documents.
- Include a filled-out copy of the Equipment Record Sheet, Exhibits C1 and C2 as the first page(s) of each Operation and Maintenance Manual. Complete maintenance requirements in detail. Simple reference to the Manual is not acceptable.
- For equipment items involving components or subunits, an Equipment Record Sheet for each operating component or subunit is required.
- D. Project Schedule:
 - 1. Contractor shall submit detailed project work schedule and have same approved by Engineer prior to commencing work activities.
 - 2. Schedule shall describe each work element with corresponding completion time.
- E. Manufacturer's Certificates:
 - 1. When specified in individual specification Sections, submit manufacturers' certificate to Engineer for review, in quantities specified for Product Data.
 - 2. Indicate material or product conforms to or exceeds specified requirements. Submit supporting references date, affidavits, and certifications as appropriate.
 - 3. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.

1.05 ENGINEER'S REVIEW ACTION

A. Shop Drawings and Samples:

- 1. Items within transmittals will be reviewed for overall design intent and will receive one of the following actions:
 - a. A FURNISH AS SUBMITTED.
 - b. B FURNISH AS NOTED (BY ENGINEER).
 - c. C REVISE AND RESUBMIT.
 - d. D REJECTED.
 - e. E ENGINEER'S REVIEW NOT REQUIRED.
- 2. Transmittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp. Drawings not stamped by the Contractor or stamped with a stamp containing language other than that specified in Paragraph 1.03.A.4.a. will not be reviewed for technical content and will be returned without any action.
- 3. Transmittals returned with Action "A" or "B" are considered ready for fabrication and installation. If for any reason a transmittal that has an "A" or "B" Action is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal. Destroy or conspicuously mark "SUPERSEDED" all documents having previously received "A" or "B" Action that are superseded by a resubmittal.
- 4. Transmittals with Action "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected) will be individually analyzed giving consideration as follows:
 - a. The portion of the transmittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference). One copy or the one transparency of the "C" or "D" drawings will be marked up and returned to the Contractor. Correct and resubmit items so marked.
 - b. Items marked "A" or "B" will be fully distributed.
 - c. If a portion of the items or system proposed are acceptable, however, the major part of the individual drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" Action. This is at the sole discretion of the Engineer. In this case, some drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package." Distribution to the Owner and field will not be made (unless previously agreed to otherwise).
- 5. Failure to include any specific information specified under the submittal paragraphs of the specifications will result in the transmittal being returned to the Contractor with "C" or "D" Action.
- 6. In addition to calculations stamped and returned "E -Engineer's Review Not Required," other transmittals such as submittals which the Engineer considers as "Not Required," submittal information which is supplemental to but not essential to prior submitted information, or items of information in a transmittal which have been reviewed and received "A" or "B" Action in a prior transmittal, will be returned with Action "E. Engineer's Review Not Required."
- 7. Samples may be retained for comparison purposes. Remove samples when directed. Include in bid all costs of furnishing and removing samples.
- 8. Approved samples submitted or constructed, constitute criteria for judging completed work. Finished work or items not equal to samples will be rejected.
- B. Operation and Maintenance Manuals:
 - 1. Engineer will review and indicate one of the following review actions:
 - a. ACCEPTABLE.
 - b. FURNISH AS NOTED.
 - c. REVISE AND RESUBMIT.
 - d. REJECTED.
 - 2. Acceptable submittals will be retained with the transmittal form returned with a request for {four} additional copies.

SECTION 01340 - SHOP DRAWINGS, PRODUCT DATA & SAMPLES, O&M MANUALS

3. Deficient submittals will be returned along with the transmittal form which will be marked to indicate deficient areas.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 CONTRACTOR'S RESPONSIBILITIES

- A. Control the quality of work produced and verify that the work performed meets the standards of quality established in the Contract Documents.
 - 1. Inspect the work performed by the Contractor, subcontractors and suppliers. Correct defective work.
 - 2. Inspect products to be incorporated into the project. Provide only those products that comply with the Contract Documents.
 - 3. Verify conformance of the work and products with the Contract Documents before notifying the Owner of need for testing.
 - 4. Provide consumable construction materials of adequate quality to provide a finished product that complies with the Contract Documents.
 - 5. Provide and pay for the services of an approved professional materials testing laboratory to insure that products proposed for use fully comply with the Contract Documents.
 - 6. Perform tests as indicated in this and other sections of the specifications. Schedule the time and sequence of testing with the Owner and Engineer. Testing is to be observed by the Owner, Engineer, or designated representative.
 - 7. Provide labor, materials, tools, equipment, and related items for testing by the Owner and/or the City of Edinburg including, but not limited to temporary construction required for testing and operation of new and existing utilities.
- B. Provide Certified Test Reports on products or constructed works to be incorporated into the project as required by Section 01300, SUBMITTALS. Reports are to indicate that products or constructed works are in compliance with the Contract Documents.
- C. Assist the Engineer, the City of Edinburg, Owner, and Owner's testing organization to perform quality assurance activities.
 - 1. Provide access to the work and to the Manufacturer's operations at all times work is in progress.
 - 2. Cooperate fully in the performance of sampling, inspection, and testing.
 - 3. Furnish labor and facilities to:
 - a. Provide access to the work to be tested.
 - b. Obtain and handle samples for testing at the project site or at the source of the product to be tested.
 - c. Facilitate inspections and tests.
 - d. Store and cure test samples.
 - 4. Furnish copies of the tests performed on products.
 - 5. Provide adequate quantities of representative product to be tested to the laboratory at the designated location.

- 6. Give the Owner adequate notice before proceeding with work that would interfere with testing.
- 7. Notify the Owner and the testing laboratory prior to the time that testing is required. Leadtime is to be adequate to allow arrangements to be made for testing.
- 8. Do not proceed with any work until testing services have been performed and results of tests indicate that the work is acceptable.
- 9. Provide complete access to the site and make Contract Documents available.
- 10. Provide personnel and equipment needed to perform sampling or to assist in making the field tests.
- 11. Testing performed by the Owner will be paid for by the Owner.

1.02 QUALITY ASSURANCE ACTIVITIES BY THE OWNER

- A. Quality assurance activities of the Owner and Engineer through their own forces or through contracts with materials testing laboratories and survey crews are for the purpose of monitoring the results of the Contractor's work to see that it is in compliance with the requirements of the Contract Documents.
 - Quality assurance activities of the Owner and Engineer in no way relieves the Contractor of the obligation to perform work and furnish products and constructed work conforming to the Contract Documents.
 - 2. Failure on the part of the Owner or Engineer to perform or test products or constructed works in no way relieves the Contractor of the obligation to perform work and furnish materials conforming to the Contract Documents.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01300, SUBMITTALS, and shall include:
 - 1. The name of the proposed testing laboratory along with documentation of qualifications, a list of tests that can be performed, and a list of recent projects for which testing has been performed with references from those projects.
 - 2. Test reports per Paragraph 1.07, TEST REPORTS of this specification.

1.04 STANDARDS

- A. Provide a testing laboratory that complies with the ACIL (American Council of Independent Laboratories) "Recommended Requirements for Independent Laboratory Qualifications".
- B. Perform testing per recognized test procedures as listed in the various sections of the specifications, standards of the State Department of Highways and Public Transportation, American Society of Testing Materials (ASTM), or other testing associations. Perform tests in accordance with published procedures for testing issued by these organizations.

1.05 DELIVERY AND STORAGE

A. Handle and protect test specimens of products and construction materials at the construction site in accordance with recognized test procedures.

1.06 VERIFICATION TESTING

- A. Provide verification testing when tests performed by the Owner indicate that materials or the results of construction activities are not in conformance with Contract Documents.
- B. Verification testing is to be provided at the Contractor's expense to verify products or constructed works are in compliance after corrections have been made.
- C. Tests must comply with recognized methods or with methods recommended by the Owner's testing laboratory and approved by the Engineer.

1.07 TEST REPORTS

- A. Test reports are to be prepared for all tests.
 - 1. Tests performed by testing laboratories may be submitted on their standard test report forms. These reports must include the following:
 - a. Name of the Owner, project title and number, equipment installer and general contractor.
 - b. Name of the laboratory, address, and telephone number.
 - c. Name and signature of the laboratory personnel performing the test.
 - d. Description of the product being sampled or tested.
 - e. Date and time of sampling, inspection, and testing.
 - f. Date the report was issued.
 - g. Description of the test performed.
 - h. Weather conditions and temperature at time of test or sampling.
 - i. Location at the site or structure where the test was taken.
 - j. Standard or test procedure used in making the test.
 - k. A description of the results of the test.
 - I. Statement of compliance or non-compliance with the Contract Documents.
 - m. Interpretations of test results, if appropriate.
 - 2. Submit reports on tests performed by Contractor or his suppliers or vendors.
- B Distribute copies of the test reports to: No. Of Copies
 Owner 2
 Engineer 2

1.08 NON-CONFORMING WORK

- A. Immediately correct any work that is not in compliance with the Contract Documents or submit a written explanation of why the work is not to be corrected immediately and when the corrective work will be performed.
- B. Payment for non-conforming work shall be withheld until work is brought into compliance with the Contract Documents.
- 1.09 LIMITATION OF AUTHORITY OF THE TESTING LABORATORY

- A. The testing laboratory representatives are limited to providing consultation on the test performed and in an advisory capacity.
- B. The testing laboratory is not authorized to:
 - 1. Alter the requirements of the contract documents.
 - 2. Accept or reject any portion of the work.
 - 3. Perform any of the duties of the Contractor.
 - 4. Stop the work.

2.00 PART 2 - PRODUCTS

2.01 TESTING APPARATUS

A. Furnish testing apparatus and related accessories necessary to perform the tests.

3.00 PART 3 - EXECUTION

- 3.01 PROTECTIVE COATINGS [NOT USED]
- 3.02 LEAKAGE TESTS FOR STRUCTURES
 - A. Test structures that will contain water on a full time or intermittent basis for leaks. Perform tests prior to installing equipment or materials within the basins. In the event that the basins fail to pass the test, drain the basin, repair the leaks, re-fill, and re-test the basin. Repeat tests until the basin passes the test. The Owner may repeat the test at any time during the one (1) year guarantee period.
 - B. Test the basin for leakage using the following procedure:
 - 1. Determine the evaporation allowance for loss of water.
 - a. Use a standard circular pan procedure established by the U.S. Weather Bureau to measure evaporation rate.
 - b. Calculate evaporation allowance by multiplying the evaporation rate in gallons per 24 hours per square foot of surface are by the open surface area of the water in the basin.
 - 2. Calculate the allowable leakage for the basin. Allowable leakage is calculated as 0.03 gallons per square foot of concrete area in contact with the water per 24 hours.
 - 3. Fill the basin to the overflow level with water at a rate not to exceed 2' per hour.
 - 4. Allow the basins to set for three (3) days.
 - 5. Observe the perimeter of the basins and identify all leaks.
 - 6. Repair basin walls and floors where leaks have been identified.

- 7. Mark the water level at the basin wall. Measure the fall in water level over a 24-hour period to the nearest 1/8" at least twice a day to determine the quantity of water lost. Provide a stilling well for measurement if required to allow accurate measurement.
- 8. Calculate the amount of water lost during this time period.
- 9. Compare the amount of water lost to the allowable loss.
- C. Drain the basin, determine the sources of leakage and repair if the amount of water lost exceeds the allowable leakage plus the evaporation allowance.

3.03 PIPING SYSTEMS

A. TEST REQUIREMENTS

- 1. Perform test on piping systems including piping installed between or connected to existing pipe.
- 2. Conduct tests on buried pipe to be hydrostatically tested after the trench is completely backfilled. If field conditions permit and if approved by the Engineer, partially backfill the trench and leave the joints open for inspection and conducting of the initial service leak test. Do not conduct the acceptance test until backfilling is complete.
- 3. Pneumatically test the buried piping and expose joints of the buried piping for the acceptance test.
- 4. Conduct the test on exposed piping after the piping is completely installed, including supports, hangers, and anchors, but prior to insulation.
- 5. Do not perform testing on pipe with concrete thrust blocking until the concrete has cured at least five (5) days.
- 6. Determine and remedy the cause of the excessive leakage for any pipe failing to meet the specified requirements for water or air tightness.
- 7. Tests must be successfully completed and reports filed before piping is accepted.
- 8. Submit the plan for testing to the Engineer for review at least 10 days before starting the test.
- 9. Remove and dispose of temporary blocking material and equipment after completion and acceptance of the piping test.
- 10. Repair any damage to the pipe coating.
- 11. Clean pipelines so they are totally free flowing prior to final acceptance.
- 12. Test piping independently from tests on structures.
- 13. Test method and test pressure depend upon the application of the piping.
 - a. Pressure pipe is defined as piping that is part of a pumped or pressurized system. Perform test for pressure pipe per the procedures indicated in Paragraph B of this section.

- b. Gravity pipe is defined as piping that depends upon the force of gravity for flow through the pipe, with the exception of process piping described in paragraph d. Perform test for gravity pipe per the procedures indicated in Paragraph C, D, or E of this section.
- c. Chemical processing lines are to be tested as pressure pipe regardless of the operating conditions. The test pressure is to be 1.5 times the pressure rating of the pipe.
- d. Process piping between hydraulic structures is to be considered as pressure pipe. Perform the test for this pipe per Paragraph B of this section. The test pressure is to be the maximum hydrostatic head plus 10'. The maximum hydrostatic head is the difference in elevation of the pipe at it lowest point and the maximum top of the wall elevation of the hydraulic structure on the piping system.
- B. PRESSURE AND LEAKAGE TESTS OF PRESSURE PIPING
 - 1. See Specification -02556 Water Transmission Lines and/or Pressure Sewer Lines.
- C. HYDROSTATIC LEAK TEST
 - 1. Perform hydrostatic leak tests after backfilling.
 - 2. The length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2' or 2' above the ground water level whichever is higher and the head over the downstream crown is not more than 6'.
 - 3. Plug the pipe by pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.
 - 4. Continue the test for one (1) hour and make provisions for measuring the amount of water required to maintain the water at a constant level during this period.
 - 5. Remove the jointing material, and remake the joint if any joint shows any visible leakage or infiltration.
 - 6. Remove and replace any defective or broken pipes.
 - 7. Determine the maximum allowable leakage or infiltration by the following formula. L = \underline{C} <u>DS</u> 126,720

Where L = the allowable leakage in gallons per hour; S is the length of pipe tested in feet; D is the nominal diameter of the pipe in inches; C is infiltration/exfiltration rate. Use 50 for C outside of 25 year floodplain, and 10 for C within 25 year floodplain.

- 8. Determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and locations are subject to the Engineer's approval.
- 9. Pipe with visible leaks or infiltration or exceeds the maximum allowable leakage or infiltration is considered defective and must be corrected.

D. LOW PRESSURE AIR TEST

- 1. Use air test in lieu of the hydrostatic test if desired, or if pipeline grades do not allow filling the entire pipeline segment or manhole to the indicated depth.
- 2. Perform low-pressure air tests, using equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. Test is to conform to
procedure described in ASTM C-828, ASTM C-924 except for testing times. The following test times are required:

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Long Length (seconds)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

- a. Provide the equipment with an air regulator valve or air safety valve set to an internal air pressure in the pipeline that cannot exceed 6 psig.
- b. Pass air through a single control panel.
- c. Provide pneumatic plugs that have a sealing length equal to or greater than the circumference of the pipe to be tested.
- d. Provide pneumatic plugs that resist internal test pressures without requiring external bracing or blocking.
- e. Provide an air compressor of adequate capacity for charging the system.
- 3. Perform air test only on lines less than 36" diameter. Air tests for pipes larger than 36" may be air tested at each joint.
- 4. Check connections for leakage with a soap solution. If leaks are found, release the air pressure, repair the leak, and retest with soap solution until results are satisfactory, before resuming air test.
- 5. Determine the maximum allowable time for the pressure to drop from 3.5 pounds per square inch to 2.5 pounds per square inch.

T = 0.0850 DK/Q

T is the time for the pressure to drop 1.0 pound per square inch gauge in seconds; K is 0.000419DL, but not less than 1.0; D is the average inside diameter in inches; L is the

length of line of the same pipe size in feet; Q rate of loss, shall be 0.0015 cubic feet per minute per square foot of internal surface.

- E. AIR TEST FOR INDIVIDUAL JOINTS
 - 1. Lines 36" and larger may be tested at individual joints.
 - 2. The maximum allowable time for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge is 10 seconds for all pipe sizes.
- F. DEFLECTION TESTING FOR PIPE
 - 1. Perform deflection tests on flexible and semi-rigid pipe in accordance with ASTM 3034.
 - a. The maximum allowable deflection of pipe measured as the reduction in vertical inside diameter is 5.0% unless specified otherwise.
 - b. Conduct test after the final backfill has been in place a minimum of 30 days.
 - c. Thoroughly clear the lines before testing.
 - 2. Perform test by pulling a properly sized mandrill through the line.
 - 3. Excavate and repair pipe with deflections in excess of the maximum allowable deflection.
- G. MANHOLE TESTING

Test manholes for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, vacuum testing or other approved methods acceptable to TCEQ. Make manhole watertight and re-test if the manhole fails the leakage test. The maximum leakage for hydrostatic testing is 0.025 gallons per foot diameter per foot of manhole depth per hour. Prepare for hydrostatic exfiltration testing by sealing all wastewater lines coming into the manhole with an internal pipe plug, then fill the manhole with water and maintain full for at least one hour. With concrete manholes a period of 24 hours prior to testing may be used in order to allow saturation of the concrete.

- H. TESTS FOR PLUMBING DRAINAGE AND VENT SYSTEMS
 - 1. Plug openings as necessary.
 - 2. Test drainage and venting systems by filling piping with water to the level of the highest vent stack for 30 minutes.
 - 3. Make the examination for leakage at joints and connections.
 - 4. There shall be no drop in water level.

3.04 ELECTRICAL TESTING

A. As required by local and state codes.

END OF SECTION

SECTION 01420 – GEOTECHNICAL ENGINEERING STUDY

1.00 PART 1 - GENERAL

1.01

END OF SECTION 01420 – Page 1 of 2

SECTION 01420 – GEOTECHNICAL ENGINEERING STUDY

THIS SHEET INTENTIONALLY LEFT BLANK 01420 – Page 2 of 2

SECTION 01510 – TEMPORARY FACILITIES

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish temporary facilities, including field offices, storage sheds, and temporary utilities needed to complete the work.
- B. Furnish, install, and maintain temporary project identification signs. Provide temporary on-site informational signs to identify key elements of the construction facilities. Do not allow other signs to be displayed.

2.00 PART 2 - PRODUCTS

2.01 SIGN MATERIALS

- A. Provide new or used, wood or metal, in sound condition for structure and framing. Materials are to be structurally adequate and suitable for the indicated finish.
- B. Provide 3/4" exterior grade A/D face veneer plywood with medium density overlay for sign surface.
- C. Bolts, brackets, fasteners, and other hardware are to be galvanized or stainless steel.

2.03 TEMPORARY STORAGE BUILDINGS

A. Furnish storage buildings of adequate size to store any materials or equipment delivered to the site that might be affected by weather.

2.04 TEMPORARY SANITARY FACILITIES

- A. Provide sanitary facilities at the job site from the commencement of the project to its conclusion. Maintain these facilities in a clean and sanitary condition at all times, and comply with the requirements of the local health authority.
- B. Contractor's workmen shall use these sanitary facilities at all times. Rest rooms within existing or Owner-occupied buildings shall not be used.

2.06 TEMPORARY UTILITIES

- A. Provide the temporary utilities needed by the trades during construction, including electrical power, water, and telephone.
 - 1. Provide a source of temporary electrical power of adequate size for the construction procedures.
 - a. Electrical pole and service shall comply with OSHA and other safety requirements and the requirements of the power company.
 - b. Make the electrical power available to the trades as needed.
 - c. Provide extensions to the various parts of the building as needed.
 - d. Provide junction boxes in such an arrangement that distribution boxes are available within 75' of any part of the structure.
 - 2. Provide temporary water. Extend water to the construction site and maintain source until such time that the permanent water supply can be extended to the site.

01510 – Page 1 of 2

SECTION 01510 – TEMPORARY FACILITIES

- B. Make arrangements with the local utility company, comply with utility company's requirements and pay for the utility costs during construction.
- C. Make utilities available to the trades during construction.

3.00 PART 3 - EXECUTION

3.01 LOCATION OF TEMPORARY FACILITIES

- A. Locate all temporary facilities in an area that will not interfere with any work to be performed under this contract.
- B. Construct and install signs at locations as required by applicable regulatory agencies or as selected by the Owner. Install informational signs at the height of optimum visibility, on groundmounted poles, or attach to temporary structural surfaces.
- C. Contractor to maintain all-weather access roads to all operational liftstations. Access road will be a minimum of ten (10) feet wide.

3.07 REMOVAL OF TEMPORARY FACILITIES

- A. Remove temporary buildings, shed, and utilities at the conclusion of the project and restore the site to original condition or finished in accordance with the drawings.
- B. Remove informational signs upon completion of construction.
- C. Remove project identification signs, framing, supports, and foundations upon completion of the project.

END OF SECTION 01510 – Page 2 of 2

SECTION 01563 – GROUNDWATER HANDLING

1.00 PART 1-GENERAL

1.01 SECTION INCLUDES

- A. Dewatering, depressurizing, draining, and maintaining trenches, shaft excavations, structural excavations, and foundation beds in a stable condition, and controlling ground water conditions for tunnel excavations.
- B. Protecting work against surface runoff and rising flood waters.
- C. Disposing of removed water.

1.02 REFERENCES

- A. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).
- B. Federal Register 40 CFR (Vol. 53. No. 222) Part 122, EPA Administrator permit Programs (NPDES), Para 122.26 (b)(14) Storm Water Discharge.

1.03 DEFINITIONS

- A. Ground water control includes both dewatering and depressurization of water-bearing soil layers using well points, for either vacuum or eductor systems, or deep wells. Use of sump pumps does not constitute ground water control.
 - 1. Dewatering is lowering the water table and intercepting seepage which would otherwise emerge from slopes or bottoms of excavations or into tunnels and shafts, and disposing of removed water.
 - 2. Depressurization is reduction of piezometric pressure within a soil strata not controlled by dewatering alone.
- B. Control of excavation drainage by sump pumping includes operating the sump pump and drainage facilities installed to collect water in the sump.
- C. Control of surface drainage is diversion of surface water away from excavations.

1.04 PERFORMANCE REQUIREMENTS

- A. Conduct subsurface investigations as needed to identify ground water conditions and to provide parameters for installation and operation of ground water control systems. Perform pump tests, if necessary, to determine drawdown characteristics of water bearing layers.
- B. Develop a ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926, to produce the following results:
 - 1. Reduce hydrostatic pressure affecting excavations to the following levels as determined by piezometer observations.

- a. For structural excavations, reduce the piezometric level to at least 3 feet below the excavation bottom elevation or within 2 feet above the top of clay layers.
- b. Where hydrostatic pressure in a confined water-bearing layer exist below the excavation, depressurize this zone to eliminate risk of uplift or other instability of the excavation or installed works.
- 2. Develop stable subgrade for subsequent construction operations.
- 3. Reduce hydrostatic pressure for tunnel excavations as necessary to maintain face stability, grade control, and to control seepage into tunnel.
- C. Provide drainage of seepage water and surface water, as well as water from any other source entering the excavation. Excavation drainage may include placement of drainage materials such as crushed stone and filter fabric, together with sump pumping.
- D. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
- E. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells, if they affect potentially contaminated areas.

1.05 SUBMITTALS

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Comply with Texas Commission on Environmental Quality (TCEQ) regulations and Texas Water Well Driller Association for development, drilling, and abandonment of wells used in dewatering system.
- B. Where potentially contaminated areas are indicated on the Drawings, monitor ground water discharge for contamination in accordance with the Project Engineer's instructions.

2.00 PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Equipment and materials are at the option of Contractor as necessary to achieve desired results for ground water control. Ground water control systems may include single-stage or multiple-stage well point systems, educator and ejector-type systems, deep wells, or combinations of these equipment types. Excavation drainage and surface drainage may also include sump pumping subsidiary to bid item.
- B. Maintain equipment in good repair and operating order.
- C. Arrange for standby equipment and materials where required.

3.00 PART 3 - EXECUTION

3.01 GROUND WATER CONTROL

- A. Install, operate and maintain the ground water control system in a manner compatible with construction methods and site conditions. Notify Project Engineer in writing of any changes made to accommodate field conditions and changes to the Work.
- B. For above ground piping in ground water control system, include a length of clear transparent piping between every well point and discharge header so that discharge from each installation can be visually monitored.
- C. Replace installations that produce noticeable amounts of sediments after development.
- D. Provide additional ground water control installations, or change the methods, if the installations do not achieve satisfactory results

01563 - Page 2 of 4

SECTION 01563 – GROUNDWATER HANDLING

achieve satisfactory results.

- E. Do not allow piezometric pressure levels to rise until foundation concrete has achieved design strength.
- F. During backfilling, dewatering may be reduced to maintain water level a minimum of 5 feet below prevailing level of backfill. However, do not allow that water level to result in uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place.
- G. Remove ground water control installations.
 - 1. Remove pumping system components and piping when ground water control is no longer required.
 - 2. Remove monitoring wells when directed by the Project Engineer.
 - 3. Grout abandoned well. Fill piping that is not removed with cement-bentonite grout or cement-sand grout.
- 3.02 MAINTENANCE AND OBSERVATION
 - A. Conduct daily maintenance and observation of the ground water control systems.
 - B. Replace inoperable or damaged system components as necessary to maintain operation.
 - C. Keep monitoring system piping accessible for observation,
- 3.03 MONITORING AND RECORDING
 - A. Observe and record elevation of water level daily as long as ground water control system is in operation. Observe levels weekly thereafter until the Work is completed or piezometers or wells are removed. Initiate more frequent observation when the Project Engineer determines that more frequent monitoring and recording are required.
- 3.04 SURFACE WATER CONTROL
 - A. Intercept surface water and divert it away from excavations. This includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.
 - B. Drive surface water and seepage water into sumps and pump it into drainage channels, setting basins, or storm drains.

4.00 PART 4 – PAYMENT

4.01 Payment of the labor, equipment and personnel needed for the activities specified under this section are subsidiary to the other items of the bid.

END OF SECTION 01563 – Page 3 of 4 THIS SHEET INTENTIONALLY LEFT BLANK 01563 – Page 4 of 4

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to provide erosion and sediment control for the duration of the construction period including furnishing, installing and maintaining erosion and sediment control structures and procedures and the proper removal when no longer required.
- B. The intent of this specification is to provide guidelines for the Contractor to adhere to all State, Federal, and Local environmental regulations. It is also the intent to provide preventive measures to keep sediment from entering any storm water system, including open channels. It is the Contractor's responsibility to adhere to all State, Federal and Local requirements. While the Owner may require the Contractor to install erosion control devices during construction, this will in no way relieve the Contractor of his responsibility.

1.02 QUALITY ASSURANCE

- A. Comply with applicable requirements of all governing authorities having jurisdiction. The Specifications and the Plans are not represented as being comprehensive, but rather to convey the intent to provide complete slope protection and erosion control for both the Owner's and adjacent property.
- B. Erosion control measures shall be established at the beginning of construction and maintained during the entire length of construction. On-site areas which are subject to severe erosion and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation are to be identified and receive additional erosion control measures as directed by the Owner or the Engineer.
- C. All land-disturbing activities shall be planned and conducted to minimize the size of the area to be exposed at any one time and to minimize the time of exposure.
- D. Surface water runoff originating upgrade of exposed area shall be controlled to reduce erosion and sediment loss during the period of exposure.
- E. When the increase in the peak rates and velocity of storm water runoff resulting from a land disturbing activity is sufficient to cause accelerated erosion of the receiving ditch or stream, the Contractor shall install measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream as directed by the Owner or the Engineer.
- F. All land-disturbing activities shall be planned and conducted so as to minimize off-site sedimentation damage.
- G. The Contractor shall be responsible for periodically cleaning out and disposing of all sediment once the storage capacity of the drainage feature or structure receiving the sediment is reduced by one-half. The Contractor shall also be responsible for cleaning out and disposing of all sediment at the time of completion of the Work.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01300, SUBMITTALS, and shall include:

- 1. Manufacturer's Literature: Descriptive data of installation methods and procedures.
- 2. Certificates: Manufacturer's certification that materials meet specification requirements.
- 1.04 STANDARDS [Not Used]
- 1.05 DELIVERY AND STORAGE [Not Used]
- 1.06 JOB CONDITIONS; CODES AND ORDINANCES
 - A. Comply with the local codes and ordinances. If local codes and ordinances require more stringent or additional erosion and sediment control measures during construction, Contractor shall provide such measures.
- 1.07 OPTIONS [Not Used]
- 1.08 GUARANTEES [Not Used]

2.00 PART 2 - PRODUCTS

- 2.01 MATERIALS
 - A. STRAW BALES: Straw bales shall weigh a minimum of fifty (50) pounds and shall be at least 30" in length. Bales shall be composed entirely of vegetable matter and be free of seeds. Binding shall be either wire or nylon string, jute or cotton binding is unacceptable. Bales shall be used for not more than three months before being replaced. However, if weather conditions cause biological degradation of the straw bales, they shall be replaced sooner than the three month time period to prevent a loss of structural integrity of the dike.
 - B. SILT FENCE: Silt fence fabric shall be a nylon reinforced polypropylene fabric which has a builtin cord running the entire length of the top edge of the fabric. The fabric must meet the following minimum criteria:

Tensile Strength, ASTM D463290Ibs.,Puncture Rating, ASTM D483360lbs.,Mullen Burst Rating, ASTM D3786200psi, ApparentOpening Size, U.S. Sieve No.40

Silt fence shall be "Enviro Fence" preassembled silt fence, AMXCO Silt Stop prefabricated silt fence, AMOCO Style 2155 preassembled silt fence or approved equal.

- C. SILT FENCE POSTS: A minimum 2" x 2" (nominal) x 54" pressure treated wood posts of Number 2 Grade southern yellow pine or approved equal.
- D. SAND BAG: Sand bag material shall be polypropylene, polyethylene, polyamide or cotton burlap woven fabric, minimum unit weight four (4) ounces per square yard, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70%. Length shall be 24 to 30 inches, width shall be 16 to 18 inches and thickness shall be six (6) to eight (8) inches and having an approximate weight of 40 pounds. Sand bags shall be filled with coarse grade sand, free from deleterious material. All sand shall pass through a No. 10 sieve.

- E. P.V.C. PIPE: Pipe shall be SDR-35 polyvinyl chloride having a minimum nominal internal diameter of 4". Pipes shall be sized for anticipated flows.
- F. SOIL RETENTION BLANKET: Soil retention blankets shall consist of a geocomposite of excelsior or fiber blanket with an extruded plastic net attached to the tope side. The plastic net shall be photodegradable and the excelsior or fiber blanket shall be made smolder resistant without the use of chemicals. Soil retention blankets shall be high velocity type to resist severe runoff. The soil retention blanket shall be one (1) of the following classes and types:
 - 1. <u>Class 1. "Slope Protection"</u>
 - a. Type A. Slopes of 3:1 or flatter Clay soils
 - b. Type B. Slopes of 3:1 or flatter Sandy soils
 - c. Type C. Slopes steeper than 3:1 Clay soils
 - d. Type D. Slopes steeper than 3:1 Sandy soils
 - 2. Class 2. "Flexible Channel Liner"
 - a. Type E. Short-term duration (Up to 2 Years) Shear Stress (t_D)< 1.0 lb./sq. ft.
 - b. Type F. Short-term duration (Up to 2 Years) Shear Stress (t_d) 1.0 to 2.0 lb./sq. ft.
 - c. Type G. Long-term duration (Longer than 2 Years) Shear Stress (td) > 2.0 to < 5.0 lb./sq. ft.
 - d. Type H. Long-term duration (Longer than 2 Years) Shear Stress (t_d) greater than 0 Equal to 5.0 lb./sq. ft.
- G. The Contractor has the option of selecting an approved soil retention blanket provided that selection conforms to the following list of approved soil retention blankets for slope protection applications:
 - 1. CLASS I. SLOPE PROTECTION

TYPE A: Slopes of 3:1 or Flatter-Clay Soils

Airtrol® ANTI-WASH®/GEOJUTE® (Regular) Contech Standards® Contech Standards Plus® Green Triangle Regular® Green Triangle Superior® GREENSTREAK® PEC MAT Curlex® North American Green® S150 North American Green® S75 North American Green® SC150 POLYJUTEÔ 407/GT SOIL SAVER® TerraJute® Verdyol® ERO-MAT® Xcel Regular® Xcel Superior®

<u>TYPE B</u>: Slopes of 3:1 or Flatter-Sandy Soils

Contech Standards® Contech Standards Plus® GEOCOIR®/DEKOWE® 700 Green Triangle Superior® Green Triangle Regular® North American Green® S75 North American Green® S150 North American Green® S150 POLYJUTEÔ 407/GT TerraJute® Verdyol® ERO-MAT® Xcel Superior® Xcel Regular®

TYPE C: Slopes Steeper than 3:1-Clay Soils

Airtrol® ANTI-WASH®/GEOJUTE® (Regular) Contech Standards Plus® Curlex® Green Triangle Superior® GREENSTREAK® PEC-MAT North American Green® SC150 North American Green® S150 POLYJUTEÔ 407/GT SOIL SAVER® TerraJute® Xcel Superior®

<u>TYPE D</u>: Slopes Steeper than 3:1-Sandy Soils

Contech Standards Plus® GEOCOIR®/DEKOWE® 700 Green Triangle Superior® North American Green® S150 North American Green® SC150 POLYJUTEÔ 407GT TerraJute® Xcel Superior®

- 2.02 MIXES [Not Used]
- 2.03 FABRICATIONS [Not Used]
- 2.04 MANUFACTURED PRODUCTS [Not Used]

3.00 PART 3 - EXECUTION

- 3.01 PREPARATION [Not Used]
- 3.02 INSTALLATION
 - A. COMPOST LOG
 - 1. Compost log shall be placed along a trench as required to prevent erosion runoff. Use compost log as required for linear construction.
 - 2. Compost log shall be tubular mesh and 10" diameter minimum.
 - 3. Compost logs shall be secured using 30" x 2" x 2" wood post and spaced as required to keep compost log in place.
 - B. TEMPORARY STRAW BALE DIKE
 - 1. Straw bales shall be embedded a minimum of 4" and securely anchored using 2" x 2" wood stakes driven through the bales into the ground a minimum of 6". Straw bales are to be placed directly adjacent to one another leaving no gap between them.
 - 2. Bales shall be placed in a single row, lengthwise on proposed line, with ends of adjacent bales tightly abutting one another. In swales and ditches, the barrier shall extend to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale. Additional bales shall be placed behind the first row where the bales abut each other. The additional bale is used to prevent unfiltered runoff from escaping between the bales.
 - 3. The excavated soil shall be backfilled against the barrier. Backfill shall conform to ground level on the downhill side and shall be built up to 4" above ground level on the uphill side. Loose straw shall be scattered over the area immediately uphill from a straw barrier.
 - C. SILT FENCE
 - 1. The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas to a limited extent. The Contractor shall excavate a 6" by 6" trench for site fence bedding along the lower perimeters of the site where necessary to prevent sediment from entering any drainage system.
 - 2. The Contractor shall install the silt fence in accordance with the manufacturer's recommendations and instructions. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence shall remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way or where soil conditions prevent a minimum toe-in depth of 6" or installation of support post to depth of 12". Fabric shall overlap at abutting ends a minimum of 3' and shall be jointed such that no leakage or bypass occurs. If concentrated flow occurs after installation, corrective action must be taken such as placing rock berm in the areas of concentrated flow.
 - D. SAND BAG BERM

- 1. The purpose of a sandbag berm is to intercept sediment-laden water from disturbed areas such as construction in steam beds, create a retention pond, detain sediment and release water in sheet flow.
- 2. A temporary sand bag berm shall be installed across a channel or right of way in a developing or disturbed area and should be used when the contributing drainage area is greater than 5 acres. The berm shall be a minimum height of 18", measured from the top of the existing ground at the upslope toe to the top of the berm. The berm shall be sized to have a minimum width of 48" measured at the bottom of the berm and 18" measured at the top of the berm.
- 3. The sand bag berm shall be inspected after each rain. The sand bags shall be reshaped or replaced as needed during inspection. Additional inspections shall be made daily by the responsible party and when the silt reaches 6", the accumulated silt shall be removed and disposed of at an approved site in a manner that will not contribute to additional siltation. The sand bag berm shall be left in place until all upstream areas are stabilized and accumulated silt removed; removal must be done by hand.

E. SOIL RETENTION BLANKETS

- A soil retention blanket (SRB) is a geotextile or biodegradable fabric placed over disturbed areas to limit the effects of erosion due to rainfall impact and runoff across barren soil. Soil retention blankets are manufactured by a wide variety of vendors addressing a wide variety of conditions such as vegetation establishment and high velocity flow. Blankets are used in areas which are difficult to stabilize such as steep slopes, drainage swales or high pedestrian traffic areas.
- 2. The soil retention blanket, whether installed as slope protection or as flexible channel liner, shall be placed within 24 hours after seeding or sodding operations have been completed, or as approved by the Engineer. Prior to placing the blanket, the area to be covered shall be relatively free of all rocks or clods over 1-1/2" in maximum dimension and all sticks or other foreign material which will prevent the close contact of the blanket with the soil. The area shall be smooth and free of ruts and other depressions. If as a result of rain, the prepared bed becomes crusted or eroded or if any eroded places, ruts or depressions exist for any reason, the Contractor shall be required to rework the soil until it is smooth and to reseed or resod the area at the Contractor's expense.
- 3. Installation and anchorage of the soil retention blanket shall be in accordance with the manufacturer's recommendations.

F. PROTECTION OF BARE AREAS

- 1. Apply seeding and soil retention blanket to bare areas including new embankment areas, fills, stripped areas, graded areas or otherwise disturbed areas, which have a grade greater than 5% or which will be exposed for more than 30 days.
- 2. Bare working areas on which it is not practical or desirable to install seeding and soil retention blankets, as determined by the Engineer, such as areas under proposed building slabs, shall be temporarily sloped to drain at a minimum of 0.2% and a maximum of 5% grade. These areas shall then be "trackwalked" with a crawler dozer traveling up and down the slope to form the effect of small "terraces" with the tracks of the dozer. Apply a minimum of three (3) coverages to each area with the dozer tracks.

- 3. Route runoff from the areas through the appropriate silt fence system.
- 4. Protect earth spoil areas by "trackwalking" and silt fences.
- G. INTERCEPTOR SWALE
 - Interceptor swales may have a v-shape or be trapezoidal with a flat bottom and side slopes of 3:1 or flatter. These are used to shorten the length of exposed slope by intercepting runoff and can also serve as perimeter swales preventing off-site runoff from entering the disturbed area or prevent sediment-laden runoff from leaving the construction site or disturbed area. The outflow from a swale must be directed to a stabilized outlet or sediment trapping device. The swales should remain in place until the disturbed area is permanently stabilized.
 - 2. Stone Stabilization shall be used when grades exceed 2% or velocities exceed 6' per second and shall consist of a layer of crushed stone 3" thick, or flexible channel liner soil retention blankets. Stabilization shall extend across the bottom of the swale and up both sides of the channel to minimum height of 3" above the design water surface elevation based on a two year storm.
 - 3. Interceptor swale shall be installed across exposed slopes during construction and should intercept no more than five (5) acres of runoff. Swales shall have a minimum bottom width of 2'-0" and a maximum depth of 1'-6" with side slopes of 3:1 or flatter. Swale must have positive drainage for its entire length to an outlet. When the slope exceeds 3%, or velocities exceed 4' per second (regardless of slope), stone stabilization is required. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary. Swales should be inspected on a weekly basis during wet weather and repairs should be made promptly to maintain a consistent cross section.
 - 4. All trees, brush, stumps, obstructions and other material shall be removed and disposed of so as not to interfere with the proper functioning of the swale.
 - 5. The swale shall be excavated or shaped to line, grade, and cross-section as required to meet criteria specified herein and be free of bank projections or other irregularities which will impede normal flow.
 - 6. All earth removed and not needed in construction shall be disposed of in an approved spoils site so that it will be conveyed to a sediment trapping device.
 - 7. Diverted runoff from a disturbed or exposed upland area shall be conveyed to a sediment trapping device.
 - 8. The on-site location may need to be adjusted to meet field conditions in order to utilized the most suitable outlet.
 - 9. Minimum compaction for the swale shall be 90% standard proctor.

H. LOCATION OF EROSION AND SEDIMENT CONTROL STRUCTURES

 Locate erosion and sediment control structures as required to prevent erosion and removal of sediment from the project site. Silt fences shall be required for disturbed areas and soil stockpiles/spoil areas. Each silt fence installation shall have a minimum net length (exclusive of embedments into diversion dikes or other ineffective areas) of 25'. The runoff from a maximum of one (1) acre of disturbed area or soil stockpile/ spoil area shall be routed through any individual silt fence installation.

- 2. Install diversion dikes to divert runoff to the silt fence installation.
- 3. Install silt traps at the inlet (upstream) end of the drainage structures, including open channels, through which runoff from disturbed areas or soil stockpiles/spoil areas may drain.
- 4. Provide an overall erosion and sediment control system which protects disturbed areas and soil stockpiles/spoil areas. The system shall be modified by the Contractor from time to time to effectively control erosion and sediment during construction.

3.03 MAINTENANCE

- A. Maintain erosion and sediment control structures and procedures in full working order at all times during construction. This shall include any necessary repair or replacement of items which have become damaged or ineffective. Remove sediment on a regular basis which accumulates in sediment control devices and place the material in approved earth spoil areas or return the material to the area from which it eroded.
- B. Upon completion of construction, properly remove the temporary erosion and sediment control structures and complete the area as indicated.
- C. Soil retention blankets will not require removal if installed on a finished graded area specified to receive seeding.
- 3.04 FIELD QUALITY CONTROL
 - A. In the event of conflict between the requirements and storm water pollution control laws, rules or regulations or other Federal, State or Local agencies, the more restrictive laws, rules or regulations shall apply.
- 3.05 CLEAN AND ADJUST [Not Used]

END OF SECTION

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide products for this project that comply with the requirements of this section. Specific requirements of the detailed equipment specification govern in the case of a conflict with the requirements of this Section.
- B. Comply with applicable specifications and standards.

1.02 QUALITY ASSURANCE

A. DESIGN CRITERIA

- 1. Assume responsibility for the design of the products to include structural stability and operational capability.
- 2. Design members to withstand all loads imposed by installation, erection, and operation of the product without deformation, failure, or adversely affecting the operational requirements of the product. Size and strength of materials for structural members are specified as minimums only.
- 3. Design mechanical and electrical components for all loads, currents, stresses, and wear imposed by start-up and normal operations of the equipment without deformation, failure, or adversely affecting the operation of the unit. Mechanical and electrical components specified for equipment are specified as the minimum acceptable for the equipment.

B. COORDINATION

- 1. Provide coordination of the entire project, including verification that structures, piping, and equipment components to be furnished and installed by the Contractor or by others for this project are compatible.
- 2. Determine that the equipment furnished by Contractor or any Subcontractor or Supplier employed in this project is compatible with the Contract design requirements and with the equipment and materials furnished by the others.
- C. ADAPTATION OF EQUIPMENT
 - Drawings and specifications are prepared for the specified products. Make modifications to incorporate the products into the project at no cost to the Owner, if a substitution for a product is requested and approved in accordance with Section 01640 – PRODUCT SUBSTITUTION.
 - 2. Do not provide a product with a physical size that exceeds the available space. Consideration may be given to the acceptance of these products equipment if the Contractor assumes all costs necessary to incorporate the item and the Engineer approves such revisions.
 - 3. Coordinate electrical requirements for the products to be installed in the project, including revisions in electrical equipment components wiring and other factors necessary to incorporate the component.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01300, SUBMITTALS, and shall include:
 - 1. Certificates of Adequacy of Design, as described in SECTION 01300, SUBMITTALS;
 - 2. Equipment Installation Reports per SECTION 01650, STARTING SYSTEM;
 - 3. Other documentation as required by detailed equipment specifications.

1.04 STANDARDS

A. The applicable provisions of the following standard shall apply as if written here in its entirety:

1. ASTM A-48 "Standard Specification for Gray Iron Casting

B. Except where otherwise indicated, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction.

1.05 GUARANTEES

- A. Guarantee products furnished by the Contractor under this contract against:
 - 1. Faulty or inadequate design
 - 2. Improper assembly or erection
 - 3. Defective workmanship or materials
 - 4. Leakage, breakage, or other failure
- B. Guarantee the products installed under this contract, including products furnished by the Owner, against leakage, breakage, or other failure due to improper assembly or erection and against improper installation of the equipment. The guarantee period shall be as defined in the General Conditions.

2.00 PART 2 - PRODUCTS

2.01 MATERIALS

- A. Design, fabricate, assemble, deliver and install according to normally accepted engineering and shop practices, except where a higher standard of quality is required by the Contract Documents.
- B. Manufacture like parts of duplicate units to standard sizes and gages. Like parts are to be interchangeable.
- C. Two (2) or more items of the same kind are to be identical and made by the same manufacturer.
- D. Provide products suitable for the intended service.

- E. Adhere to the equipment capacities, sizes, and dimensions indicated by the Contract Documents.
- F. Do not use products for any purpose other than that for which it is designed.
- G. Provide new products unless previously used products are specifically allowed in the Contract Documents.
- H. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- I. Materials shall be suitable for service conditions.
- J. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws, or excessive shrinkage and shall conform to ASTM A-48.
- K. Structural members shall be considered as subject to shock or vibratory loads.
- L. Unless otherwise indicated, steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4" thick. All edges are to be chamfered to preclude any sharp exposed edges.
- 2.02 ELECTRIC MOTORS [NOT USED]
- 2.03 EQUIPMENT APPURTENANCES [NOT USED]
- 2.04 ANCHOR BOLTS
 - A. Provide suitable anchor bolts for each product.
 - B. Provide anchor bolts, with templates or setting drawings, sufficiently early to permit setting the anchor bolts when the structural concrete is placed.
 - C. Provide two (2) nuts for each bolt.
 - D. Provide anchor bolts for products mounted on baseplates that are long enough to permit 1-1/2" of grout beneath the baseplate and to provide adequate anchorage into structural concrete.
 - E. Provide stainless steel anchor bolts, nuts, and washers.

2.05 SPECIAL TOOLS AND ACCESSORIES

- A. Furnish tools, instruments, lifting and handling devices, and accessories necessary for proper maintenance and adjustment that are available only from the Product Vendor or are not commonly available.
- 2.06 EQUIPMENT IDENTIFICATION PLAQUES [Not Used]
- 2.07 LUBRICATION SYSTEMS FOR EQUIPMENT
 - A. Provide equipment lubricated by systems which:

- 1. Require attention no more frequently than weekly during continuous operation.
- 2. Do not require attention during start-up or shutdown.
- 3. Do not waste lubricants.
- B. Provide lubricants to fill lubricant reservoirs and to replace lubricant consumed during testing, start-up, and operation prior to acceptance of equipment by the Owner.
- 2.08 INSULATION OF PIPING
 - A. Insulate all piping on or related to equipment as required to prevent freezing under any condition. Insulate piping per the Manufacturer's written instruction.

3.00 PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment including equipment pre-selected or furnished by the Owner as part of this project as if this equipment had been selected and purchased by the Contractor. Assume responsibility for proper installation, start-up and making the necessary adjustments so that the equipment is placed in proper operating condition per SECTION 01650, STARTING SYSTEMS.

3.02 LUBRICATION

A. Lubricate all products provided or installed for this project, including products furnished by the Owner, per the Manufacturer's written recommendations until the product is accepted by the Owner.

END OF SECTION

SECTION 01601 – JOB CONDITIONS

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Job conditions for work to be performed.
- B. Related Sections include but are not necessarily limited to:
- 1. Bidding Requirements, Contract Forms, and Provisions of the Contract.
- 2. Division 1 General Requirements.
- 3. Division 2 Site Work.

1.02 PROJECT CONDITIONS

- A. Overhead and underground utilities are located in and adjacent to the work area. The Contractor must confirm the location of underground utilities within and adjacent to the work site. The Contractor is responsible for locating, marking and preserving these utilities as well as any damage caused by the work.
- B. The majority of the work under this project occurs within the right-of-way or in easements. Protection of benchmarks, permanent fencing, mailboxes, signs, driveways, poles and other facility appurtenances is the responsibility of the Contractor. Contractor will be held liable for any and all damage to facilities caused by the Contractor or his Subcontractors.
- C. Contractor shall confine his operations to those areas shown on the construction drawings. Exceptions may be granted by the Engineer or the City of Edinburg.
- D. A geotechnical engineering study with boring logs in provided in Section 01420 for Contractor's use.

1.03 SCHEDULE

A. Contractor shall comply with the requirements of Section 01310.

END OF SECTION

01601 – Page 1 of 2

SECTION 01601 – JOB CONDITIONS

THIS SHEET INTENTIONALLY LEFT BLANK 01601 – Page 2 of 2

SECTION 01640 – PRODUCT SUBSTITUTIONS

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. The procedure for requesting substitution approval for a product which is specified by descriptive or performance criteria or defined by reference to one or more of the following:
 - a. Name of manufacturer.
 - b. Name of vendor.
 - c. Trade name.
 - d. Catalog number.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 General Requirements.
 - 2. Division 9 Coatings
 - 3. Division 11 Equipment
 - 4. Division 16 Electrical
- C. Requests for Substitution General:
 - 1. Base all bids on materials, equipment, and procedures specified.
 - 2. Certain types of equipment and kinds of material are described in specifications by means of references to names of manufacturers and vendors, trade names, or catalog numbers. When this method of specifying is used, it is not intended to exclude from consideration other products bearing other manufacturer's or vendor's names, trade names, or catalog numbers, provided said products are capable of accomplishing the same tasks as the products specifically indicated.
 - 3. Other types of equipment and kinds of material may be acceptable.

1.02 QUALITY ASSURANCE

- A. In making request for substitution or in using an approved product, Contractor represents:
 - 1. He has investigated proposed product, and has determined that it is adequate or superior in all respects to that specified, and that it will perform function for which it is intended.
 - 2. He will provide same guarantee for substitute item for product specified by Engineer.
 - 3. He will coordinate installation of accepted substitution into work, to include building modifications if necessary, making such changes as may be required for work to be complete in all respects.
 - 4. He waives all claims for additional costs related to substitution which subsequently arise.
- 1.03 DEFINITIONS

A. Product: Manufactured material or equipment.

- 1.04 PROCEDURE FOR REQUESTING SUBSTITUTION
 - A. Considered after award of Contract.

01640 - Page 1 of 2

SECTION 01640 – PRODUCT SUBSTITUTIONS

- B. Written requests through Contractor only.
- C. Transmittal Mechanics:
 - Follow the transmittal mechanics prescribed for shop drawings in Section 01340. Product substitution will be treated in a manner similar to "deviations," as described in paragraph a) of Section 01340. List the letter describing the deviation and justifications on the transmittal form in the space provided under the column with the heading "DESCRIPTION." Include in the transmittal letter, either directly or as a clearly marked attachment, the items listed in paragraph D below.
- D. Transmittal Contents:
 - 1. Product identification:
 - a. Manufacturer's name.
 - b. Telephone number and representative contact name.
 - c. Specification section or drawing reference of originally specified product, including discrete name or tag number assigned to original product in the Contract Documents.
 - 2. Manufacturer's literature clearly marked to show compliance of proposed product with Contract Documents.
 - 3. Itemized comparison of original and proposed product addressing product characteristics including but not necessarily limited to:
 - a. Size.
 - b. Composition or materials of construction.
 - c. Weight.
 - d. Electrical or mechanical requirements.
 - 4. Product experience:
 - a. Location of past projects utilizing product.
 - b. Name and telephone number of persons associated with referenced projects knowledgeable concerning proposed product.
 - c. Available field data and reports associated with proposed product.
 - 5. Data relating to changes in construction schedule.
 - 6. Data relating to changes in cost.
 - 7. Samples:
 - a. At request of Engineer.
 - b. Full size if requested by Engineer.
 - c. Held until substantial completion.
 - d. Engineer not responsible for loss or damage to samples.

1.05 APPROVAL OR REJECTION

- A. Written approval or rejection of substitution given by the Engineer.
- B. Engineer reserves the right to require proposed product to comply with color and pattern of specified product if necessary to secure design intent.
- C. In event substitution results in a change of Contract price or time, provisions in General Conditions will be applied for adjustment.
- Substitutions will be rejected if:
 - 1. Submittal is not through the Contractor with his stamp of approval.
 - 2. Requests are not made in accordance with this Section. In the Engineer's opinion, acceptance will require substantial revision of the original design.

END OF SECTION 01640 – Page 2 of 2

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide step-by-step procedures for the starting of various systems, including equipment, pumps and processes.
- B. Provide pre-start up inspections by equipment manufacturers.
- C. Provide instruction and demonstration of operation, adjustment, and maintenance of each system and the component parts.
- D. Place each system in service and operate the system to prove performance and provide for initial correction of defects in workmanship, calibration, and operation.
- E. Provide for initial maintenance and operation.

1.02 SUBMITTALS

- A. Submittals shall be in accordance with Section 01300, SUBMITTALS, and shall include:
 - 1. A Plan of Action for testing, checking, and starting major equipment and process piping systems. Submit reports as required by this specification.
 - 2. Equipment Installation Reports.
 - 3. Operation and Maintenance Manuals per Section 01730, OPERATION AND MAINTENANCE MANUALS.

1.03 STANDARDS

A. Comply with any standards associated with the testing or start-up of equipment, as listed in the various sections of the specifications.

1.04 SPECIAL JOB CONDITIONS

- A. Do not start or test any apparatus until the complete unit has been installed and thoroughly checked.
- B. A representative of the Manufacturer shall be in attendance of tests and start-up procedures when required by these specifications.
- C. Submit an Equipment Installation Report for the equipment installed on the project.

2.00 PART 2 - PRODUCTS

2.01 TESTING INSTRUMENTATION

A. Furnish any instrumentation or other testing devices needed to conduct tests.

3.00 PART 3 - EXECUTION

3.01 SERVICES OF MANUFACTURERS' REPRESENTATIVES

- A. The Manufacturer's representative for inspection, supervision of installation, and training must be an experienced and competent technical (not sales) representative of the Manufacturer or Supplier.
- B. Perform installation, adjustment, and testing of the equipment under the direct supervision of the Manufacturer's representative where specified.
- C. The Manufacturer's representative is to instruct the Owner or his authorized personnel on operational procedures and maintenance requirements.
- D. Include the cost of the services of the Manufacturer's representative as part of the equipment price.

3.02 INSPECTION AND START-UP

- A. Inspect equipment prior to placing any equipment or system into operation. Make adjustments as necessary for proper operation.
 - 1. Check for adequate and proper lubrication.
 - 2. Determine that parts or components are free from undue stress from structural members, piping or anchorage.
 - 3. Adjust equipment for proper balance and operations.
 - 4. Determine that vibrations are within acceptable limits.
 - 5. Determine that equipment operates properly under full load conditions.
 - 6. Determine that the equipment is in true alignment.
- B. Have the Manufacturer's representative present when the equipment is placed in operation.
 - 1. The Representative is to be on site as often as necessary for proper and trouble free operation.
 - 2. The cost for the services of the technical representative required for the proper start-up and operation of the equipment is to be included in the cost for the equipment.
 - 3. Ensure that the proper procedure is employed in start up of systems.
- C. Provide Equipment Installation Reports for Equipment.
 - 1. Certify that the equipment and related appurtenances have been thoroughly examined and approved for start-up and operation.
 - 2. The report is to indicate the date when Owner's personnel were instructed in the proper operation and maintenance of the equipment.

3.03 STARTING REQUIREMENTS

- A. Refer to the individual sections of the specifications for specific start up procedures.
- 3.04 INITIAL OPERATION

- A. Start, test, and place equipment and systems into operation for 30 days to allow the Owner and Engineer to observe the operation and overall performance of the equipment and to determine that controls function as intended.
- B. Equipment which operates on a limited or part-time basis shall be operated in the presence of the Owner, the City, and Engineer to demonstrate that controls function as specified.
- C. Perform acceptance test as specified in individual specification sections. Demonstrate that equipment and systems meet the specified performance criteria.
- D. Equipment and systems shall not be accepted prior to this initial operation period.
- 3.05 OPERATOR TRAINING [NOT USED]
- 3.06 INITIAL MAINTENANCE
 - A. Maintain equipment until the Owner accepts the project. Contractor shall insure that mechanical equipment is properly greased, oiled, or otherwise cared for as recommended by the Manufacturer.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

A. Comply with requirements of the General Conditions and specified administrative procedures in closing out the Construction Contract.

1.02 SUBMITTALS

A. Submit affidavits and releases.

1.03 SUBSTANTIAL COMPLETION

- A. Submit written notification that the work or designated portion of the work is substantially complete to the Engineer when the work is considered to be substantially complete per the General Conditions. Include a list of the items remaining to be completed or corrected before the project will be considered complete.
- B. Engineer shall visit the project site to observe the work within a reasonable time after notification is received to determine the status of completion.
- C. Engineer shall issue notification to the Contractor that the work is either substantially complete or that additional work must be performed before the project may be considered substantially complete.
 - 1. Engineer shall notify the Contractor in writing of items that must be completed before the project can be considered substantially complete.
 - a. Correct the noted deficiencies in the work.
 - b. Issue a second written notice with a revised list of deficiencies when work has been completed.
 - c. Engineer shall revisit the site and the procedure shall begin again.
 - 2. Engineer shall issue a tentative Certificate of Substantial Completion to the Project Owner when the project is considered substantially complete. Certificate shall include a tentative list of items to be corrected before final payment.
 - a. Owner will review and revise the list of items and notify the Engineer of any objections or other items that are to be included in the list.
 - b. Engineer shall prepare and send to the Contractor a definite Certificate of Substantial Completion with a revised tentative list of items to be corrected or completed.
 - c. Review the list and notify the Engineer in writing of any objections within 10 days of receipt of Certificate of Substantial Completion.

1.04 FINAL INSPECTION

A. Submit written certification when the project is complete and:

- 1. Contract Documents have been reviewed.
- 2. Work has been completed in compliance with the Contract Documents.
- 3. Specified spare parts and special tools have been provided.
- 4. Work is complete and ready for final inspection.
- B. Engineer shall make an inspection with the Owner and appropriate regulatory agencies to determine the status of completeness within a reasonable time after the receipt of the Certificate.
- C. Engineer shall issue notice that the project is complete or notify the Contractor that work is not complete or is defective.
 - 1. Submit the request for final payment with Closeout submittals described in Paragraph 1.07 if notified that the project is complete and the work is acceptable.
 - 2. Upon receipt of notification from the Engineer that work is incomplete or defective, take immediate steps to remedy the stated deficiencies. Send a second certification to the Engineer when work has been completed or corrected.
 - 3. Engineer shall re-visit the site and the procedure will begin again.

1.05 REINSPECTION FEES

- A. Pay fees to the Owner to compensate the Engineer for reinspection of the work required by the failure of the work to comply with the claims of status of completion made by the Contractor.
- B. Owner may withhold the amount of these fees from the Contractor's final payment.
- C. Cost for additional inspections will be billed to the Owner by the Engineer for the actual hours required for the inspection and preparation of related reports in accordance with the following rates:

Principal in Charge	\$150.00
Project Manager	\$125.00
Design Engineer	\$ 90.00
Engineering Technician	\$ 75.00
Clerk	\$ 50.00

1.06 CLOSEOUT SUBMITTALS TO THE ENGINEER

- A. Record Drawings.
- B. Keys and keying schedule.
- C. Warranties and bonds.
- D. Provide evidence of payment or release of liens as required by the General Conditions.
- E. Consent from Surety to Final Payment.

- F. Record data, and other submittals as required by the Contract Documents.
- G. Specified spare parts and special tools.
- H. Evidence of final, continuing insurance, and bond coverage as required by the Contract Documents.

1.07 FINAL PAYMENT REQUEST

- A. Submit a preliminary final payment request. This request is to include adjustments to the Contract Amount for:
 - 1. Approved Change Orders
 - 2. Allowances not previously adjusted by Change Order
 - 3. Unit prices
 - 4. Deductions for defective work that has been accepted by the Owner
 - 5. Penalties and bonuses
 - 6. Deductions for liquidated damages
 - 7. Deductions for reinspection payments per Paragraph 1.05
 - 8. Other adjustments
- B. Engineer shall prepare a final Change Order, reflecting the approved adjustments to the contract amount which have not been covered by previously approved Change Orders.
- C. Submit the final application for payment per the General Conditions, including the final Change Order.

1.08 WARRANTIES, BONDS, AND SERVICES AGREEMENTS

- A. Provide warranties, bonds, and service agreements required by Section 01300, SUBMITTALS or by the individual sections of the specifications.
- B. The date for the start of warranties, bonds, and service agreements is established per the General Conditions.
- C. Compile warranties, bonds, and service agreements and review these documents for compliance with the Contract Documents.
 - 1. Each document is to be signed by the respective manufacturer, supplier, and subcontractor.
 - 2. Each document is to include:

- a. The product or work item description
- b. The firm, with the name of the principal, address, and telephone number
- c. Scope of warranty, bond or services agreement
- d. Date, duration, and expiration date for each warranty bond and service agreement
- e. Procedures to be followed in the event of a failure
- f. Specific instances that might invalidate the warranty or bond
- D. Submit two (2) copies of each document to the Engineer for review and transmittal to the Owner.
 - 1. Submit duplicate sets.
 - 2. Documents are to be submitted on 8-1/2" x 11" paper, punched for a standard three-ring binder.
 - 3. Submit each set in a commercial quality three-ring binder with a durable and cleanable plastic cover. The title "Warranties, Bonds, and Services Agreements", the project name and the name of the Contractor are to be typed and affixed to the cover.
- E. Submit warranties, bonds and services agreements:
 - 1. At the time of final completion and before final payment.
 - 2. Within 10 days after inspection and acceptance for equipment or components placed in service during the progress of construction.

1.9 CLAIMS AND DISPUTES

A. Claims and disputes must be resolved prior to recommendations of final payment. Acceptance and final payment by the Contractor will indicate that any outstanding claims or disputed issues have been resolved to the full satisfaction of the Contractor.

END OF SECTION
1.01 WORK INCLUDED

- A. Prepare a complete and detailed Operation and Maintenance Manual for each type and model of equipment or product furnished and installed under this contract.
- B. Prepare the manuals in the form of an instruction manual for the Owner. The manual is to be suitable for use in providing operation and maintenance instruction as required by Section 01650, STARTING SYSTEMS.
- C. Provide complete and detailed information specifically for the products or systems provided for this project. Include the information required to operate and maintain the product or system.
- D. Manuals are to be in addition to any information packed with or attached to the product when delivered. This information is to be taken from the product and provided as an attachment to the manual.

1.02 SUBMITTALS

A. Submit manuals in accordance with Section 01300, SUBMITTALS.

1.03 GUARANTEES

A. Provide copies of the Manufacturer's warranties, guarantees, or service agreements in accordance with Section 01700, CONTRACT CLOSEOUT.

2.00 PART 2 - PRODUCTS

- 2.01 MATERIALS
 - A. Print manuals on heavy, first quality paper.
 - 1. Paper shall be 8-1/2" X 11" paper.
 - a. Reduce drawings and diagrams to 8-1/2" X 11" paper size.
 - b. When reduction is not practical, fold drawings and place each separately in a clear, super heavy weight, top loading polypropylene sheet protector designed for ring binder use. Provide a typed identification label on each sheet protector.
 - 2. Punch paper for standard three-ring binders.
 - B. Place manuals in Wilson Jones 385 Line D-Ring Dubllock Presentation Binders.
 - 1. Binders are to have clear front, back, and spine covers.
 - 2. Sheet lifters are to be provided.
 - 3. Minimum size is 2" capacity. Maximum size is 3" capacity.

- C. Provide tab indexes for each section of the manual.
 - 1. Indexes are to be constructed of heavy-duty paper with a reinforced binding edge and punched with 9/32" holes to fit the binders.
 - 2. Index is to have clear insertable tabs or may have clear tabs for a typed insert.

3.00 PART 3 - EXECUTION

3.01 MANUAL ORGANIZATION AND CONTENTS

- A. Provide a Table of Contents listing each section of the manual for each product or system.
 - 1. Identify each product or system using the nomenclature shown in the Contract Documents.
 - 2. Assign a number and letter to each section in the manual.
 - a. Assign a number to each product or system. The number is to correspond to the Owner's equipment numbering system or other system designated by the Engineer.
 - b. A cross reference is to be provided for the Owner's numbering system and designations for equipment indicated in the Contract Documents.
 - c. The letter assigned will represent the part of the manual, consistent with the manual contents as required by Paragraphs 3.02, 3.03, and 3.04.
 - 3. Provide index tabs for each section in the manual.
 - 4. The designation on each index tab is to correspond to the number and letter assigned in the Table of Contents.
- B. Include only the information that pertains to the product described. Annotate each sheet to:
 - 1. Clearly identify the specific product or component installed.
 - 2. Clearly identify the data applicable to the installation.
 - 3. Delete reference to inapplicable information.
- C. Supplement manual information with drawings as necessary to clearly illustrate relations of component parts of equipment and systems, and control and flow diagrams.
- D. Identify each manual by placing a printed cover sheet in the front cover of the binder and as the first page in the manual. The first page is to be placed in a clear polypropylene sheet protector. The information on first page and the cover page are to include:
 - 1. Name of Owner
 - 2. Project Name
 - 3. Volume number
 - 4. The Table of Contents for that volume
- E. Insert the Table of Contents into the spine of each manual.
- F. Manuals for several products or systems may be provided in the same binder.
 - 1. Sections for each product or system must be included in the same binder.

- 2. Sections must be in numerical order from volume to volume.
- G. Correlate the data into related groups when multiple binders are used.
- H. Fill binders to only 3/4 of its indicated capacity to allow for addition of materials to each binder by the Owner.

3.02 EQUIPMENT AND SYSTEMS MANUAL CONTENT

Manual shall provide the following information:

- A. A description of the unit and component parts.
- B. Operating instructions for startup, normal operations, regulation, control, shutdown, emergency conditions, and limiting operating conditions.
- C. Maintenance instructions including assembly, installation, alignment, adjustment, and checking instructions.
- D. Lubrication schedule and lubrication procedures. Include a cross reference for recommended lubrication products.
- E. Troubleshooting guide.
- F. Schedule of routine maintenance requirements.
- G. Description of sequence of operation by the Control Manufacturer.
- H. Warnings for detrimental maintenance practices.
- I. Parts lists including:
 - 1. Part numbers for ordering new parts
 - 2. Assembly illustrations showing an exploded view of the complex parts of the product
 - 3. Predicted life of parts subject to wear
 - 4. List of the Manufacturer's recommended spare parts, current prices with effective date and number of parts recommended for storage
 - 5. Directory of a local source of supply for parts with company name, address, and telephone number
 - 6. Complete nomenclature and list of commercial replacement parts
- J. Outline, cross section and assembly drawings, engineering data, test data, and performance curves.

SECTION 01730 – OPERATION AND MAINTENANCE MANUALS

- K. Control schematics and point to point wiring diagrams prepared for field installation, including circuit directories of panel boards and terminal strips.
- L. List of identification nameplates installed on equipment and valve identification.
- M. Other information as may be required by the individual sections of the specifications.
- 3.03 ELECTRICAL AND ELECTRONICS SYSTEMS MANUAL

A. As required in Section 01730, 3.02

3.04 ARCHITECTURAL PRODUCTS MANUAL [NOT USED]

3.05 LIST OF SERVICE ORGANIZATIONS

A. Provide a directory of authorized service organizations with company name, address, telephone number, and the contact person for warranty repair.

END OF SECTION

1.01 DESCRIPTION OF WORK

A. This specification shall provide for the removal and disposal of old structures or portions of old structures including but not limited to pavement, curb and gutter sections, sidewalks, driveways, pipe lines, wet wells, manholes, etc., as noted on the plans, and shall include all excavation and backfilling necessary to complete the removal. The work shall be done in accordance with the provisions of these specifications. Remove all permanent structures to piping three (3) feet below finished grade.

2.00 PART 2 - PRODUCTS [NOT USED]

3.00 PART 3 - EXECUTION

3.01. METHOD OF REMOVAL

- A. Pipelines: Pipe shall be removed by careful excavation of all dirt on top and the_sides in such manner that the pipe will not be damaged. Removal of sewer and/or waterline appurtenances shall be included for removal with the pipe. Those pipes which are deemed unsatisfactory for reuse by the Engineer may be removed in any manner the Contractor may select.
- B. Concrete Structures: Concrete structures or concrete portions of structures shall be removed by saw-cutting and/or sledging the concrete into sizes not larger than one cubic foot. Portions of the old structure shall be removed to the lines and dimensions shown on the plans, and these materials shall be disposed of as shown on the plans or as directed by the Engineer. Any portion of the existing structure, outside of the limits designated for removal, damaged during the operations of the Contractor shall be restored to its original condition at his entire expense. Explosives shall not be used in the removal of portions of the existing structure. Reinforcement shall be cut off close to the concrete. All removed concrete shall not have exposed rebar protruding more than 2-inches. The city will be given the opportunity for use of concrete rubble.
- C. Salvage:
 - 1. All material such as pipe, timbers, railings, etc., which the Engineer deems as salvageable for reuse, and all structural steel shall be in the property of City unless otherwise specified and delivered to a designated storage area.
 - 2. All mechanical and electrical lift station material, which the Engineer deems as salvageable for reuse, including pumps and control panels shall be in the property of the City unless otherwise specified and delivered to a designated storage area.
 - 3. Materials which are not deemed salvable by the Engineer, shall become the property of the Contractor and shall be removed to suitable disposal sites off of the right-of-way arranged for by the Contractor, or otherwise disposed of in a manner satisfactory to the Engineer.
 - 4. Where temporary structures are necessary for a detour adjacent to the present structure, the Contractor will be permitted to use the material in the old structure for the detour structure, but he shall dismantle and stack or dispose of the material as required above as soon as the new structure is opened for traffic. 01732 Page 1 of 2

SECTION 01732 - DEMOLITION OF CIVIL SITE IMPROVEMENTS

Backfill: All excavation made in connection with this specification and all openings below the natural ground line caused by the removal of old structures or portions thereof shall be backfilled to the level of the original ground line, unless otherwise provided on the plans. All dirt and caliche needs to be graded to avoid ponding.

That portion of the backfill which will support any portion of the roadbed or embankment shall be placed in layers of the same depth as those required for placing embankment. Material in each layer shall be wetted uniformly, if required, and shall be compacted to the density required in the adjoining embankment. In places inaccessible to blading and rolling equipment, mechanical or hand tamps or rammers shall be used to obtain the required compaction.

That portion of the backfill which will not support any portion of the roadbed or embankment shall be placed as directed by the Engineer in such manner and to such state of compaction as will preclude objectionable amount of settlement.

END OF SECTION 01732 - Page 2 of 2

1.01 WORK INCLUDED

- A. Certain abbreviations and acronyms have been used in the Contract Documents to identify organizations whose standards are specified by reference as the minimum requirements of these specifications, except as the specifications may modify or supersede, or establish stricter requirements.
- B. The following organizations, trade associations, and societies are related to the building industry, and have been referred to in the specifications. Where such organizations have established standards for their particular trade, these standards shall be accepted by the Contractor as the minimum conditions for construction. Obtain copies of referenced standards from designated organizations when required. The latest publication in effect shall be used unless a specific publication date is specified.

1.02 ORGANIZATIONS

A. The following organizations are listed herein for Contractor's reference.

AA	Aluminum Association 818 Connecticut AVE, N.W. Washington, DC 20006
AAN	American Association of Nurserymen 1250 Eye ST, N.W., Ste. 500 Washington, DC 20005
ACI	American Concrete Institute 22400 W. Seven Mile RD Detroit, MI 48219
ACPI	American Concrete Pipe Institute P.O. Box 19150 Redford Station Detroit, MI 48219
AISI	American Iron and Steel Institute 1000 16th ST, NW Washington, DC 20036
AISC	American Institute of Steel Construction 4100 N. Michigan AVE Chicago, IL 60611
ANSI	American National Standard Institute, Inc. 1430 Broadway New York, NY 10018
APFA	American Pipe Fittings Association Old Keene Mill RD Springfield, VA 22152
ASTM	American Society for Testing and Materials Race ST

Philadelphia, PA 19103

ASCC	American Society of Concrete Construction 426 S. Westgate Addison, IL 60101
ASME	American Society of Mechanical Engineers 345 East 47th ST New York, NY 10017
AWWA	American Water Works Association 6666 W. Quincy AVE Denver, CO 80235
AWS	American Welding Society, Inc. 550 NW LeJeune RD Miami, FL 33126
AI	Asphalt Institute Asphalt Institute BLDG College Park, MD 20740
CLFMI	Chain Link Fence Manufacturers Institute 1101 Connecticut AVE, NW #700 Washington, DC 20036
CRSI	Concrete Reinforcing Steel Institute 933 N. Plum Grove RD Scheumburg, IL 60195
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, BLDG 197 Washington, DC 20407
FM	Factory Mutual System 1151 Boston-Providence Turnpike Norwood, MA 02062
IES	Illuminating Engineering Society of North America 345 East 47th ST New York, NY 10017
IEEE	Institute of Electrical and Electronic Engineers 245 East 47th ST New York, NY 10017
MLFA	Metal Lath/Steel Framing Association 600 S. Federal ST, Ste. 400 Chicago, IL 60605
NAPA	National Asphalt Pavement Association 6811 Kenilworth AVE

NBS	National Bureau of Standards Gaithersburg, MA 20899
NEMA	National Electrical Manufacturers Association 2101 L ST, N.W., Ste. 300 Washington, DC 20037
NEC	National Electrical Code
NFPA	National Fire Protection Agency 470 Atlantic AVE Boston, MA 02210
NLA	National Lime Association 3601 North Fairfax DR Arlington, VA 22201
NRMC	National Ready Mixed Concrete Association 900 Spring ST Silver Spring, MD 20910
PPI	Plastics Pipe Institute 355 Lexington AVE New York, NY 10017
RCRC	Reinforced Concrete Research Council 5420 Old Orchard RD Skokie, IL 60077
SJI	Steel Joist Institute 1205 48th AVE N., Ste. A Myrtle Beach, SC 29577
SSPC	Steel Structures Painting Council 4400 5th AVE Pittsburgh, PA 15213
UL	Underwriters' Laboratories, Inc. 333 Pfingston RD Northbrook, IL 60062
UBC	Uniform Building Code International Conference of Building Officials 5360 South Workman Mill RD Whittier, CA 90601
UFC	Uniform Fire Code International Conference of Building Officials 5360 South Workman Mill RD Whittier, CA 90601

Riverdale, MD 20737

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.01 SCOPE OF WORK

- A. This technical specification covers the furnishing of all labor, materials, tools, and equipment necessary for clearing and grubbing of the project area in preparation for the construction activities described under this contract. Included in the work is the stripping, removal, and disposal of all trees, downed timber, snags, brush, vines, rubbish, stumps, logs, topsoil, existing sidewalks, concrete steps, curbing, driveways, pavement, fencing, guiderails, signs, yard drains, pipe, light fixtures, bases, old wire, and other incidentals that interfere with the planned construction. The work includes the resetting of walls, fence fabric, and poles, relocation and/or resetting of lawn sprinklers, signs, mail boxes, etc., including the installation of temporary and construction fencing, and relocation and trimming of shrubs, trees, or other plantings to remain.
- B. Site preparation work also includes the construction, maintenance, and removal of construction site entrance pads, if shown on the plans or ordered by the Engineer.
- 1.02 SECTION INCLUDES:
- A. Preparation for work.
- B. Protection of existing features.
- C. Clearing and grubbing.
- D. Debris removal.
- E. Mailbox Relocations.
- 1.03 RELATED SECTIONS:
- A. Earthwork for Top Soil Requirements Section 02200.
- B. Excavating, Backfilling and Compacting for Utilities Section 02221.

2.00 PART 2 - EXECUTION

- 2.01 GENERAL:
 - A. The scope of work shall be as listed in Section 1.01 Scope of Work.
- 2.02 PREPARATION FOR WORK:
 - A. Verify that existing plant life designated to remain, if any, is tagged or identified, and protected as described in the Specifications.
 - B. Verify and protect survey control.
- 2.03 PROTECTION OF EXISTING FEATURES:

- A. Locate, identify, and protect from damage utilities to remain.
- B. Protect trees, plant growth, and features designated to remain.
- C. Protect bench marks and survey control from damage or displacement.
- 2.04 CLEARING AND GRUBBING:
- A. The designated construction area shall be cleared of all trees, brush, shrubbery, and plants, not indicated on Drawings to be preserved. Trees and brush designated to be left in place shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. Pruned limbs over 2 inches in diameter shall be treated by painting the exposed ends with an approved asphaltic material.
- B. Stumps In any case where the Engineer determines that the material encountered below the finished grade is unfit for a proper foundation, the material shall be removed.
- C. All excess material, except topsoil, shall be the property of and disposed by the Contractor. Any topsoil to be used for the finished grading shall be stockpiled and preserved for future use in a location and manner approved by the Engineer. Any excess or unusable stripped topsoil under this item shall become the property of the City and shall be removed at the expense of the Contractor. Stumps, roots, and other objectionable material shall be removed from areas requiring fill or from borrow sites and/or materials sources to the complete extent necessary to prevent objectionable matter from becoming mixed with the material to be used in construction.
- D. Unless otherwise provided, all merchantable timber removed as previously specified shall become the property of the Contractor. It is the intent of this specification to provide for the removal and disposal of all obstructions and objectionable materials not specifically provided for elsewhere by the Contract Documents.
- E. In areas where certain trees and shrubs have been designated to be relocated, or to remain, or in areas adjacent to the construction activity, the Contractor shall protect this growth from damage or injury during construction. Trees shall be trimmed to provide a minimum of 8 feet of vertical clearance from the finished grade of any sidewalk constructed or repaired. In case of unavoidable damage to branches and limbs, the damaged portions shall be neatly trimmed and preserved as directed by the Engineer. Any trees or bushes that have been designated to be preserved and/or relocated and are damaged by the Contractor and are beyond recovery, shall be removed and replaced as directed by the Engineer, at the expense of the Contractor.
- F. Remove existing concrete and asphalt paving, curb, gutter, walks and other items shown or described to be removed in the Contract Documents.
- G. Remove trees, shrubs and other plant life within the site shown or described to be removed in the Contract Documents. Remove tree and shrub stumps and root system to a depth of 24 inches below existing grades. Remove grass and ground cover root system to a depth of 6 inches.
- 2.05 DEBRIS REMOVAL:
- A. Removed material shall become the property of the Contractor. Contractor shall remove debris, rock, and extracted plant life from site and legally dispose.

C. Remove existing concrete and asphalt paving, curb, gutter, culverts, walks and other items, as needed for construction, or shown or described to be removed in the Contract Documents.

2.06 CLEARING AND GRUBBING:

A. Remove and relocate all existing sidewalks, concrete steps, curbing, driveways, pavement, fencing, guiderails, signs, yard drains, pipe, light fixtures, bases, and other incidentals that interfere with the planned construction. The work includes the resetting of walls, fence fabric, and poles, relocation and/or resetting of lawn sprinklers, signs, mail boxes, etc., including the installation of temporary and construction fencing, and relocation and trimming of shrubs, trees, or other plantings to remain.

2.07 CONSTRUCTION ENTRANCE:

A. Construction site entrance pads shall be constructed prior to any clearing and grubbing. They shall be maintained so as to prevent tracking of dirt onto the adjacent paved roadway. The local roadways shall be swept as necessary to remove any materials that have been tracked from the site.

3.00 PART 3 - MEASUREMENT AND PAYMENT

3.01 PAYMENT:

A. No separate payment shall be made to the Contractor for the work described in this Section. Such work shall be considered incidental to the project and the payments made under specific Pay Items shall be considered as full compensation for these requirements.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.01 SECTION INCLUDES:

- A. Grading and earthwork which occurs in areas other than under structures, under paving, or trenching for utilities.
- B. Earthwork consists of operations required for the excavation of materials on site; excavation of borrow material from designated areas; compaction of natural or improved sub-grades: finish grading; disposal of excess or unsuitable materials; and other required operations. Earthwork shall conform with dimensions and typical sections shown, and within lines and grades established on Drawings.
- 1.02 RELATED SECTIONS:
- A. Trench Protection Section 19000.
- B. Excavating, backfilling and compacting for utilities Section 02221.
- 1.03 REFERENCES:
- A. ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 lbf/ft³).
- B. ASTM D4972 pH of Soil.
- C. ASTM G57 Field Measurement of Soil Resistivity Using the Wenner Four Electrode Method.
- D. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- 1.04 EXISTING UTILITIES:
- A. Where pipes, ducts and structures are encountered in the excavation but are not shown on the Drawings, immediately notify the ENGINEER.
- 1.05 DEFINITIONS:
- A. Borrow: Material taken from on-site designated areas or approved off-site sources to make up any deficit of excavated material. Obtain from area that is normally dry and well drained. Borrow does not include top soil.
- B. Classification: Earthwork materials are classified in accordance with definitions in this Article.
- C. Compaction: Compaction of soil materials shall be measured as a percent of Standard Proctor density as determined by the ASTM D698.
- D. Excavation: Excavation of every description and of whatever substances encountered within the limits of the project to the lines and grades indicated on the Drawings.
- E. Finish Grading: Operations required for smoothing disturbed areas that are not overlaid with pavement.
- F. General Site Fill: Suitable, clean material excavated on-site or off-site may be used as fill material. Suitable material shall consist of clay soils classified as CH according to the unified

soil classification system. Clay soil used as fill shall have a liquid limit of less than 55 and a Plasticity Index comparable with on-site soils.

- G. Select Fill: Select fill material, as required for construction, defined in the plans and Sections 02221, shall consist of inorganic silty or sandy clay.
- H. Subgrade: Consists of that portion of the surface on which a compacted fill, backfill or topsoil is placed.
- I. Topsoil: Top 6 inches of natural surface soil possessing the characteristics of representative soils on the site that produce growths of grass or other vegetation. Topsoil includes roots and other vegetation.

2.00 PART 2 - PRODUCTS

- 2.01 SELECT FILL:
- A. Source: Obtain select fill material from required excavation, or if excavated material is not adequate, from borrow areas approved by the ENGINEER. Material from source shall be tested for compliance with project requirements and approved by the Owner and Testing Laboratory.
- B. Suitability: Use the best material available from excavation or borrow, suitability of select fill is subject to the ENGINEER'S approval.
- C. Quality: Select fill material must be free of rock and clay lumps or excessive silts. Do not use soil containing brush, roots, sod or similar organic materials.
- D. Characteristics: Select fill material shall consist of inorganic silty or sandy clay. Additional select fill requirements are described in Sections 02221.
- 2.02 FILL AND BACKFILL UNDER TOPSOIL:
- A. Source: Obtain site fill from required excavation or, if excavated material is not sufficient, from borrow areas approved by the ENGINEER.
- B. Suitability: Use the best material available from excavation or borrow. Suitability of fill material is subject to the Testing Laboratory\Engineer's approval.
- C. Quality: Fill material shall be free of excessive silts. Do not use soil containing brush, roots, sod or similar organic materials.
- D. Characteristics: Fill material shall have a plasticity index between 6 and 25, inclusive, and shall generally be of similar character to that of existing soil at the site.

3.00 PART 3 - EXECUTION

3.01 STRIP AND STOCKPILE:

A. Remove topsoil at all non-paved areas where excavation of topsoil is required or where fill material will be added for site grading. Remove top 6 inches of topsoil where necessary and stockpile on the property as directed by the Owner. Protect stockpiled topsoil from other

excavated materials, dumping of unwanted material, dumping by the public, and erosion. Upon completion of rough grading, replace topsoil in 4-inch minimum layer to finish grade elevations as shown on the grading plan.

B. Removal of topsoil in building areas and paving areas is further described under provisions of Section 02221.

3.02 EXCAVATION:

- A. Objective: As shown on the Drawings, excavate to lines, grades and elevations required for subsequent construction. All excavation shall be made in such manner as to permit all surfaces to be brought to final line and grade within plus or minus 0.1 foot. Over excavation shall be restored by the Contractor at his own expense. Finished grades consistently high or low will not be acceptable and shall be corrected by the Contractor at his expense and no additional cost to the Owner.
- B. Drainage: During excavation, maintain grades as required to provide positive drainage away from structures; or, as directed by the Engineer, install temporary drains or drainage ditches to intercept or divert surface water and prevent interference or delay of the work.
- C. Stockpiling: If at time of excavation it is not possible to place material in the proper section of permanent construction, stockpile the material in Owner approved areas for later use.
- D. Stone or Rock: Stone or rock fragments greater than 6" will not be allowed in fills or embankments. Stones or rock fragments larger than 2 inches in their greatest dimension will not be permitted in top 6 inches of subgrade.
- E. Dressing: Uniformly dress cut and fill slopes to slope, cross section and alignment, as shown.

3.03 TREATMENT OF SUBGRADES:

- A. All topsoil and vegetation shall be stripped from the ground surface and stockpiled, exposing sound undisturbed subgrade soils.
- B. After stripping the topsoil in areas to receive fill or cut areas, the exposed ground surface shall be scarified to a depth of 6 inches, the moisture adjusted, and then recompact to a density of 95 to MIN. percent of the maximum density as obtained in the Standard Proctor Compaction Test (ASTM D698), at a moisture content between minus 1 to plus 3 percent of optimum. Any soft or compressible areas detected during the recompaction process shall be undercut such that sound subgrade soils are exposed and recompacted. Site excavated or select fill shall then be used to bring all areas to grade. Allow for placement of minimum 4-inch layer of top soil in areas not covered by building or pavement.
- C. Finished subgrade shall be inspected by Testing Laboratory for determination that subgrade meets requirements of Contract Documents.
- 3.04 PLACING FILL AND BACKFILL:
- A. Examination of Subgrade: Do not place fill on any part of the subgrade until the subgrade preparation has been accepted by the Engineer.

- B. Removing Debris: During the dumping and spreading process, remove all roots, stones and debris that are uncovered in the fill material.
- C. Spreading Fill and Backfill: After dumping, spread the material in horizontal layers over the entire fill area. The thickness of each layer before compaction shall not exceed 8 inches unless otherwise directed by the Engineer. Maintain positive drainage throughout construction. The combined excavation and fill placing operation shall be such that the material when compacted in the fill will be blended sufficiently to secure the best practicable degree of compaction. The suitability of the materials shall be subject to testing by the Testing Laboratory and approval of the Engineer. After each layer of fill has been spread to the proper depth, it shall be thoroughly manipulated with a disc plow or other suitable and approved equipment until the material is uniformly mixed, pulverized and brought to a uniform approved moisture content.
- D. Attaining Proper Bond: If, in the opinion of the Testing Laboratory, the compacted surface of a layer is too smooth to bond with succeeding layers, loosen the surface by harrowing or other approved method before continuing the work.
- E. Place materials to proper elevation allowing for depth of topsoil furnished under this Contract.
- 3.05 MOISTURE CONTROL:
- A. Intent: Developing the maximum density obtainable with the natural moisture of the material is preferred. However, the moisture content shall not vary from the optimum, as determined by ASTM D698, by more than minus 1 to plus 3 percent of optimum.
- B. Adjustment: If the moisture content is too high, adjust to within the specified limits by spreading the material and permitting it to dry. Assist the drying process by discing or harrowing if necessary. When the material is too dry, sprinkle each layer with water. Work the moisture into the soil by harrowing or other Engineer approved method.
- 3.06 COMPACTION:
- A. Rough Grade: Compact each layer of fill material with suitable equipment as necessary to secure 95% to 98% Standard Proctor Density (ASTM D698) within the specified range of the moisture content.
- B. Finish Grade: Place and lightly compact topsoil to achieve finish grades.
- 3.07 DISTRIBUTION OF TOPSOIL:
 - A. Perform rough grading and topsoil/finish grading work.
 - B. Preparation:
 - 1. Prior to placing topsoil, scarify the subgrade to a depth of 2 inches to provide effective bonding of the topsoil with the subgrade.
 - 2. Shape all areas designated for grading, including cut and fill areas, to receive a minimum of 4 inches of topsoil
 - C. Placement:

- 1. Do not haul or place wet topsoil. Also prohibited is placement of topsoil on a subgrade that is excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading or proposed planting.
- 2. Distribute topsoil uniformly and spread evenly. Correct irregularities in the surface to prevent formation of depressions where water could stand.
- 3. Perform the spreading operation so that planting can proceed with little additional tillage or soil preparation. Leave the area smooth and suitable for lawn planting.
- 4. Lightly compact topsoil to obtain proper bond with previously placed or prepared material.
- D. Maintenance: Where any portion of the surface becomes eroded or otherwise damaged, repair the affected area to establish the condition and grade prior to topsoil placement; then replace topsoil.

3.08 MATERIAL DISPOSAL:

- A. Excess Excavation Material (soil material free of trees, stumps, logs, brush, roots, rubbish and other objectionable matter which has been accepted by the Geotechnical Engineer): Remove excess excavated material from the construction site or place on the property as directed by the ENGINEER.
- B. Waste Material (soil material including trees, stumps, logs, brush, roots, rubbish and other objectionable matter which has not been accepted by the Geotechnical Engineer): Remove waste material from the project site before Final Inspection. Legally dispose of material at a licensed site or with written and notarized permission from the property owner for a private disposal site. All costs associated with waste material removal and disposal shall be paid for by the Contractor.

4.00 PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. No separate payment shall be made to the CONTRACTOR for the work described in this Section. Such work shall be considered incidental to the project and the payments made under specific Pay Items shall be considered as full compensation for these requirements.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.01 GENERAL DESCRIPTION OF WORK

- A. Excavation, shoring, dewatering, pipe bedding, trench backfill, compaction, grading and cleanup of all pipeline trenching for the project.
- B. All work must be done in accordance with these specifications and the safety requirements of the State and OSHA Standards.

1.02 JOB CONDITIONS

- A. Site Acceptance
 - 1. Accept site in condition existing during Contract time frame.
 - 2. Ground water/surface water found during construction are conditions of the contract and responsibility of Contractor.
- B. Adverse Weather
 - 1. Place no backfill that is excessively wet or frozen.
 - 2. Place no backfill in excessively wet or frozen trenches.

1.03 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

2.00 PART 2 - PRODUCT

2.01 MATERIAL CLASSIFICATIONS FOR PIPE BEDDING AND BACKFILL

Materials for bedding and backfill shall be classified for the purpose of quality control in accordance with the Unified Soil Classification Symbols as defined in ASTM D2487 and with ASTM D2321. Material use and application is defined by class in accordance with ASTM D2321, or by product descriptions, as described below. Determination of source of materials for bedding and backfill to meet the stated conditions shall be responsibility of Contractor, but use of such materials shall be subject to approval of Engineer. Contractor shall submit characterization/sieve analysis of proposed pipe embedment material for approval prior to commencement of construction.

- A. Class Designations Based on Laboratory Testing (ASTM D2321):
 - 1. Class IA and IB: Manufactured aggregates, open or dense graded, clean.
 - a. Plasticity Index: Non-plastic.
 - b. Gradation: 100% passing 1½" sieve, ≤ 50% passing No. 4 sieve, and < 5% passing No. 200 sieve.
 - Class II: Well and poorly graded gravels and sands, clean or with little to moderate fines (GW, GP, SW, SP, and combinations of the preceding with GM, GC, SM, and SC)
 - a. Plasticity Index: Non-plastic

- b. Gravel (GW, GP) Gradation: 100% passing 1½" sieve, < 5% passing No. 200 sieve (i.e. <5% fines), and < 50% of the non-fines passing a No. 4 sieve. For pipes 15" diameter and smaller, bedding material shall be 3/4-inch maximum (i.e. 100% passing 3/4-inch sieve).
- c. Sand (SW, SP) Gradation: 100% passing 1½" sieve, < 5% passing No. 200 sieve (i.e. <5% fines), and > 50% of the non-fines passing a No. 4 sieve.
- d. Gravel, Sand W/ Fines Gradation: 100% passing 1¹/₂" sieve, and 5% to 12% passing No. 200 sieve (i.e. 5% to 12% fines).
- 3. Class III: Silty/clayey gravels and sands, gravel-sand-silt/clay mixtures (GM, GC, SM, SC)
 - a. Plasticity Index: (Refer to ASTM D2321)
 - b. Gradation: 100% passing 1¹/₂" sieve, 12% to 50% passing No. 200 sieve.
- B. Designations Based on Product Descriptions:
 - 1. Excavated Material Backfill: Excavated material may be used in the trench backfill, provided that all hard rock and stones having any dimensions greater than 6" and frozen earth, debris and roots larger than 2" are removed for the initial backfill. Plasticity Index shall be less than 30. Excavated backfill material must be approved by Engineer for bedding material.
 - 2. Select Backfill: Select Backfill shall be gravel, fine rock cuttings, sand, sandy loam or loam free from excessive clay. Rock cuttings shall have no dimensions greater than 2 inches. Plasticity Index shall be between 7 and 22. Select backfill must be approved by Engineer.
 - 3. Sand Backfill: Sand backfill shall be clean, hard, durable, uncoated grains, free from lumps and organic material. All materials must pass a No. 8 sieve with less than 5% passing a No. 200 sieve.
 - 4. Granular Backfill: Granular backfill shall be free flowing, such as sand or hydraulically graded stone fines, or mixed sand and gravel, or sandy loam. The material shall be free from lumps, stones over 2 inches in diameter, clay and organic matter.
 - 5. Controlled Density Fill: Use high slump mixture of portland cement, fly ash and fine aggregate formulated, licensed and marketed as K-Krete or equal. Provide mixture with minimum 28-day compressive strength of 70 psi with no measurable shrinkage or surface settlement.

2.02 CRADLING ROCK

- A. Use crushed rock or stone with 70-100% passing 1½ inch sieve and no more than 50% passing 1 inch sieve.
- 2.03 SHEETING, SHORING AND BRACING
 - A. Use sound timber or structural steel.
 - B. Use shapes and sizes as required.

3.00 PART 3 - EXECUTION

- 3.01 GENERAL
 - A. Dewatering

- 1. Execute work "dry". No pipe or conduits shall be laid or concrete poured on wet soil.
- 2. Prevent surface water from flowing into excavation.
- 3. Provide equipment for handling water encountered as required. Obtain approval of proposed method of dewatering.
- 4. No Sanitary sewer shall be used for disposal of trench water.
- B. Protection of Existing Utilities:
 - 1. Notify all utilities of location and schedule of work.
 - 2. Locations and elevations of utilities shown on plans are to be considered approximate only. Notify utility and Engineer of conflicts between existing and proposed facilities.
 - 3. Repair, relay or replace existing utilities damaged, destroyed or disrupted during work. Unless specified otherwise, replacement will be at the Contractors expense.
- C. Protection of Existing Facilities:
 - 1. Mailboxes, driveways, fences, etc., existing near excavation shall be protected from damage. If needed, facilities shall be removed during construction and replaced to before construction condition or better.
 - 2. Mail delivery service shall not be interrupted.
 - 3. Driveway access shall be maintained.
- D. Sheeting, Shoring and Bracing
 - 1. All sheeting, shoring, and bracing shall be in accordance with the Excavation Safety System Plan, these specifications and the safety requirements of the State and OSHA Standards.
 - 2. Provide as necessary, to hold walls of excavation, prevent damage to adjacent structures, and to protect workmen and property.
 - 3. Leave Sheeting and shoring in place where removal might cause damage to work or otherwise indicated on drawings.
 - 4. When movable trench shield is used below spring line of pipe, it shall be lifted prior to any forward movement to avoid pipe displacement.
- E. Changes in Grade
 - 1. Grades may be adjusted 1.5 feet (plus or minus) from plan grades to suit unforeseen construction conflicts or conditions with prior approval of Engineer.
 - 2. No additional compensation will be made for such changes.

3.02 EXCAVATION AND TRENCHING

- A. General
 - 1. Method of excavation at Contractor's option.
 - 2. Allow no more than 300 feet of trench to be open at one time.
 - 3. Excavate by hand under tree roots 3 inches and larger, and under and around structures and utilities.
 - 4. Stockpile and replace topsoil to a minimum of 8-inches for surface restoration in grassed or agricultural areas.
- B. Trench Characteristics
 - 1. Depth
 - a. As indicated for pipe installation to lines and grades required with proper allowance for thickness of pipe and type of bedding specified or indicated.

- Width
 a. Minimum trench width shall be pipe O.D. plus 16 inches or pipe O.D. x
 1.25 + 12 inches, whichever is greater.
 b. Maximum width as follows:
- Maximum Trench Pipe Size Inches Width 4 2-feet 0-inches 6 2feet 0-inches 8 2-feet 4-inches 10 2-feet 4-inches 12 2-feet 6-inches 15 2-feet 9-inches 18 3-feet 0-inches Over 18 Pipe O.D. × 2
- 3. Trench walls must be vertical below top of pipe and may be vertical or sloped above pipe to conform to excavating codes.
- 4. Provide bell holes for each pipe joint where pipe bears on undisturbed earth.
- 5. Trench bottom shall be free of large stones and other foreign material.
- 3.03 SOFT, SPONGY OR UNSTABLE MATERIALS (e.g. peat, muck, and highly expansive soils)
 - A. Stop work and notify Engineer.
 - B. Perform remedial work as directed.
 - C. If material is judged unsuitable and removal is authorized, remove and replace with trench stabilizing material as directed by Engineer.

3.04 ROCK EXCAVATION

2.

- A. Excavate any rock to maintain minimum 6-inch clearance around pipe.
- B. Dispose of rock material not suitable for backfill as directed by Engineer.
- C. Use of explosives not permitted without prior written authorization from owner and Engineer.
- D. Provide Special Hazard Insurance covering liability for blasting operations.

3.05 PIPE EMBEDMENT

- A. Bedding
 - 1. Place after bottom of trench has been excavated to proper depth and grade.
 - 2. Place, compact and shape bedding material to conform to barrel of pipe and bell to insure continuous firm bedding for full length of pipe.
 - 3. Provide bedding as described in following table unless indicated otherwise on Plans or in Special Conditions.

Pipe Material	Minimum Bedding Class
1. Non-reinforced Concrete Pipe	Class C*
3. Reinforced Concrete Pipe Class D*	4. Ductile Iron Pipe
Class D* 5. Steel Cylinder Class C*	
6. Flexible (PVC) or Composite Pipe	Class I, II, and III*

*Refer to ASTM D2321 and standard pipe bedding details in the Drawings.

- B. Haunching (bottom of pipe to springline)
 - 1. Haunching shall be same material used for bedding.
 - 2. Place after pipe has been bedded and checked for alignment, grade and internal obstructions.
 - 3. Do not backfill until concrete or mortar has sufficiently cured.
 - 4. Record location of connections and appurtenances before backfilling.
 - 5. Work bedding under pipe haunches and compact by hand to springline of pipe in 6-inch maximum lifts.
- C. Initial Backfill
 - 1. Initial backfill shall be same material used for bedding.
 - 2. From springline to not less than 6-inches above top of pipe, place backfill and compact in 6-inch layers using vibratory compactors.
 - 3. Backfill simultaneously on both sides of pipe to prevent displacement.

3.06 TRENCH BACKFILL

- A. Final Backfill
 - 1. Place backfill into trench at an angle so that impact on installed pipe is minimized.
 - 2. Compaction of all backfill material shall be performed in a manner that shall not crack, crush, and/or cause the installed pipe to be moved from the established grade and/or alignment.
 - 3. Place cushion of 4-foot compacted backfill above pipe envelope before using heavy compacting equipment.
 - 4. Use excavated material for final backfill subject to the requirements stated for Select Backfill unless otherwise specified.
 - 5. Areas under or within 5 feet of pavement, and under or within 2 feet of utilities, buildings, or walks shall be backfilled with sand and mechanically compacted to the top of the subgrade in 8 inch lifts to a minimum of 95% Standard Proctor Density.
 - 6. Areas not subject to vehicular traffic shall be backfilled in layers not more than 12inches.
 - 7. Structural and non structural backfill shall be mechanically compacted. Compaction method is at discretion of Contractor with following exceptions:
 - a. If in Owner's opinion compaction method presents potential damage to pipe, it will not be allowed.
 - b. Flooding or water jetting may be permitted only if a geotechnical report justifying the use of water jetting/puddling is submitted to the Engineer by a qualified laboratory and the Engineer approves.
 - 8. Mound excavated materials no greater than 6-inches in open areas only.
 - 9. Fill upper portion of trench with topsoil as specified hereinbefore.
- B. Controlled Density Fill
 - 1. Use where shown on plans.
 - 2. Provide suitable forms to limit volume of control density fill material.
 - 3. Prevent flow of material into existing drain lines.
 - 4. Protect exposed utility lines during placement.
 - 5. Place material in accordance with suppliers' written recommendations unless directed otherwise by Engineer.

3.07 EXCESS MATERIAL

A. Waste of excess excavated material shall be the responsibility of the Contractor.

3.08 TESTING

- A. Unless specified elsewhere, testing will be responsibility of Owner.
- B. Standard Proctor Density 1. ASTM D698.2. One (1) required for each type of material encountered.

C. In Place Density

- 1. ASTM D1556 (Sand Cone)
- 2. ASTM D2167 (Balloon)
- 3. ASTM D3017 (Nuclear)
- D. One (1) test per 250 linear feet of trench on alternating lifts, with a minimum of three tests per visit, for non-structural areas. One (1) test per 100 linear feet of trench on alternating lifts, with a minimum of three tests per visit, for structural areas.
- E. Contractor will be responsible for any costs associated with testing performed as a result of failed tests

4.00 PART 4 - MEASUREMENT AND PAYMENT

4.01 TRENCH EXCAVATION

- A. Trench excavation shall be considered incidental to pipeline installation.
- B. Payment shall be made at the contract unit price per cubic yard <u>only</u> if a bid item is established in the contract.

4.02 BACKFILL

- A. Payment for backfill shall be made at the contract unit price per cubic yard <u>only</u> if a separate bid item is established in the contract, otherwise it shall be considered incidental to the pipeline installation.
- B. No allowance for waste shall be made.
- C. If Engineer orders an initial backfill material other than that specified in contract, it shall be paid for as an extra in price per cubic yard as compacted in place, EXCEPT if a higher class embedment is ordered by Engineer because the Contractor has over-excavated the trench width.
- D. If the Engineer orders the excavated material to be removed and disposed of and replaced with another material and a separate bid item is not established as a bid item, the material shall be paid as an extra.
- E. If the Contractor fails to compact the backfill to the density requirements, the Engineer may order the material removed and replaced at no cost to the Owner.

F. The disposal of rejected material shall be at no cost to the Owner.

END OF SECTION

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for slabs-on-grade.
 - 2. Excavating and backfilling for buildings and structures.

B. Related Sections include the following:

- 1. Division 1 Section "Temporary Facilities" for temporary controls, utilities, and support facilities.
- 2. Division 2 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
- 3. Division 2 Section "Groundwater Handling" for lowering and disposing of ground water during construction.
- 4. Division 2 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
- 5. Divisions 2, 15, and 16 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

1.03 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
- B. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
- C. Fill: Soil materials used to raise existing grades.
- D. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- E. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- F. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.04 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.

- 3. If required, submission of product data and mix design for controlled low-strength material.
- B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.05 QUALITY ASSURANCE

A. Provide Material Test Reports from a qualified testing agency indicating and interpreting test results for compliance of the requirements of this section.

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

2.00 PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- E. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- F. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 CONTROLLED LOW-STRENGTH MATERIAL

- A. Flowable Fill: Low-density, self-compacting, flowable concrete material as follows:
 - 1. Portland Cement: ASTM C 150, Type [I] [II] [or] [III].
 - 2. Fly Ash: ASTM C 618, Class C or F.

- 3. Normal-Weight Aggregate: ASTM C 33, [3/4-inch (19-mm)] [3/8-inch (10-mm)] <Insert dimension> nominal maximum aggregate size.
- 4. Retain first subparagraph below if low-density, controlled low-strength material is required.
- 5. Foaming Agent: ASTM C 869.
- 6. Water: ASTM C 94/C 94M.
- 7. Delete subparagraph below for low-density, controlled low-strength material using foaming agent.
- 8. Air-Entraining Admixture: ASTM C 260.
- B. Produce low-density, controlled low-strength material with the following physical properties:
 - 1. As-Cast Unit Weight: 30 to 36 lb/cu. ft. (480 to 576 kg/cu. m) at point of placement, when tested according to ASTM C 138/C 138M.
 - 2. Compressive Strength: 80 psi (550 kPa), when tested according to ASTM C 495.

3.00 PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.04 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.05 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Engineer.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.06 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Surveying locations of underground utilities for Record Documents.
 - 2. Testing and inspecting underground utilities.
 - 3. Removing concrete formwork.
 - 4. Removing trash and debris.
 - 5. Removing temporary shoring and bracing, and sheeting.
 - 6. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.07 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations under slabs and foundations using engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.08 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.09 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under structures and slabs, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.10 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Grading inside structure lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 500 sq. ft. or less of paved area or slab, but in no case fewer than 3 tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.12 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.13 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.
- B. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.
 - 1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT:

- A. Compensation for work included under this specification shall be subsidiary to the cost for the installation of the pipe or structure.
- B. Compensation will be for furnishing all materials, labor, equipment, tools and incidental work required by this specification and in accordance with the plans.
- C. If the compaction tests fail, the trouble spot is to be corrected all as incidental to the construction of the line or structure.

END OF SECTION
SECTION 03200 – CONCRETE REINFORCEMENT

- 1.00 PART 1 GENERAL
- 1.01 RELATED WORK SPECIFIED ELSEWHERE
- 1.02 QUALITY ASSURANCE
 - A. Reference Standards:
 - 1. ACI 315, Details and Detailing of Concrete Reinforcement.
 - 2. ASTM A615, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. ASTM A185, Specifications for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 4. Concrete Reinforcing Steel Institute, Manual of Standard Practice.
 - B. Allowable Tolerances:
 - 1. Fabricating: (per ACI 117-90)
 - a. Saw cut length to: Plus or minus 1". (Remove all burrs).
 - b. Stirrups and ties: Plus or minus 1/2".
 - c. All other bends: Plus or minus 1".
 - 2. Placing:
 - a. Concrete cover to formed surfaces: Plus or minus 1/4".
 - b. Minimum spacing between bars: Plus or minus 1/4".
 - c. Top bars in slabs and beams:
 - 1) Members 8" deep or less: Plus or minus 1/4".
 - 2) Members more than 8" but not over 2'-0" deep: Plus or minus 1/2".
 - 3) Members more than 2'-0" deep: Plus or minus 1".
 - 4) Crosswise of members: Space evenly within 2" of stated separation.
 - 5) Lengthwise of members: Plus or minus 2".
 - 3. Maximum bar relocation to avoid interference with other reinforcing steel, conduits, or other embedded item: 1 bar diameter.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement to project site in bundles marked with tags indicating bar size, length and mark.
- B. Unload reinforcing carefully to prevent damage. Store above ground in dry, well drained area; protect from mud, dirt and corrosion.

03200 – Page 1 of 2 SECTION 03200 – CONCRETE REINFORCEMENT

2.00 PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing Bars: ASTM A615, deformed billet steel bars, domestic manufacture, Grades 40 and/or 60 as indicated on structural drawings.
- B. Welded Wire Fabric Reinforcing: ASTM A185, steel wire spot welded at intersections and of size indicated.
- C. Metal Accessories: Include spacers, chairs, bolsters, ties and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place, conforming to requirements to CRSI "Manual of Standard practice for Detailing Reinforced Concrete Structures." Metal accessories shall be galvanized or plastic coated where legs will be exposed in finished concrete surfaces.
- D. Tie Wire: FS QQ-W-461, black annealed steel, 16 ga. min.

2.02 FABRICATION:

A. In accordance with CRSI "Manual of Standard Practice."

3.00 PART 3 - EXECUTION

3.01 PREPARATION

A. Cleaning: Before placing in work, thoroughly clean reinforcement of loose rust, mill, scale, dirt, oil, and other coating which might tend to reduce bonding. Reinspect reinforcing left protruding for future bonding, or following delay in work, and reclean if necessary.

3.02 INSTALLATION

- A. Bar Placement: In accordance with CRSI "Recommended Practice for Placing Reinforcing Bars" and "Recommended Practice for Placing Bar Supports."
 - 1. Bending: Bend bars cold; do not heat reinforcing or bend by make-shift methods. Discard bent, kinked or otherwise damaged bars.
 - 2. Splices: In accordance with ACI 315.
 - 3. Placing: Accurately position reinforcement; securely saddle tie at intersections.

4. Supports: In accordance with ACI 315 for number, type, spacing and placing.

END OF SECTION

03200 - Page 2 of 2

1.00 PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK:

- A. This work shall consist of furnishing and placing a foundation course for surface courses or for other base courses.
- B. Flexible base shall be composed of either caliche (argillaceous limestone, calcareous or calcareous clay particles, with or without stone, conglomerate, gravel, sand or other granular materials), crushed stone, gravel, or crushed slag.
- C. Flexible base shall be constructed as specified herein in one or more courses in conformance with details, lines and grades shown on the plans, and as established by the ENGINEER.

2.00 PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Materials for flexible base shall be crushed or uncrushed as necessary to comply with the requirements hereinafter specified.
- B. Materials shall consist of durable course aggregate particles mixed with approved binding materials.
- 2.02 LIME STABILIZATION:
 - A. Where shown on the plans, or directed by the ENGINEER, material for flexible base shall be lime stabilized in accordance with TxDOT Item 260.

2.03 TYPES:

- A. Type A Crushed or broken aggregate (excluding gravel aggregate).
- B. Type B Gravel Aggregate
- C. Type C Iron Ore Topsoil
- D. Type D Shell Aggregate with Sand Admixture
- E. Type E Shell Aggregate with Sand and Caliche Admixture
- F. Type F Caliche
- G. Type G Crushed Slag
- H. Unless otherwise noted on the plans, the CONTRACTOR may use any one type of these types provided the material used meet the requirements set forth in the specification test limits herein.
- 2.04 GRADES:
 - A. Base courses or subbase materials, unless otherwise noted on the plans or directed by the ENGINEER, may consist of Grades 1, 2, 3, or 4, as specified in Table 02500-1.

- B. All grades shall, when tested in accordance with standard laboratory test procedures, meet the physical requirements set forth in Table 02500-1.
- C. Testing of flexible base materials shall be in accordance with the following test procedures:

TEST	TESTING	PROCEDURE
Preparation fo	or soil constants alvsis	TEX-101-E
Liquid Limit TEX-104-E	Plastic Limit TEX-105-E	Plasticity Limit
TEX-106-E Sieve Analysis Triaxial Test	TEX-110-E Wet Ball Mill	TEX-116-E TEX-117-E (Part I or II)

- D. Unless otherwise specified on the plans, samples for testing the material for Soil constants, Gradation and Wet Ball Mill shall be taken prior to the compaction operations.
- E. Unless otherwise specified on the plans, samples for triaxial tests shall be taken from the stockpile or from production, as directed by the ENGINEER, where stockpiling is required and from production where stockpiling is not required.

TABLE 02500-1

PHYSICAL REQUIREMENTS FOR FLEXIBLE BASE MATERIALS

GRADES

TYPES	Grade 1: Triaxial Class 1) minimum compressive strength, psi: 45 at 0 psi lateral pressure and 175 at 15 psi lateral pressure	Grade 2: Triaxial Class 1 to 2.3) Min. compressive strength, psi: 35 at 0 psi lateral pressure and 175 at 15 psi lateral pressure		Grade 4:
TYPE A Crushed or Broken Aggregate (excluding gravel aggregate)	Retained on % Sq. Sieve 1-3/4 1-3/4	Retained on % Sq. Sieve 1-3/4" 1-3/4" 0- 10 No. 4 45-75 No. 40	Retained on % Sq. Sieve 1-3/4" 1-3/4" 0- 10 No. 40 60-85 Max Hax LL 45 Max PI 15 Wet Ball Mill Max. Amt 55 Max Increase in passing No. 40 20	As Shown on Plans
TYPE B Gravel Aggregate		Retained on % Sq. Sieve 1-3/4" 1-3/4" 0- 10 No. 4 30-75 No. 40 70-85 Max LL 35 Max PI 12	Retained on % Sq. Sieve 1-3/4" 1-3/4" 0- 5 No. 4 30-75 No. 40 65-85 Max LL	As Shown on Plans
TYPE C Iron Ore Topsoil		Retained on % Sq. Sieve 2-1/2" 2-1/2"	Retained on % Sq. Sieve 2-3/4" 2-3/4" 0 No. 40 45-85 Max LL	As Shown on Plans

TABLE 02500- (CONT'D)

TYPE D Sand-Shell	Retained on % Sq. Sieve 0- 1-3/4 0- 10 No. 4 45-65 No. 40	Retained on % Sq. Sieve - 1-3/4" 0- 10 No. 40 - 45-65 Max LL 35 Max PI 12	As Shown on Plans
TYPE E Shell with Sand and Caliche	Retained on % Sq. Sieve 1-3/4" 10 No. 40 45-65 Max LL	Retained on % Sq. Sieve 1-3/4" 0 No. 40 45-65 Max LL	As Shown on Plans
TYPE F Caliche	Retained on % Sq. Sieve 1-3/4" 1-3/4"	Retained on % Sq. Sieve 1-3/4" 1-3/4" 0 No. 40 50-85 Max LL	As Shown on Plans
TYPE G Crushed Blast Furnace Slag			As Shown on Plans

- F. The limits establishing reasonable close conformity with the specified gradation and plasticity index are defined by the following:
 - 1. The ENGINEER may accept the material, providing not more than 2 of 10 consecutive gradation tests performed are outside the specified limits on any individual or combination of sieves by no more than 5% and where no two consecutive tests are outside the specified limits.
 - 2. The ENGINEER may accept the material providing not more than 2 of 10 consecutive plasticity index samples tested are outside the specified limit by no more than two points and where no two consecutive tests are outside the specified limit.

2.05 STOCKPILING:

- A. When specified on the plans, the material shall be stockpiled prior to delivery on the road. The stockpile shall be not less than the height indicated and shall be made up of layers of material not to exceed the depth shown on the plans.
- B. After a sufficient stockpile has been constructed as specified on the plans, the CONTRACTOR may proceed with loading from the stock- pile for delivery to the road.

- C. In loading from the stockpile for delivery to the road, the material shall be loaded by making successive vertical cuts through the entire depth of the stockpile.
- D. If the CONTRACTOR elects to produce the Type A material from more than one material or more than one source, each material shall be crushed separately and placed in separate stockpiles so that at least 75 percent of the material in the course aggregate stockpiles will be retained on the No. 4 sieve and at least 70 percent of the material in the fine aggregate stockpile will pass the No. 4 sieve.
- E. The materials shall be combined in a central mixing plant in the proportions determined by the ENGINEER to produce a uniform mixture which meets all of the requirements of the specification. In the event that combinations of the materials produced fail to meet all of the specification requirements, the CONTRACTOR will be required to secure other materials which will meet specifications requirements.
- F. The central mixing plant shall be either the batch or continuous flow type, and shall be equipped with feeding and metering devices which will add the materials into the mixer in the specified quantities.
- G. Mixing shall continue until a uniform mixture is obtained.

3.00 PART 3 - EXECUTION

3.01 PREPARATION OF SUBGRADE:

- A. The roadbed shall be excavated and shaped in conformity with the typical sections shown on the plans and to the lines and grades as established by the ENGINEER.
- B. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material.
- C. All holes, ruts and depressions shall be filled with approved material and, if required, the subgrade shall be thoroughly wetted with water and reshaped and rolled to the extent directed in order to place the subgrade in an acceptable condition to receive the base material.
- D. The surface of the subgrade shall be finished to line and grade as established and in conformity with the typical section shown on plans, and any deviation in excess of 1/2 inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
- E. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work.
- F. Material excavated in the preparation of the subgrade shall be utilized in the construction of adjacent shoulders and slopes or otherwise disposed on as directed, and any additional material required for the completion of the shoulders and slopes shall be secured from sources indicated on plans or as directed by the Engineer.
- 3.02 PLACEMENT OF FIRST COURSE TYPE A, TYPE B, TYPE C, TYPE F, AND TYPE G MATERIAL:
 - A. Immediately before placing the base material, the subgrade shall be checked as to conformity with grade and section.

- B. The material shall be delivered in approved vehicles of a uniform capacity, and it shall be the charge of the CONTRACTOR that the required amount of specified material shall be delivered in each 100- foot station.
- C. Material deposited upon the subgrade shall be spread and shaped the same day.
- D. In the event inclement weather or other unforeseen circumstances render impractical the spreading of the material during the first 24-hour period, the materials shall be scarified and spread as directed by the Engineer.
- E. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to typical sections as shown on plans.
- F. All areas and "nests" of segregated coarse or fine material shall be corrected to removed and replaced with well graded material, as directed by the ENGINEER.
- G. If additional binder is considered desirable or necessary after the material is spread and shaped, it shall be furnished and supplies in the amount directed by the ENGINEER. Such binder material shall be carefully and evenly incorporated with the material in place by scarifying, harrowing, brooming or by other approved methods.
- H. The course shall be compacted by method of compaction hereinafter specified as the "Ordinary Compaction" method or the "Density Control" method of compaction as indicated on the plans, or as directed by the ENGINEER.
 - 1. When the "Ordinary Compaction" method is to be used, the following provisions shall apply:
 - a. The course shall be sprinkled as required and rolled ad directed until a uniform compaction is secured. Throughout this entire operation, the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical sections shown on plans and to the established lines and grades.
 - b. In that area on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
 - c. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.
 - 2. When the "Density Control" method of compaction is to be used, the following provisions shall apply:
 - a. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as hereinafter specified under "Density".
 - b. In addition to the requirement specified for density, the full depth of the flexible base shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment.

- c. After each section of flexible base is completed, tests as necessary will be made by the ENGINEER. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements.
- d. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections shown on the plans and to established lined and grades.
- e. In that area on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
- f. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.
- I. Should the base course, due to any reason or cause, lose the required stability, density or finish before the surfacing is complete; it shall be recompacted and refinished at the sole expense of the CONTRACTOR.
- J. Where Type C material is used, the material shall be scarified, thoroughly wetted, mixed, manipulated, and bladed so as to secure a uniformly wetted material, and pulled in over the subgrade in courses and set under the action of blading and rolling. The work of mixing, blading, rolling, shaping, and subsequent maintenance shall be performed by the continuous use of sufficient number of satisfactory rollers and power maintainers with adequate scarifier attachments.
- 3.03 PLACEMENT OF FIRST COURSE TYPE D MATERIAL:
 - A. Immediately before placing the base material, the subgrade shall be checked as to conformity with grade and section, and corrections made if necessary.
 - B. All materials shall be delivered in approved vehicles of a uniform capacity.
 - C. The required amount of shell shall be uniformly spread across the section and allowed to dry sufficiently to insure proper slaking and mixing of the binder material. Immediately upon completion of the drying period, as determined by the ENGINEER, the specified amount of sand admixture as required to produce a combined material meeting the requirements hereinbefore specified shall be spread uniformly across the shell.
 - D. The material shall then be sprinkled as required and thoroughly mixed by blading and harrowing, or other approved methods.
 - E. Failure to proceed with the placing of sand admixture or mixing and placing operations will be grounds for the suspension of placing of shell.
 - F. Under no conditions will the CONTRACTOR be allowed to place an excessive amount of shell without proceeding with the mixing and placing operations.
 - G. The course shall be compacted by the method of compaction hereinafter specified as the "Ordinary Compaction" method or the "Density Control" method of compaction as indicated on the plans, or as directed by the ENGINEER.

- 1. When the plans indicate that the "Ordinary Compaction" method is to be used, the following provisions shall apply:
 - a. After mixing, all material shall be windrowed, and then spread over the section in layers.
 - b. The layer shall not exceed 2 inches in loose depth.
 - c. If necessary to prevent segregation, the material shall be wetted in the window prior to spreading.
 - d. After each lift is spread, it shall be sprinkled and rolled to secure maximum compaction as directed by the ENGINEER. Succeeding layers shall then be placed similarly until the course is completed.
 - e. All areas and "nest of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by the ENGINEER.
 - f. The course shall then be sprinkled as required and rolled as directed until a uniform compaction is secured.
 - g. Throughout this entire operation, the shape of the course shall be maintained by blading; and the surface, upon completion, shall be smooth and in conformity with the typical sections shown on plans, and to the established lines and grades.
 - h. In that area on which pavement is to be place, any deviation in excess of 1/4 inch in cross section in a length of 16-feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
 - i. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.
- 2. When the plans indicate that the "Density Control" method of compaction is to be used, the compaction method shall be the same as prescribed for Type A, Type B, Type C, Type F and Type G material.
- H. When indicated on the plans or permitted by the ENGINEER, Type D material may be mixed in a central mixing plant and delivered to the road as a combined mixture. When this method is used, the combined mixture shall meet the requirements for type D material as hereinbefore specified and the placing and compaction requirement shall be the same as prescribed for Type A, Type B, Type C, Type F and Type G material.

3.04 PLACEMENT OF FIRST COURSE - TYPE E MATERIAL:

A. The construction methods for placing the first course of Type E material shall be the same as prescribed for Type D material except that after the shell and sand have been placed, the prescribed amount of caliche shall then be spread across the sand and shell.

- B. The composite mixture shall then be sprinkled as required and thoroughly mixed by blading and harrowing or other approved methods.
- C. Compaction of the first course of Type E material shall be the same as prescribed above for Type D material.
- D. Failure to proceed with placing the sand and caliche admixture or mixing and placing operations will be grounds for the suspension of placing of shell.
- E. Under no conditions will the CONTRACTOR be allowed to place an excessive amount of shell without proceeding with the mixing and placing operations.

3.05 PLACEMENT OF SUCCEEDING COURSES - ALL MATERIAL TYPES:

- A. Construction methods shall be the same as prescribed for the first course.
- B. Prior to placing the surfacing on the completed base, the base shall be "dry cured" to the extent directed by the ENGINEER.

3.06 DENSITY CONTROL:

- A. When the "Density Control" method of compaction is indicated on the plans, each course of flexible base shall be compacted to the percent density shown on the plans.
- B. The testing will be as outlined in Test Method Tex-114-E.
- C. It is the intent of this specification to provide in that part of the base included in the top 8 inches immediately below the finished surface of the roadway not less than 100 percent of the density as determined by the compaction ratio method.
- D. Field density determination shall be made in accordance with Test Method Tex-115-E.

3.07 TOLERANCES:

- A. Flexible base will be measured by the square yard of surface area of completed and accepted work based on the width of flexible base as shown on the plans.
 - The ENGINEER may accept the work providing not more than 25 percent of the density tests performed each day are outside the specified density by no more than three pounds per cubic foot and where no two consecutive tests on continuous work are outside the specified limits.

4.00 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

- A. Flexible base will be measure by the square yard of surface area of completed and accepted work or by the cubic yard delivered and spread for manipulation.
 - 1. The flexible base shall be measured for depth by the units of 2000 square yards, with one measurement taken at a location selected by the ENGINEER.

- 2. In that unit where flexible base is deficient by more than 1/2 inch in thickness, the deficiency shall be corrected by scarifying, adding material as required, reshaping and recompacting by sprinkling and rolling.
- 3. No additional payment over the contract unit price will be made for any flexible base of a thickness exceeding that required by plans.
- B. The CONTRACTOR shall schedule his operations in such a manner as to facilitate the measurement of the pay item.
- C. The ENGINEER may accept the work provided no more than 2 out of 10 depth tests performed are deficient by not more 1/2 inch and where no two consecutive tests on continuous work are outside the specified depth.

4.02 PAYMENT:

- A. The accepted quantities of flexible base type, grade, compaction method specified, labor, equipment and personnel needed for the activities specified under this section are subsidiary to the other items of the bid, complete in place.
- B. Regardless of the type of compaction or Density Control specified, all sprinkling, rolling, and manipulation required will not be paid for directly, but will be incidental.
- C. The lump sum bid shall each be full compensation for shaping and fine grading the roadbed; for securing and furnishing all materials, including all royalty and freight involved; for furnishing scales and labor involved in weighing the material when required; for loosening, blasting, excavating, screening, crushing and temporary stockpiling when required; for loading all materials for all hauling and delivering. on the road; for spreading, mixing, blading, dragging, shaping and finishing and for all manipulation, labor, tools and incidentals necessary to complete the work.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sanitary sewer wetwells, manholes and appurtenances.
 - 2. Valve vaults.
- B. Related Sections include but are not necessarily limited to:
 - 1. Forms of Contract, Bond and Proposal.
 - 2. General Specifications.
 - 3. Section 02221 Excavating, Backfilling, and Compacting for Utilities.
 - 4. Section 02300 Structural Earthwork
 - 5. Section 02556 Force Main
 - 6. Section 02570 Sanitary Sewer.
 - 7. Section 11322 Submersible Lift Station.

1.02 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M198, Standard Specification for Asbestos-Cement Underdrain Pipe.
 - b. H20, Axial Loading.

2. American Society for Testing and Materials (ASTM):

- a. A48, Gray Iron Castings (Class 35 Minimum).
- b. C478, Precast Reinforced Concrete Manhole Sections.
- c. C581, Practice for Determining Chemical Resistance of Chemical Thermosetting Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service.
- d. C582, Plastic Laminate.
- e. C923, Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
- f. C950, Glass-Fiber Reinforced Thermosetting Resin Pressure Pipe.
- g. D695, Test Method for Compressive Properties of Rigid Plastics.
- h. D790, Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- i. D2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.
- j. D2583, Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impresser.
- k. D2584, Test Method for Ignition Loss of Cured Reinforced Resins.
- I. D3753, Standard Specification for Glass-Fiber Reinforced Polyester Manholes.

3. Occupational, Health and Safety Administration (OSHA).

1.03 SUBMITTALS

- A. Refer to Section 01300.
- B. Product technical data including:
 - 1. Acknowledgment that products submitted meet requirements of standards referenced.
 - 2. Manufacturer's installation instructions.
 - 3. Operation and maintenance manuals.
- C. Fabrication and/or layout drawings:
 - 1. Include detailed diagrams of wetwells/manholes and valve vaults showing typical components and dimensions.
 - 2. Itemize, on separate schedule, sectional breakdown of each wetwell/manhole or valve vault structure with all components and refer to drawing identification number or notation.
 - 3. Indicate knockout elevations for all piping entering each wetwell/manhole.
- D. Certifications.
- E. Design calculations.
- F. Concrete pad foundation design and drawings.
- G. Test reports.
- H. Warranty information.

2.00 PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Wetwell/manhole rings, covers and frames:
 - a. Halliday.
 - b. Bilco.
 - c. Bass & Hays Foundry.
 - d. Neenah Foundry.
 - e. Deeter Foundry.
 - 2. Black mastic joint compound:

- a. Kalktite 340.
- b. Tufflex.
- c. Plastico.
- 3. Premolded joint compound:
 - a. Ram Nec.
 - b. Kent Seal.
- 4. Fibered asphalt compound:
 - a. Sonneborn Hydrocide 700B Semi-Mastic.
- 5. Fiberglass Wetwells/Manholes:
 - a. Containment Solutions, Inc.
 - b. Flowtite Products.
 - c. Bellco.
- 6. Precast Concrete Wetwells/Manholes:
 - a. Hanson.
 - b. Oldcastle Precast.
 - c. American.
 - d. Park Engineering.
- 7. Interior Protective Epoxy Coating for Concrete Wetwells/Manholes: a. Refer to Section 09900.
- B. Submit request for substitutions in accordance with Specification Section 01640.

2.02 SANITARY SEWER WETWELL

- A. Wetwell/Manhole Interior Dimensions:
 - 1. Diameter: 96 inches (wetwell). 60 inches (receiving manhole).
 - 2. Depth: See plans.
 - 3. The dimensions provided herein are approximate. The Contractor shall refer to the Drawings for exact dimensions.
- B. Physical Requirements:
 - 1. Fiberglass Wetwell/Manhole:
- a. The complete wetwell/manhole shall have a minimum dynamic-load rating of 16,000 ft-lbs when tested in accordance with the requirements of this specification. To establish this rating, the complete wetwell/manhole shall not leak, crack or suffer other damage when load tested to 40,000 ft-lbs and shall not deflect vertically downward more than ¼ inch at the point of load application when loaded to 24,000 lbs.
- b. The wetwell/manhole cylinder shall meet the minimum pipe-stiffness values specified below:

Length (ft)	Stiffness Requirements (F/AY-psi)
10 to 20	2.01
21 to 30	3.02

SECTION 02515 - WETWELL AND MANHOLE STRUCTURES

31 to 40	5.24

c. Physical properties:

	Physical Prop	erty	Hoop Directi	on	Axial Directi	on
	Tensile strength (psi)		18,000		5,000	
	Tensile modulus (psi)		800,000		700,000	
	Flexural strength (psi)		26,000		4,500	
Flexural modulus (psi)						
No ribs – 48", 60" or		1,400,000		700,000		
	72"					
With I	ribs – 96" or 144"		700,000		700,000	

- d. Tests shall be performed as specified in ASTM D3757.
- e. The Contractor shall furnish all materials, labor and equipment for the installation of a onepiece, prefabricated fiberglass reinforced polyester (FRP) wetwell/manhole and accessories including concrete sections as shown on the Drawings and as specified herein.
- f. FRP wetwell/manhole shall be built to meet the requirements of ANSI/ASTM D3753 at a minimum and shall be manufactured from commercial grade polyester resin or vinyl ester resin with fiberglass reinforcements. The resin system shall be suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with wastewater collection systems.
- g. Pipe connections shall be installed by the manufacturer.
- h. FPR wetwells/manholes shall be marked by the manufacture in letters no less than one (1) inch in height with the following information: i. ASTM Designation. ii. Manhole Length.
 iii. Manufacturer's Identification. iv. Manufacturer's Serial Number.
- i. Provide the following components for each wetwell/manhole structure:
 - i. Level reinforced concrete base pad (cast-in-place).
 - ii. Circular penetrations as required.
 - iii. Barrel section(s). iv. Adjuster ring(s).
- j. Contractor shall coordinate size, type, and location of all penetrations with all other trades and equipment.
- k. FRP wetwells/manholes shall be suitable for use in sanitary sewer environment.
- I. Cylinders shall be designed and fabricated to provide sufficient strength for the following conditions:
 - i. Resistant to buckling when empty and when the groundwater elevation is at grade.
 - ii. The anchoring wall structure at the embankment within the reinforced concrete base zone shall be designed to resist external hydrostatic water forces of an empty or full cylinder with the groundwater at grade elevation.
 - iii. Load bearing capacity: Properly installed wetwell/manhole shall be capable of withstanding H-20 dynamic loading (24,000 lbs) applied vertically.
- m. FRP wetwells shall be manufactured to the diameters and heights as shown on the Drawings and as specified herein.

- n. FRP wetwells shall be designed to perform as underground structures at the depths required and to withstand the necessary lateral hydrostatic pressures with a minimum safety factor of 2.5. FRP structures shall be capable of supporting the top slab covers, frames, soil overburdens plus a live load equivalent to AASHTO H-20 Loading.
- o. All cutouts shown in the plans and details for each FRP wetwell/manhole shall be capable of maintaining the unit's structural integrity.
- C. Wetwell and Valve Vault Access Doors and Frames:
 - 1. Furnish and install double-hinged doors constructed of aluminum.
 - 2. Furnish size shown on Drawings.
 - 3. Equip with nonsparking upper guide rail support, cable brackets, and flush locking mechanism, and safety grating.
 - 4. Doors shall be spring-assisted and shall remain in open position while work is being performed with safety handles.
 - 5. Securely place frame above pump(s).
 - 6. Provide doors of skidproof design.
 - 7. Provide doors with snap locks and removable handle.
 - 8. Provide door hardware including latching mechanism and hinges of stainless steel materials.
 - 9. Access doors shall be sized and designed to withstand H-10 loads and shall allow for the easy removal of pumps and valves from the wetwell or valve vault.
 - 10. Aluminum access doors shall be of a non-watertight design.
- D. Nonpressure Type Frames and Manhole Covers:
 - 1. Cast or ductile iron frame and covers: ASTM A48, Class 30, with asphalt varnish coating applied at the foundry.
 - 2. Use only cast or ductile iron of best quality, free from imperfections and blowholes.
 - 3. Machine all horizontal surfaces.
 - 4. Unless dimensioned or specifically noted on Drawings, manhole frame and cover shall be 24-inch diameter standard cast iron and shall weigh approximately 400 LB.
 - 5. Furnish unit with solid nonventilated lid with concealed pickholes. Letter covers "SEWER" for all collection system manholes.
 - 6. Ensure minimum clear opening of 30-inch diameter.
- E. Special Coatings and Joint Treatment:

- 1. Joints for precast sections: Resilient O-ring gaskets manufactured from natural or synthetic materials complying with ASTM C923, of suitable cross section and size to meet specified infiltration or exfiltration requirements.
- 2. All interior surfaces of concrete wetwells/manholes shall be epoxy-coated to protect from sulfide corrosion. Contractor shall propose coating materials and methods for Owner approval prior to ordering materials. The interior coating shall be in place prior to setting of wetwell/manhole section. Refer to Section 09900 for interior concrete coating specification.

2.03 MATERIALS

A. FRP Wetwell/Manhole

1. Resin:

a. Unsaturated isophthalic polyester resins shall be used and they must meet the requirements listed below:

Property	Test Method	Requirement
Acid number	ASTM D465-59	Maximum = 15
Hydroxyl number		Maximum = 30
Solids content	ASTM D1259-61	Maximum = 50%

b. The following requirements are determined when testing the resin without any reinforcing material included:

Property	Test Method	Requirement
Flexural strength	ASTM D790-70	Minimum = 10,000 psi
Flexural E-modulus	ASTM D790-70	Minimum = 400,000 psi
Elongation at rupture	ASTM D790-70	Minimum = 2 ½ %
Heat distortion	ASTM D648-61	Minimum = 167°F
temperature		
Weight change after 28	ASTM D570-63	Maximum = 150 mg/sample
days storing in distilled		
water		
Surface hardness	ASTM D2583-67	Minimum = 80% of resin's
(Barcol)		normal value

c. All resin shall be supplied by same supplier. Mixed lots or "odd lots" of resin from different vendors shall not be used.

2. Reinforcement:

- a. Reinforcement shall be fiberglass mat, continuous roving, chopped roving, roving fabric or a combination of the above.
- b. The fiberglass shall be type "E" and have a finish compatible with the resin used.
- c. The interior surface shall be reinforced layer 10 to 20 mils.
- d. Reinforcement materials shall be chemically resistant surface mat or organic surfacing veil.
- e. Reinforcements shall have a coupling agent which will provide a suitable bond between the reinforcement and the resin.
- f. If reinforcing material is used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin-rich surface.

- 3. Fillers, when used, must not degrade the resin chemical resistant properties as defined in this specification.
- 4. Additives, such as thixotropic agents, catalysts and promoters may be added as required by the specific manufacturing process used to meet this standard. However, calcium carbonate mixed by the manufacturer shall not be permitted. The resulting reinforced plastic material must meet the requirements of this specification.
- 5. Laminate: (Cured composite including glass fiber reinforcement) Cured laminate must meet the following conditions:

Property	Test Method	Requirement
Glass content (% by wt.)	ASTM D2584-68	20 to 70%
Compressive strength	ASTM D695-69	Minimum = 12,000 psi
Flexural strength	ASTM D790-70	Minimum = 12,000 psi
Flexural E-modulus	ASTM D790-70	Minimum = 700,000 psi
Surface hardness	ASTM D2583-67	Minimum = 90% of resin's
(Barcol)		normal value

- 6. UV inhibitors/stabilizers shall be added directly to resins system to prevent photodegradation of laminate or wetwell/manhole shall have exterior gray gel-coat for UV inhibitor.
- B. Wetwell/manhole concrete shall meet the requirements of ASTM C478.

2.04 FABRICATION

A. FRP Wetwell/Manhole:

- 1. The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than ½ inch diameter, delamination and fiber show.
- 2. Interior surface shall be resin-rich with no exposed fibers. The surface shall be free of grazing, delamination, blisters larger than ½ inch diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to six (6) square feet if they are less than ¾ inch in diameter and less than 1/16 inch deep.
- 3. The bottom shall be fabricated using fiberglass material and shall meet all physical requirements as specified herein. The bottom shall be attached to the wetwell/manhole with fiberglass lay up to comply with ASTM D3299.
- 4. The FRP wetwell/manhole top shall be fabricated using fiberglass material and shall meet all physical requirements as specified herein. The top shall be attached to the wetwell/manhole with fiberglass lay up to comply with ASTM D3299.
- 5. When reinforcement is necessary for strength, the reinforcement shall be completely enclosed with a fiberglass lay up per ASTM D3299.

6. The FRP receiving manhole shall be fabricated to allow the installation of a slide gate and appurtenances as shown on the plans. The slide gate shall be factory installed by the FRP manhole manufacturer.

2.05 QUALITY ASSURANCE/QUALITY CONTROL

A. FRP Wetwell/Manhole:

- 1. Examination: Each FRP cylinder component part shall be examined for dimensional requirements, hardness and workmanship.
- 2. Composition control: Controls on glass and resin content shall be maintained for all manufacturing processes and for each portion of the FRP cylinder fabrication. Records shall be maintained for these control checks. Proper glass content may be shown by glass usage checks, by glass and resin application rate checks, in accordance with the material composition test in ASTM D3753, Section 8.8.1.
- 3. All required ASTM D3753 testing shall be completed and records of all testing shall be kept and copies of test results shall be presented to Owner/Engineer upon written request within a reasonable time period.
- 4. When requested by the Owner/Engineer, a certification shall be made the basis of acceptance. This shall consist of a copy of the manufacturer's test report or a statement by the supplier, accompanied by a copy of the test results, that the FRP cylinders have been sampled, tested and inspected in accordance with the provisions of ASTM D3753 and the requirements of this specification. Each certification so furnished shall be signed by an authorized agent of the supplier and manufacturer.
- 5. Rejection of FRP Wetwells/Manholes: FRP wetwells/manholes are subject to rejection on account of any of the following visual defects:
 - a. Fuzz: Glass fibers loosely adhering to wetwell/manhole which are not wet out with resin.
 - b. Protruding fibers: Glass fibers sticking out from pipe surface that are not wet out with resin.
 - c. Resin runs: Runs of resin and sand on surface of wetwell/manhole.
 - d. Dry areas: Areas in laminate with glass to wet out with resin.
 - e. Delamination: Separation in the laminate.
 - f. Blisters: Light (straw) colored areas resulting from too hot a cure.
 - g. Craze: Crack usually star shaped; caused by sharp impact.
 - h. Surface pits or voids: small air pockets on the surface or directly beneath the surface mat.
 - i. Wrinkles: Smooth irregularities on the surface.
 - j. Torn edges, end delamination and end gauges: tears and rips in the edge of cuts.
 - k. Ground area: Areas around lay-up which have been abraded and not covered by layup.
 - I. Hand lay-up ragged edges: Areas at the edge of hand lay-up that are not rolled down properly and that are rough.
 - m. Painting or gel-coating of exterior or interior laminate.

2.06 HANDLING AND STORAGE REQUIREMENTS

A. FRP Wetwell/Manhole:

- 1. FRP wetwells/manholes may be stored upright or horizontally; however, the wetwell/manhole vertical deflection shall not exceed 4% of the diameter. The wetwell/manhole shall not be dropped or impacted. If stored horizontally, the wetwell/manhole shall be chocked.
- 2. If wetwells/manholes must be moved by rolling, the ground traversed shall be smooth and free of rocks, debris, etc.
- 3. Additional handling instructions shall be in accordance with the FRP wetwell/manhole manufacturer's instructions.
- 4. Each FRP section manufactured in accordance with this specification and the Drawings shall be clearly marked to indicate the intended pump station installation location. The contractor shall be responsible for the installation of the correct FRP sections in their designated pump station locations.
- B. Handle and store precast concrete wetwell/manhole sections in accordance with manufacturer recommendations.

3.00 PART 3 - EXECUTION

- 3.01 MANHOLE CONSTRUCTION
 - A. General:
 - 1. Construct cast-in-place concrete base slabs as shown on the Drawings.
 - 2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
 - 3. Shape inverts accurately and steel trowel finish. For changes in direction of the sewer and entering branches into the wetwell/manhole, make a circular curve in the wetwell/manhole invert using as large a radius as wetwell/manhole inside diameter will permit. Place base slab integral with bottom barrel section.
 - B. Build each wetwell/manhole to dimensions indicated on Drawings and at such elevation that pipe sections built into wall of wetwell/manhole will be true extensions of line of pipe.
 - C. For all horizontal mating surfaces between concrete to concrete and concrete to metal, install resilient O-ring type gaskets.
 - D. For horizontal joints which fall below established high groundwater elevation, install a resilient O-ring type gasket in addition to (pre-molded) mastic compound.
 - E. Seal all pipe penetrations in wetwell/manhole. Form pipe openings smooth and well shaped. After installation, seal cracks with, non-shrink grout. After grout cures, wire brush smooth and apply two coats emulsified fibered asphalt compound to minimum wet thickness of 1/8 inch to ensure complete seal.
 - F. Set and adjust frame and cover final 6 inches (minimum) to 18 inches (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

- G. FRP Wetwells/Manholes:
 - 1. Install fiberglass wetwells/manholes as per manufactures installation instructions.
 - 2. FRP wetwells/manholes shall be lifted by the installation of lifting lugs as specified by the manufacturer on the outside surface near the top or by a sling or choker connection around center. Use of chains or cables in contact with the wetwell/manhole surface is prohibited. Wetwells/manholes may be lifted horizontally using one support point.
 - 3. Each excavation and backfill are to be done as part of the work under this section, including any necessary sheeting and/or bracing.
 - 4. Excavation: The limit of the excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Drainage shall be kept clear.
 - 5. The Contractor shall keep the excavation free from water by use of cofferdams, bailing, pumping, well pointing, or any combination as the particular situation may warrant. All dewatering devices shall be installed in such a manner as to provide clearance for construction, removal of forms, and inspection of exterior form work. It is the intent of these specifications that the foundation be placed on a firm dry bed. The foundation bed shall be kept in a dewatered condition a sufficient period of time to insure the safety of the structure. All dewatering methods and procedures are subject to the approval of the Owner. The excavation shall be protected from excessive rainfall, drainage and drying.
 - 6. The excavation shall be inspected and approved by the Owner before work on the structure is started. It is the intent of these specifications that the Contractor provide a relatively smooth, firm foundation bed for footings and slab that bear directly on the undisturbed earth without additional cost to the owner, regardless of the soil conditions encountered. The Owner will be the sole judge as to whether these conditions have been met.
 - 7. When necessary to protect existing or proposed structures or other improvements, the Contractor shall maintain vertical sides of the excavation. The limit shall not exceed three feet outside the footing on a vertical plane parallel to the footing except where specifically approved otherwise by the Owner. The Contractor shall provide and install any sheeting, shoring and bracing as necessary to provide a safe work area as required to protect workmen, structures, equipment, power poles, etc. The Contractor shall be responsible for the design and adequacy of all sheeting, shoring and bracing. The sheeting, shoring and bracing shall be removed as the excavation is backfilled in such a manner as to prevent injurious caving.
 - 8. Where sufficient space is available, the Contractor shall be allowed to back slope the sides of the excavation. The back slope shall be such that the excavation shall be safe from caving. The type of material being excavated shall govern the back slope used, but in any case the back slope shall be no steeper than one foot horizontal to one foot vertical.

- 9. Excavation for slabs, footings, etc. that bear on the earth shall not be carried below the elevation shown on the Drawings. In the event that the excavation is carried on below the indicated elevation, the Contractor shall bring the slab, footing, etc. to the required grade by filling with concrete having a minimum compressive strength of at least 3,000 psi at 28 days.
- 10. The bottom of the excavation shall be compacted to 95% Standard Proctor Density. The Contractor shall pour reinforced concrete base one foot deep and at least two feet larger than the FRP wetwell/manhole outside diameter. As soon as the concrete has set-up enough to support the FRP wetwell/manhole, the wetwell/manhole shall be lowered into place. A minimum of one foot of reinforced concrete shall be poured on the inside of the wetwell/manhole. Reinforced concrete shall be poured one foot deep and two feet from the wetwell/manhole wall on the outside of the wetwell/manhole. A ram neck type sealant shall be inset on the outside of the FRP wetwell/manhole around the bottom where the fiberglass and concrete come together.
- 11. A minimum of 12 inches of bedding shall be placed as a foundation for the wetwell/manhole base slab.
- 12. Do not backfill until the concrete base has hardened sufficiently to provide rigid support for both the wetwell/manhole and backfill. Unless otherwise shown on the Drawings, sand shall be used for backfill around the wetwell/manhole for a distance of two feet from the external surface of the fiberglass wetwell/manhole and extending from the bottom of the excavation to the bottom of the top slab.
- 13. Contractor shall use extreme caution when backfilling and compacting around the perimeter of the FRP wetwell/manhole so as not to crack or damage the wetwell/manhole.
- 14. Suitable material chosen from the excavation may be used for the remainder of the backfill. The material shall be free of large lumps or clods, which will not readily break down under compaction. This material shall be subject to approval by the Owner.
- 15. Backfill material shall be free of vegetation or other extraneous material. Excavated materials which are to be used for fill or backfill may be stockpiled on the site. Location of stockpiles shall be approved by the Owner. Top soil shall be stockpiled separately and used for finish grading around the structure.
- 16. Backfill shall be placed in layers of not more than 12 loose measure inches and mechanically tamped to at least 95% Standard Proctor Density. Flooding will not be permitted. Backfill shall be placed in such a manner as to prevent any wedging action against the structure.
- 17. One foot outside of the FRP wetwell/manhole and a minimum of six (6) inches thick.
- 18. Pre-cast concrete bases are permitted with Owner pre-approval for installation with the wetwell/manhole. If such bases are used and are to be set with the wetwell/manhole, all lifting shall be done on the base itself with Owner approved lifting eyes or loops and not the wetwell/manhole structure.
- 19. Wetwell/manhole manufacturer shall provide a competent representative, knowledgeable in the installation of fiberglass wetwells/manholes, to inspect the

concrete base and provide Owner with a letter certifying that the base has been inspected and is suitable for installation of the wetwell/manhole.

- 20. Wetwell/manhole cutouts may be made in the FRP wetwell/manhole using a circular saw, saber saw, hole saw or similar equipment with a masonry type blade. Axes, hammers, chisels, or similar impact type tools shall not be used.
- 21. Fiberglass wetwell and manhole structures to have fabricated stubouts and connections. (unless otherwise stated.)
- 22. Stubouts and connections:
- a. Type I: Make the cutout in the wetwell/manhole wall equivalent to the outside diameter of the pipe plus ½ inch maximum. Slip the pipe into position and apply industrial grade silicone around the pipe next to the wetwell/manhole wall cutout on the inside and the outside. Cover the outside silicone area with epoxy grout and backfill.
- b. Type 2: Make the cutout in the wetwell/manhole wall equivalent to the outside diameter of the pipe plus ½ inch maximum. Grind the outside surface of the pipe and both the inside and the outside surfaces of the cutout in the wetwell/manhole wall. Apply a priming agent to any PVC pipe that might be used before fiberglass lay-up. Insert the pipe through the cutout in the wall of the wetwell/manhole and apply fiberglass putty to the inside and outside of the wetwell/manhole wall cutout, filling openings between the pipe and cutout. Make a good radius for the fiberglass lay-up. After the putty has set-up, fiberglass the pipe into place. Use one layer of woven roving sandwiched between two layers of fiberglass mat. Allow the fiberglass to completely set before backfilling. Fiberglass lay-up method shall comply with ASTM D3299.
- c. Type 3: Install Insert-A-Tee type fittings per manufacturer's instructions (Fowler Manufacturing Company or approved equal).
- d. The fiberglass top may have stubouts installed or may have a raised fiberglass collar around the hatch opening. The fiberglass top has been designated to withstand the weight of a concrete reinforced slab to be installed over it.
- H. Debris must be removed from the wetwell/manhole by the Contractor before the wetwell/manhole will be accepted.
- I. Build each wetwell/manhole to dimensions indicated on Drawings and at such elevation that pipe sections built into wall of wetwell/manhole will be true extensions of line of pipe.
- J. For all horizontal mating surfaces between concrete to concrete and concrete to metal, install resilient O-ring type gaskets.
- K. For horizontal joints which fall below established high groundwater elevation, install a resilient O-ring type gasket in addition to (pre-molded) mastic compound.
- L. Seal all pipe penetrations in wetwell/manhole. After installation, seal cracks with, non-shrink grout. After grout cures, wire brush smooth and apply two coats emulsified fibered asphalt compound to minimum wet thickness of 1/8 inch to ensure complete seal.
- M. Set and adjust wetwell/manhole frame and cover final six (6) inches (minimum) to 18 inches (maximum) to match finished pavement or finished grade elevation using adjuster rings.

3.02 FIELD TESTING

A. All wetwells/manholes shall be field tested to verify watertightness:

02515 – Page 12 of 14

- 1. Hydrostatic Exfiltration Test:
 - a. All wastewater lines coming into the wetwell/manhole shall be sealed with an internal pipe plug.
 - b. Fill the wetwell/manhole with water and maintained full for at least one hour
 - c. For concrete wetwells/manholes a wetting period of 24 hours may be used prior to testing in order to allow saturation of the concrete.
 - d. The maximum leakage of hydrostatic testing shall be 0.025 gallons per foot diameter per foot of wetwell/manhole depth per hour.
- 2. Vacuum Test
 - a. All wastewater lines coming into the wetwell/manhole shall be sealed with a plug braced adequately to prevent them from being drawn into the wetwell/manhole.
 - b. Plugs shall be installed beyond drop connections or stub-outs.
 - c. The test head shall be placed inside the frame at the top of the wetwell/manhole and inflated in accordance with the manufacturer's recommendations.
 - d. A vacuum of 10-inches of mercury shall be drawn, and the vacuum pump will be turned off.
 - e. With the valve closed the level of vacuum shall be read after the required test time as shown in the table below.
 - f. If the drop in vacuum level is less than one-inch of mercury at the end of the required test time the wetwell/manhole will have passed the vacuum test.

Manhole Depth (Ft.)	4-Foot Diameter	5-Foot Diameter	6-Foot Diameter
0 – 20'	0 m 50 sec	1 m 05 sec	1 m 20 sec
20' – 24'	1 m 00 sec	1 m 18 sec	1 m 36 sec
Over 24' *	0 m 05 sec	0 m 6.5 sec	0 m 08 sec

Minimum Time Required for Vacuum Drop of 1" Mercury

* Add these items to that required for wetwells/manholes 20 to 24 feet deep for every two (2) feet of depth greater than 24 feet.

B. Structures failing watertight testing shall be rejected. Contractor shall either fix and retest the failing structure or replace the structure at no additional cost to the Owner.

3.03 INSPECTION

A. FRP Wetwell/Manhole:

- 1. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other designated representative of the Owner. Such inspections shall be made at the place of manufacture or at the site of delivery. The sections shall be subject to rejection on account of failure to meet any of the specification requirements as specified herein. Sections rejected after delivery to the job site shall be marked for identification and shall be removed from the job at once. All sections which have been damaged after delivery will be rejected, and if already installed shall be acceptable if repaired or removed and replaced at the Contractor's expense.
- 2. At the time of inspection the material shall be examined for compliance with the requirements of this specification and the approved drawings.

END OF SECTION

1.00 PART 1 - GENERAL

- 1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE
 - A. Trenching, Backfilling and Compacting: Section 02221.
 - B. Valves and Appurtenances: Section 15100.

1.02 SUBMITTALS

- A. Conform to requirements of Section 01300 Submittals.
- B. Manufacturer's Literature: Manufacturer's descriptive literature and recommended method of installation.
- C. Certificates: Manufacturer's certification that products meet specification requirements.
- 1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials on manufacturer's original skids or in original unopened protective packaging. OWNER reserves the right to reject surplus material from a different project/jobsite.
 - B. Protect materials during transportation, storage, and installation to avoid physical damage.

1.04 GENERAL DESCRIPTION OF WORK COVERED

A. Furnish and install all pipe, fittings, structures and accessories required for water transmission line and/or pressure sewer lines.

1.05 QUALITY ASSURANCE

- A. Comply with the latest published edition of American Water Works Association (AWWA) Standards:
 - 1. AWWA C104 Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
 - 2. AWWA C105 Polyethylene Encasement for Ductile Iron Pipe Systems
 - 3. AWWA C110 & C110a Gray Iron and Ductile-Iron Fittings, 2-inch through 48-inch for Water and Other Liquids.
 - 4. AWWA C111 Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings.
 - 5. AWWA C115 Flanged Ductile Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
 - 6. AWWA C150 Thickness Design of Ductile-Iron Pipe.
 - 7. AWWA C151 Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
 - 8. AWWA C153 Ductile-Iron Compact Fittings, 3-inch through 24-inch, and 54-inch through 64-inch for Water and Other Liquids.
 - 9. AWWA C 600 Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
 - 10. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 12-inch for water.
 - 11. AWWA C907 Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4-inch through 8-inch.
 - 12. AWWA C909 Polyvinyl Chloride (PVC) Pressure Pipe 6-inch through 12-inch for water.
 - 13. AWWA C905 Polyvinyl Chloride (PVC) Pressure Pipe 14-inch through 36-inch for water.
 - 14. AWWA C301-99 Pre-stressed Concrete Pressure Pipe Steel Cylinder Type, for water and other liquids.
- B. Comply with the latest published editions of the American Society for Testing and Materials (ASTM) Standards:

<u>SECTION 02556</u> - WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

- 1. D 1248 Polyethylene Plastics Molding and Extrusion Materials.
- 2. D 2241 Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR).
- 3. D 3139 Joints for PVC Pressure Pipes using Flexible Elastomeric Seals.
- 4. G 62 Test Methods for Holiday Detection in Pipeline Coatings.
- C. Comply with the latest published editions of Plastics Pipe Institute (PPI) Standards:
 - 1. TR2 PPI PVC Range Composition, Listing of Qualified Ingredients.
- D. Comply with the latest published editions of Canadian Standards Association (CSA) Standards:
 1. CSA B137.3 Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.
- E. Comply with the latest published editions the Steel Structures Painting Council (SSPC) Standards, for Commercial Blast Cleaning.

2.00 PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Water Pipe: Pipe furnished shall be Polyvinyl Chloride (PVC). Ductile Iron (DI) pipe shall be provided only where specifically identified on the Drawings or in the Specifications.
- B. Wastewater Pipe: Pipe shall be Polyvinyl Chloride (PVC) for buried service, and flanged Ductile Iron (DI) for non-buried service unless shown otherwise on the Drawings or Specifications.
- C. All pipe and fittings shall be marked in accordance with the applicable standard specification under which the pipe is manufactured unless otherwise specified.
- D. The quality of materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the ENGINEER at the pipe manufacturing plant and at the project site prior to and during installation. All water distribution pipe and fittings shall be listed in the Fire Protection Equipment Directory published by the Underwriter's Laboratories, Inc. or shall be Factory Mutual approved for fire service.

2.02 POLYVINYL CHLORIDE PIPE (PVC)

- A. Water Pipelines:
 - 1. Pipe shall be blue in color.
 - Water lines 12-inch and smaller may be constructed of PVC water pipe, Pressure Class 150, in accordance with AWWA C900 (DR18) or AWWA C909 unless otherwise noted on drawings.
 - 3. Water lines 14-inch through 24-inch may be constructed of PVC water pipe in accordance with AWWA C905 (DR 18) unless otherwise noted on drawings.
 - 4. Water lines 30-inch and larger shall not be constructed of PVC.
- B. Wastewater Pipelines:
 - 1. Pipe shall be green in color.
 - 2. Forcemains 12-inch and smaller may be constructed of PVC pipe in accordance with AWWA C900 (Pressure Class 150, DR18), AWWA C909 (Class 150), or ASTM 2241 (Pressure Rated 160 psi, SDR 26).

- 3. Forcemains 14-inch through 24-inch may be constructed of PVC pipe in accordance with AWWA C905 (Pressure Rated 165 psi, DR 25) or ASTM 2241 (Pressure Rated 160 psi, SDR 26).
- 4. Forcemains 30-inch and larger may be constructed of PVC pressure pipe in accordance with AWWA C905 (Pressure Rated 165 psi, DR25).
- C. Where PVC pipeline is installed using non-encased, trenchless methods, the pipe shall conform to all preceding requirements for PVC pipe and may be one of the following:
 - Jointless PVC conforming also to the requirements of PPI TR2. The pipe shall be extruded with plain ends square to the pipe and free of any bevel or chamfer. Pipe shall be Fusible C900[™] or Fusible C905[™] as manufactured by Underground Solutions, Sarver, PA.
 - Restrained joint PVC having non-metallic couplings incorporating high-strength, flexible thermoplastic splines which shall be inserted in to mating, precision-machined grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading. Couplings shall be designed for use at or above the pressure class/rating of the pipe on which they are installed, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F 477. Pipe shall be C900/RJ[™] or C905/RJ[™] as manufactured by CertainTeed Corporation, Valley Forge, PA.
- D. Provide push-on joints with bell integrally cast into pipe or with coupling of same material as pipe.
- E. Use elastomeric gaskets, as provided in AWWA C900 or ASTM D3139.
- F. On PVC pipelines, provide compatible fittings meeting or exceeding all requirements and ratings for the pipe on which they are installed. Use long radius fittings where possible.
 - 1. For water lines, provide either AWWA C907 PVC or ductile iron fittings as shown on the Drawings.
 - 2. For wastewater forcemains, fittings shall be one of the following:
 - a. AWWA C907 PVC or 200 psi Pressure Rated PVC for 8-inch and smaller sizes.
 - b. Fabricated PVC for 10-inch through 24-inch sizes. Fittings shall be made from segments of AWWA C900, C905, or ASTM 2241 PVC pipe bonded together and over-wrapped with fiberglass-reinforced polyester.
 - c. Ductile iron on 14-inch and larger lines conforming to AWWA C905. Ductile iron fittings for wastewater service shall be coated as specified for Ductile Iron Pipe.
- G. Provide sleeve type or restraint follower glands where indicated or required to join pipe or provide restraint to offset internal or hydrostatic test pressures.
- H. All pipe shall be designed and installed with a minimum of four foot cover.
- I. PVC pipe shall be marked to indicate the following:
 - 1. Nominal Pipe Size.
 - 2. Material Code Designation.
 - 3. Standard Dimension Ratio.
 - 4. Pressure Rating.
 - 5. Manufacturer's name or trademark.
 - 6. National Sanitation Foundation Seal.
 - 7. Appropriate AWWA or ASTM designation number.
- 2.03 DUCTILE IRON PIPE (DIP)

<u>SECTION 02556</u> - WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

- A. Ductile iron push-on and mechanical joint pipe for buried service shall meet all requirements of standard AWWA C151, Class 350. Provide push-on joints unless otherwise indicated on the Drawings.
- B. Ductile iron flanged pipe for non-buried service shall meet all requirements AWWA C115. Flanges shall be fabricated and attached to the pipe barrels by U.S. fabricators using flanges and pipe barrels of U.S. manufacture. If fabrication is to be by other than the pipe barrel manufacturer, a complete product submittal and approval by the Utility will be required. Additionally, such fabricator shall furnish certification that each fabricated joint has been satisfactorily tested hydrostatically at a minimum pressure of 250 psi
- C. Joints shall meet all requirements of AWWA C111 for push-on, mechanical, and flanged pipe. Threaded- or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.
- D. Provide manufacturer's certifications that all ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at the factory.
- E. Joint Materials:
- 1. Gaskets for ductile iron pipe shall conform to AWWA C111.
- Joining of slipjoint iron pipe shall be accomplished with the natural or synthetic rubber gaskets of the manufacturer of that particular pipe being used. Pipe to be installed in areas potentially contaminated by petroleum shall have nitrile rubber gaskets. Where other contaminants are present, gaskets shall be as recommended by the pipe manufacturer.
- 3. Gaskets for flanged joints shall be continuous full face gaskets, of 1/8 inch minimum thickness of natural or synthetic rubber, cloth reinforced rubber or neoprene material, preferably of deformed cross section deign and shall meet all applicable requirements of AWWA C111 for gaskets. Flange gaskets shall be manufactured by, or satisfy all recommendations of, the manufacturer of the pipe/fittings being used.
- 4. Tee-head bolts, nuts, and washers for mechanical joints shall be high strength, low alloy, corrosion resistant steel stock equal to "COR-TEN A" having UNC Class 2 rolled threads or alloyed ductile-iron conforming to ASTM A 536; either shall be fabricated in accordance with ASTM B18.2 with UNC Class 2 rolled threads.
- Hex-head bolts and nuts shall satisfy the chemical and mechanical requirements of ASTM A449 SAE Grade 5 plain, and shall be fabricated in accordance with ASTM B 18.2 with UNC Class 2 rolled threads.
- Bolts, washers and nuts on flanged fittings shall be Grade B, ASTM A-307, 304 stainless steel. In corrosive environments such as wastewater lift station wetwells, bolts, nuts, and washers shall be 316 stainless steel and shall be coated after assembly in the same manner specified above for piping.
- 7. All threaded fasteners shall be marked with a readily visible symbol cast, forged or stamped on each nut and bolt, which will identify the fastener material and grade. The producer and the supplier shall provide adequate literature to facilitate such identification; painted markings are not acceptable.
- F. Polyethylene Film Wrap:
 - All iron pipe, fittings, and accessories including polyurethane coated pipe shall be wrapped with standard 8-mil (minimum) low density polyethylene film or r-fill (minimum) cross laminated highdensity polyethylene conforming to AWWA C105, with all edges overlapped and taped securely with duct tape to provide a continuous wrap to prevent contact between the piping and the surrounding backfill. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling.

- 2. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners. Alternatively, provide bolts made of Type 304 stainless steel.
- G. Markings: Each ductile iron pipe joint and fitting shall be marked as required by the applicable AWWA specification including the following:
 - 1. Manufacturer's identification.
 - 2. Country where cast.
 - 3. Year of casting.
 - 4. "DUCTILE" or "DI".
 - 5. Barrels of flanged pipe shall show thickness class; others shall show pressure class.
 - 6. The flanges of pipe sections shall be stamped with the fabricators identification.
 - 7. Fittings shall show pressure rating and the nominal diameter of openings and the number of degrees for bends.
 - 8. Painted markings are not acceptable.
- H. Linings and Coatings:
 - 1. Interior:
 - a. Pipe and fittings for water pipelines shall be cement-mortar lined and seal coated as required by AWWA C104. The type and brand of interior lining shall be clearly marked on the outside of the pipe and fittings. Except as authorized by the ENGINEER, only one type and brand of pipe lining shall be used on a given project.
 - b. Pipe and fittings for wastewater pipelines shall be coated to a minimum 40 mils dry film thickness with an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Coating shall be "Protecto 401" ceramic epoxy, as manufactured by Induron Protective Coatings or equal.
 - 2. Exterior:
 - a. Buried ductile iron piping and fittings shall have a prime coat and outside asphaltic coating conforming to the applicable AWWA standard for the pipe or fitting being installed. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer and approved by the ENGINEER as resistant to the contaminants identified.
 - Above-ground ductile iron piping shall have a shop prime with one coat of Koppers No. 621 Rust Inhibitive Primer or equal, and a finish coat of Tnemec 75 Endura-Shield or equal.
 - c. Ductile iron piping and fittings in non-buried, corrosive environments such as wastewater lift station wetwells shall be coated as follows:
 - 1) Minimum 25 mils DFT with "Ceramawrap" ceramic epoxy as manufactured by Induron Protective Coatings.
 - 2) Minimum 40 mils DFT with "Corropipe II TX-15 (AM)" as manufactured by Madison Chemical. 3) Or equal.
 - d. Non-buried pipe with specified coating shall be provided with touch-up kit for field repair of damaged coating.
 - e. Pipe and fittings to receive external coating shall be shop primed or delivered to the coating applicator bear as recommended by the manufacturer of the finish coat. Pipe and fittings for non-buried service receiving asphaltic coating at any point prior to application of the specified coating are not acceptable.

2.04 DUCTILE IRON PIPE FITTINGS

- A. Fittings shall be flanged for above-ground service or mechanical joint for buried service unless otherwise indicated or approved, and shall meet all requirements of the following standards:
 - 1. AWWA C110 or AWWA C153 (buried service only).
 - 2. AWWA C111.

<u>SECTION 02556</u> - WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

- B. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings.
- C. Where long radius bends are indicated, fittings shall have center-to-face and radius dimensions according to the ANSI B16.1 Class 125 standard for long radius bends, and shall conform to all other applicable requirements of AWWA C110 including pressure rating.
- D. Shall be compatible with joint type of adjacent pipe.
- E. Provide all specials, taps, plugs, flanges and wall fittings as required.
- F. Linings and coatings for ductile iron fittings shall be as specified for ductile iron pipe.

2.05 VALVES, HYDRANTS, METERS AND APPURTENANCES

- A. For valve requirements refer to Section 15100.
- B. Valve Boxes:
 - 1. Provide for all buried valves.
 - 2. Use nominal 6 inch cast-iron sliding type pipe shaft with cover and base casting.
 - 3. Set box top at finished grade.
 - 4. Furnish drop cover appropriately marked "WATER".

C. Corporation Stops:

- 1. Conform to AWWA C800.
- 2. Use 3/4 inch unless indicated otherwise.
- D. Hydrants:
 - 1. Design: latest edition of AWWA C502, traffic model with break flange.
 - a. Mueller Centrurion A423
 - b. American-Darling B-84-B
 - c. Kennedy Guardian K-81A
 - d. U.S. Pipe Metropolitan
 - e. Others as approved by OWNER in writing
 - 2. Provide 6 inch inlet, 2 2> inch hose nozzles, 1 4> inch pumper.
 - 3. Provide compression type main valve, minimum size 5< inches.
 - 4. Pentagon operating nut.
 - 5. Design to open counterclockwise.
 - 6. Provide mechanical joint bell on footpiece.
 - 7. Furnish depth as noted on plans.
 - 8. Furnish National (American) Standard Fire Hose Coupling Screw Thread (NH).
- E. Polyethylene Wrapping:
 - 1. Material: AWWA C105.
 - 2. Thickness: 8 mils.
- F. Polyethylene Plastic Pipe (PE):
 - 1. Material: ASTM D2737.
 - 2. Fittings: ASTM D2683.
 - 3. Size: 3/4 inch unless shown otherwise on plans.
- G. Copper Pipe (CU):
 - 1. Material: seamless, Type K, ATM B88.

- 2. Fittings: wrought copper solder joint or flared.
- 3. Size: 3/4 inch unless shown otherwise on plans.

3.00 PART 3 - EXECUTION

3.01 GENERAL

A. Provide all labor, equipment and materials, and install all pipe fittings, specials and appurtenances as indicated or specified.

3.02 PIPE INSTALLATION

A. Handling:

- 1. Handle in a manner to insure installation in sound and undamaged condition.
 - a. Do not drop or bump.
 - b. Use slings, lifting lugs, hooks and other devices designed to protect pipe, joint elements, and coatings.
- 2. Ship, move and store with provisions to prevent movement or shock contact with adjacent units.
- 3. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.

B. Installation:

- 1. Utilize equipment, methods, and materials insuring installation to lines and grades as indicated.
- 2. Do not lay piping on blocks unless pipe is to receive total concrete encasement.
- 3. Accomplish horizontal and vertical alignment adjustments with fittings or deflection of joints. a. Limit joint deflection:
 - 1) Conform to AWWA C600 for ductile iron pipe.
 - 2) Not more than 80% of pipe manufacturer's recommended maximum for PVC pipe.
- b. Use short specials preceding curves as required.
- c. Obtain approval of ENGINEER of method proposed or transfer of line and grade from control to the work.
- 4. Install pipe of size, material, strength class, and joint type with embedment as shown on the Drawings or specified herein.
- 5. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during discontinuance of installation.
 - a. Close open ends of pipe with snug fitting closures.
 - b. Do not let water fill trench. Prevent flotation of pipe where potential for trench flooding is present.
 - c. Remove water, sand, mud and undesirable materials from trench before removal of end cap.
- 6. Inspect pipe prior to installation to determine if any pipe defects are present.
- 7. Brace or anchor as required to prevent displacement after establishing final position.
- 8. Perform only when weather and trench conditions are suitable. Do not lay pipe in water.
- 9. Observe extra precaution when hazardous atmospheres might be encountered.
- 10. Sanitary sewer separation distance from water lines:
 - a. Conform to all TCEQ requirements for separation.
 - b. Maintain 9-foot horizontal separation whenever possible.
 - c. When conditions prevent a lateral separation of 9 feet, water line may be installed closer to a sewer subject to the following conditions:
 - 1) Crossings: Sewer shall be constructed of PVC pipe meeting the requirements specified above for pressure sewer lines and have a minimum working pressure rating of 150 psi

<u>SECTION 02556</u> - WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

or greater for pipe and fittings. The water line may be placed no closer than 6 inches from the sewer. The separation distance shall be measured between the nearest outside pipe diameters. The water line shall be located at a higher elevation than the sewer line whenever possible and one length of the sewer pipe must be centered on the water line;

- Parallel Alignment: the water line shall be separated by a minimum vertical distance of 2-feet (water above sewer) and a minimum horizontal distance of 4-feet, measured between the nearest outside diameters of the pipes.
- 11. Separation of water lines from sewer manholes:
 - a. No water pipe shall pass through or come in contract with any part of a sewer manhole.
 - b. A minimum horizontal separation of 9 feet shall be maintained.
- 12. Construct service lines where shown on plans in accordance with Standard Detail Drawing. Use pipe material specified on plans or in contract documents.
- 13. Wrap ferrous pipe, fittings and tie rods with polyethylene where shown on plans in accordance with AWWA C105.
 - D. Jointing:
- 1. General requirements:
 - a. Locate joint to provide for differential movement at changes in type of pipe embedment, at changes from rock to soil trench bottom, and within 18 inches of structure walls.
 - b. Perform in accordance with manufacturer's recommendations.
 - c. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
 - d. Utilize methods and equipment capable of fully homing or making up joints without damage.
 - e. Check joint opening and deflection for specification limits.
- 2. Special provisions for jointing ductile iron pipe:
 - a. Conform to AWWA C600.
 - b. Visually examine while suspended and before lowering into trench.
 - 1) Paint bell, spigot, or other suspected portions with turpentine and dust with cement to check for cracks invisible to the eye.
 - 2) Remove turpentine and cement by washing when test is satisfactorily completed. 3) Reject all defective pipe.
- 3. Special provisions for jointing and laying PVC pipe:
 - a. Conform to AWWA C600 and ASTM D2321.
 - b. Allow pipe to reach trench soil temperature prior to installation in ditch.
 - E. Cutting:
 - 1. Cut in neat workmanlike manner without damage to pipe.
 - 2. Cut cast-iron with Carborumdum saw or other approved method.
 - a. Smooth cut by power grinding to remove burrs and sharp edges.
 - b. Repair lining as required and approved by Engineer.
 - F. Closure Pieces:
 - 1. Connect two segments of pipelines or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
 - 2. Observe specifications regarding location of joints, type of joints and pipe materials and strength classifications.
 - 3. May be accomplished with sleeve coupling of rating equal to or greater than that of pipe:
 - a. Of length such that gaskets are not less than 3 inches from pipe ends.
 - b. Include spacer ring identical to pipe end such that clear space does not exceed 1/4 inch.
 - G. Temporary Plugs:
 - 1. Install whenever installed pipe is left unattended.
 - 2. Use water-tight plug rated for 150 psi or greater.
H. Joint Restraint:

- 1. Thrust Blocks:
 - a. Provide for all horizontal or vertical bends.
 - b. Use on all dead-ends, tee fittings, and changes in pipe diameter.
 - c. Install as indicated on Standard Detail Drawing.
 - d. Construct to undisturbed edge of trench for bearing.
 - e. Mechanical joints shall be protected by felt roofing paper prior to placing concrete. Concrete shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms or sand bags shall be provided for thrust blocks.
 - f. Provide minimum bearing area in square feet. based on 150 psi test pressure and 2000 psf soil bearing capacity and as shown on construction drawings.
 - g. Adjust thrust block areas accordingly if pressures and/or soil bearing capacity varies
- 3. Restraint follower glands for use with mechanical joint fittings shall be used in addition to thrust blocks where indicated on the Drawings. Restraint gland shall have torque limiting twist-off nuts and shall meet the requirements of ASTM 1674-96 for use with PVC pipe and be equal to "MEGALUG®" as manufactured by EBAA Iron, Eastland, TX.
- I. After installation, non-buried pipe shall be visually inspected for damage to protective coating and repaired using coating manufacturer's repair kit.

3.03 VALVE AND APPURTENANCE INSTALLATION

- A. Valves:
 - 1. Install with stems vertical when installation is horizontal.
 - 2. Set valves on concrete thrust block having four (4) square feet of bearing area on undisturbed earth.
- B. Valve Boxes:
 - 1. Center on valves.
 - 2. Carefully tamp earth around each valve box to a distance of 4 feet on all sides of box or to undisturbed trench face, if less than 4 feet.
- C. Hydrants:
 - 1. Set hydrants where shown on plans in accordance with Standard Detail Drawing.
 - 2. Install gravel, blocks and anchors in accordance with Standard Detail Drawing.
 - 3. Set reference elevation 3 inches above existing grade or to elevation established by ENGINEER (not to exceed 6 inches).
 - 4. Break-a-way flange to be either ground level where applicable or between 3 inches and 6 inches above curb as established by Engineer.

3.04 ACCEPTANCE TESTS FOR PRESSURE MAINS

- A. Perform hydrostatic pressure and leakage test.
 - 1. Conform to AWWA C600 procedures.
 - a. As modified herein.
 - b. Shall apply to all pipe materials specified.
 - 2. Perform after backfilling.
- B. Test separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs.
 - 1. Contractor to furnish and install test plugs, including all anchors, braces and other temporary or permanent devices to withstand hydrostatic pressure on plugs, at no additional cost to the Owner.

<u>SECTION 02556</u> - WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

- 2. Contractor responsible for any damage to public or private property caused by failure of plugs.
- C. Limit fill rate of line to available venting capacity. Fill rate shall be regulated to limit velocity in lines when flowing full to not more than 1 fps.
- D. OWNER will make water for testing available to contractor at nearest source. Valves of existing water system will at all times be operated by City personnel only.
- E. Pressure test:
 - 1. Conduct at pressure at least 1.5 times the normal working pressure (not less than 150 psi test pressure).
 - 2. Maintain pressure for a minimum of two (2) hours.
 - 3. Test pressure shall not vary by more than +5 psi
- F. Leakage Test:
 - 1. Conduct concurrently with the pressure test.
 - 2. Maintain pressure for a minimum of two (2) hours.
 - 3. Acceptable when leakage does not exceed that determined by the following formula:

$$L = \underline{N} \cdot \underline{D} \cdot \underline{P}_{0.5}$$
7400

- L = Maximum permissible leakage in gallons per hour.
- N = Number of pipe joints in segment under test.
- D = Nominal internal diameter of pipe being tested in inches.
- P = Average actual leakage test pressure, psig.
- 4. Repeat leakage test as necessary:
 - a. After location of leaks and repair or replacement of defective joints, pipe or fittings.
 - b. Until satisfactory performance of test.
 - c. At no increase in cost to the OWNER.
- G. Refit and replace all pipe not meeting the leakage or pressure requirements. Repair clamp is not permitted.
- H. Repair all visible leaks regardless of the amount of leakage.
- I. OWNER or ENGINEER will observe all tests.

3.05 DISINFECTION OF PIPELINES FOR CONVEYING POTABLE WATER

- A. CONTRACTOR to provide all equipment and materials and perform in accordance with AWWA C601.
 - 1. As modified herein.
 - 2. Include chlorination and final flushing.
- B. Add chlorine to attain an initial concentration of 50 mg/l chlorine with 10 mg/l remaining after 24 hours.

- C. Flush main until concentration is 2 mg/l or less prior to placing main in service.
- D. Obtain approval of materials and methods proposed for use.
- E. May be conducted in conjunction with acceptance tests.
- F. Dispose of flushing water without damage to public or private property.
- G. Repeat disinfection procedure should initial treatment fail to yield satisfactory results.1. At no additional cost to the OWNER.
 - 2. OWNER will provide water under terms specified for acceptance tests.
- H. Do not exceed 500 gpm rate in flushing.
- I. Provide safe bacterial sample results before placing main into service.

4.00 PART 4 - MEASUREMENT AND PAYMENT

4.01 PRESSURE LINES

- A. Payment of the labor, equipment and personnel needed for the activities specified under this section are subsidiary to the other items of the bid. Line along the center of the pipe includes fittings or other pipe connections.
- B. Compensation will be for furnishing all materials, labor, equipment, tools and incidental work required by the construction of the pressure line, all in accordance with the plans and these specifications.
- C. If pressure line fails any test procedure, trouble spot is to be corrected all as incidental to the construction of the pressure line.

END OF SECTION

1.00 GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

- A. Trenching, Backfilling and Compacting for Utilities: Section 02221
- B. Force Mains: Section 02556
- C. Wetwells and Manhole Structures: Section 02515

1.02 SUBMITTALS

- A. Conform to requirements of Section 01300 Submittals.
- B. Manufacturer's Literature: Manufacturer's descriptive literature and recommended method of installation.
- C. Certificates: Manufacturer's certification that products meet specification requirements.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials on manufacturer's original skids or in original unopened protective packaging. OWNER reserves the right to reject surplus material from a different project/jobsite.
- B. Protect materials during transportation, storage, and installation to avoid physical damage.

1.04 GENERAL DESCRIPTION OF WORK COVERED

A. Furnish and install all sewer pipe, fittings and structures, and accessories required for sanitary sewer construction as indicated.

1.05 QUALITY ASSURANCE

- A. Comply with latest published editions of American Society of Testing and Materials (ASTM) Standards:
 - 1. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 2. ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - 3. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 4. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 5. ASTM F679 Standard Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings (SDR35).
 - 6. ANSI A21.11 Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings.
 - 7. ASTM D3753 Standard Specification for Glass Fiber Reinforced Polyester Manholes.
 - 8. ASTM C-923 Standard Specification for Resilient Manhole Connectors.
 - 9. ASTM C-1244 Specification for Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
 - 10. ASTM D-1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds, and Chlorinated Poly (Vinyl Chloride) (CPVC) Compound.

- 11. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 12-inch for water distribution.
- 12. AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14inch through 36-inch.
- 13. ASTM 2241 Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR PR Series).

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide PVC pipe and fittings as standard material unless specifically identified otherwise on the Drawings. PVC fittings shall have rating/thickness equal to or greater than that for the pipe on which they are installed. Ductile iron fittings are not acceptable and will be rejected unless specifically indicated on the Drawings and approved beforehand by the Engineer.
- B. All pipe shall be marked in accordance with applicable standard specification under which pipe is manufactured unless otherwise specified.
- 2.02 POLYVINYL CHLORIDE PLASTIC PIPE (PVC)
 - A. Unless otherwise required for trenchless installation or for water line crossings, provide pipe and fittings complying with ASTM D3034 or ASTM F679, manufactured using material conforming to ASTM D1784, and having wall thickness equivalent to SDR 26. Joints shall be single elastomeric gasket push-on type complying with ASTM F477 and D3212.
 - B. Where PVC gravity sewers cross water lines and where indicated on the plans, sewer shall conform to the following standards and have a minimum pressure rating of 150 psi for pipe, joints, and fittings:
 - 1. AWWA C900 (DR 18)
 - 2. AWWA C905 (DR 25)
 - 3. ASTM 2241 (SDR 26)
 - C. Where PVC gravity sewer is installed using non-encased, trenchless methods, pipe may be one of the following having minimum wall thickness corresponding to SDR 18:
 - 1. Jointless PVC conforming also to the requirements of PPI TR2. The pipe shall be extruded with plain ends square to the pipe and free of any bevel or chamfer. Pipe shall be Fusible C900[™] or Fusible C905[™] as manufactured by Underground Solutions, Sarver, PA.
 - 2. Restrained joint PVC having non-metallic couplings incorporating high-strength, flexible thermoplastic splines which shall be inserted in to mating, precision-machined grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading. Couplings shall be designed for use at or above the pressure class/rating of the pipe with which they are installed, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F 477. Joints shall be designed to meet the zero leakage test requirements of ASTM D3139. Pipe shall be C900/RJ[™] or C905/RJ[™] as manufactured by CertainTeed Corporation, Valley Forge, PA.
 - D. All PVC pipe for sewer service shall be green in color.
 - E. Lubricant for jointed pipe to be in accordance with the requirements of ASTM D3212. Lubricant to be suitable for lubricating the parts of the joints in the assembly. The lubricant shall not have any deteriorating effects on the gasket and pipe materials.
 - F. Service laterals shall be Schedule 40 PVC in accordance with ASTM D1785 and D2665.
 - G. Mark all pipe and fittings.

2.03 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe and fittings for sanitary sewer service shall be provided only where specifically indicated on the Drawings.
- B. Comply with the latest published edition of American Water Works Association (AWWA) Standards:
 - 1. AWWA C110 & C110a Gray Iron and Ductile-Iron Fittings, 2-inch through 48-inch for water

and other liquids.

- 2. AWWA C111 Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings.
- 3. AWWA C150 Thickness Design of Ductile-Iron Pipe.
- 4. AWWA C151 Ductile-Iron Pipe, centrifugally cast in metal mold or sand lined molds, for water or other liquids.
- 5. AWWA C153 Ductile Iron Compact Fittings, 3-inch through 12-inch for water and other liquids.
- 6. Polyethylene encasement for the protection of ductile and cast iron pipes, fittings valves, and appurtenances shall be furnished and installed in accordance with the requirements of AWWA C105.
- C. Linings and Coatings
 - 1. Interior Lining: Ductile iron pipes, fittings, valves, and appurtenances for sanitary sewer service shall be furnished with corrosion resistant interior lining furnished by the manufacturer:
 - a. Ceramic-Epoxy "Protecto 401" as manufactured by Induron Protective Coatings and applied by certified applicator.
 - d. Engineer Approved Equal
 - 2. Exterior Coating: Buried ductile iron pipe and fittings shall have a prime coat and outside asphaltic coating conforming to the applicable AWWA standard for the pipe or fitting being installed. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer and approved by the Engineer as resistant to the contaminants identified. Refer to Section 02556 for requirements relating to above-ground or exposed ductile iron piping.

2.04 MANHOLES, STRUCTURES AND PIPE ACCESSORIES

- A. Fittings
 - 1. Fittings allowed only on manhole/wetwell drop connections.
 - 2. Fittings shall equal or exceed quality and rating of pipe.
 - 3. Fittings shall be heavy wall PVC conforming to ASTM D3034 (SDR 26) and F1336.
 - 4. Joints shall be single elastomeric gasket push-on type complying with ASTM F477 and D3212. Gaskets shall meet the same performance requirements of the sewer pipe to be installed.
- B. Fiberglass Manholes
 - 1. Fiberglass manholes shall be in accordance with ASTM D3753. Refer to Section 02515 FIBERGLASS MANHOLES AND WETWELLS for manhole structure requirements.
 - 2. The inside diameter of the manhole barrel shall be either 48-inches or 1.5 times the nominal pipe diameter of the largest pipe, which ever is larger, or as indicated on the Drawings. A concentric reducer over the barrel of the manhole shall have an inside diameter of 30 inches.
 - 3. Pipe Connections: Connections to manholes shall be via pipe stubouts of length not greater than the pipe diameter. Attachment of pipe to stubouts shall be by means of gasketed flexible joints such as bell-and-spigot or size-on-size sleeve coupling that allow for differential settlement.

- a. 15-inch pipe and smaller: Attachment of stubout to manhole shall be by means of gasketed watertight compression connection (e.g. "Inserta Tee" or equal) or by fiberglass layup in accordance with the manufacturer's recommendations.
- b. 16-inch pipe and larger: stubout shall be factory-installed.
- D. Manhole Accessories
 - 1. Manhole frame and cover:
 - a. Gray cast iron, with minimum clear opening of 24 inches.
 - b. Use Western Iron Works A770R or approved equal with vent holes.
 - c. Provide anchor bolt holes for exposed manhole tops.
 - 2. Manhole Grade Adjustment Rings:
 - a. Provide minimum of three grade rings but not more than 12 inches total between cone and manhole lid and cover. Adjustment rings shall be High Density Polyethylene grade rings as manufactured by LadTech® or approved equal.
 - b. Each ring face shall be sealed to adjacent rings, manhole cone, and frame-and-cover using 1/2-inch minimum butyl rope sealant (ASTM C990) in strict accordance with manufacturer's instructions to provide an airtight seal.
 - 3. Coating: All internal concrete, masonry, grout, and metallic surfaces shall be coated with minimum 20 mils coal tar epoxy as manufactured by Inertol Company unless otherwise indicated. Materials shall be installed and applied in accordance with the manufacturer's instructions and as approved by Engineer.
 - 4. Infiltration Inserts: Provide infiltration insert to fit the manhole frame rim upon which the manhole cover rests.
 - a. Insert body shall be made of high density polyethylene copolymer material that meets ASTM D 1248, Class A, Category 5, Type III. Minimum thickness 1/8-inch.
 - b. Gasket shall be of closed cell neoprene and have pressure sensitive adhesive on one side and be placed under the weight-bearing surface of the insert by the manufacturer.
 - c. Lift strap of 1-inch woven polyethylene (seared on all cut ends to prevent unraveling. Strap shall be attached to the rising edge of the bowl off the insert by means of stainless steel rivet and washer.
 - d. Vent shall have 1/8-inch hole located on the side wall of the insert 3/4-inch below the lip.
 - e. Load capacity insert shall have certified test data verifying minimum collapse load of 1500 lbs. minimum applied to a 5.50-inch square area in the center of the insert.

PART 3 - EXECUTION

- 3.01 GENERAL
 - A. Provide all labor, equipment and materials and install all pipe, fittings, specials and appurtenances as indicated or specified.

3.02 PIPE INSTALLATION

- A. Handling
 - 1. Handle in a manner to insure installation in sound and undamaged condition.
 - a. Do not drop or bump.
 - b. Use slings, lifting lugs, hooks and other devices designed to protect pipe, joint elements, and coatings.
 - 2. Ship, move and store with provisions to prevent movement or shock contact with adjacent units.
 - 3. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.
- B. Installation

- 1. Installation, jointing and testing of pipe, fittings, and accessories shall be in accordance with the provisions of the applicable reference standard and in accordance with the requirements of this specification and related specifications referenced or contained in the contract documents for pressure or gravity sewers.
- 2. Lay pipe to slope gradient noted on the drawings.
- 3. Utilize equipment, methods, and materials insuring installation to lines and grades as indicated.
 - a. Do not lay on blocks unless pipe is to receive total concrete encasement.
 - b. Use laser or minimum of 3 batter boards for control of line and grade.
 - c. Obtain approval from Engineer for method proposed for transfer of line and grade from control to the work.
- 4. Install pipe of size, material, strength class, and joint type with embedment shown for plan location.
- 5. Insofar as possible, commence laying of pipe at downstream end of line, and, install pipe with bell ends in direction of pipe laying. Sewer pipe shall have spigot ends in direction of flow. Obtain approval of Engineer for deviations therefrom.

6. Clean interior of all pipe, fittings and joints prior to installation. Exclude entrance of foreign matter during discontinuance of installation.

- a. Close open ends of pipe with snug fitting closures.
- b. Do not let water fill trench. Prevent flotation of pipe where potential for trench flooding is present.
- c. Remove water, sand, mud and other undesirable materials from trench before removal of end cap.
- 7. Inspect pipe prior to installation to determine if any pipe defects are present.
- 8. Brace or anchor as required to prevent displacement after establishing final position.
- 9. Perform only when weather and trench conditions are suitable. Do not lay pipe in water.
- 10. Observe extra precaution when hazardous atmospheres might be encountered.
- 11. Sanitary sewer separation distance from water mains:
 - a. Maintain 9-foot horizontal separation whenever possible.
 - b. When conditions prevent a lateral separation of 9 feet, sewer may be installed closer to a water main subject to the following:
 - (1) Crossings: sewer shall be constructed of PVC pipe meeting the requirements of AWWA C900/C905 or ASTM 2241 and have a minimum working pressure rating of 150 psi or greater for pipe and fittings. The sewer may be placed no closer than 6 inches from the water line. The separation distance shall be measured between the nearest outside pipe diameters. The sewer line shall be located at a lower elevation than the water line whenever possible and one length of the sewer pipe must be centered on the water line;
 - (2) Parallel Alignment: the sewer line and water main shall be separated by a minimum vertical distance of 2-feet (water line above sewer) and a minimum horizontal distance of 4-feet, measured between the nearest outside diameters of the pipes.
- 12. Separation of water lines from sewer manholes:
 - a. No water pipe shall pass through or come in contract with any part of a sewer manhole.
 - b. A minimum horizontal separation of 9 feet shall be maintained.
- 13. Auger or jack casing pipe in place where shown on plans.

C. Jointing

- 1. General requirements:
 - a. Locate joint to provide for differential movement at changes in type of pipe embedment, at changes from rock to soil trench bottom, and within 18 inches of structure walls or manholes.
 - b. Perform in accordance with manufacturer's recommendations.
 - c. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
 - d. Utilize methods and equipment capable of fully homing or making up joints without damage.
 - e. Check joint opening and deflection for specification limits.
- D. Closure Pieces

- 1. Connect two segments of pipelines or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
- 2. Observe specifications regarding location of joints, type of joints and pipe materials and strength classifications.
- 3. May be accomplished with sleeve coupling of rating equal to or greater than that of pipe:
 - a. Of length such that gaskets are not less than 3 inches from pipe ends.
 - b. Include spacer ring identical to pipe end such that clear space does not exceed ¼ inch.
- E. Temporary Plugs
 - 1. Furnish and install temporary plugs at each end of work for removal by others where indicated.
 - 2. Remove plug on existing line to perform tie-in indicated in coordination with Utility operations staff.
 - 3. Plugs:
 - a. Use test plugs as manufactured by pipe supplier, or
 - b. Fabricate by Contractor of substantial construction.
 - c. Must be watertight against heads up to 20 feet of water.
 - d. Secure in place in a manner to facilitate removal when required to connect pipe.

3.03 MANHOLE INSTALLATION

- A. Install fiberglass manholes and appurtenances in strict accordance with manufacturer's recommendations. Refer to Section 02515 for additional installation requirements.
- B. Foundations shall be poured in place with channel inverts integrally formed with the foundation. See standard details shown on the plans.
- C. Heat materials for casting in place in freezing weather and protect work from cold; maintain temperature of work at 40° F. for at least 24 hours after placing.
- D. Invert Channels
 - 1. The bottom of the manhole shall be provided with a "U" shaped channel that is a smooth continuation of the inlet and outlet pipes. Channel dimensions shall be as follows based on outlet pipe diameter:
 - a. 12-inch and smaller: channel depth shall be at least 1/2 the outlet diameter.
 - b. 15 to 24-inch: channel depth shall be at least 3/4 the outlet diameter.
 - c. 24-inch and greater: channel depth shall be at least equal to the outlet diameter.
 - 2. In manholes with pipes of different sizes, the crown of the pipes shall be placed at the same elevation and flow channels in the invert shall be evenly sloped from pipe to pipe.
 - 3. The bench provided above the channel shall be sloped at a minimum of 1-inch per foot.
- E. Drop Manholes: A drop manhole as shown on the Drawings shall be provided for a sewer entering a manhole more than 24-inches above the invert.
 - 1. Drop pipe shall be of the same material and size as sewer pipe.
 - 2. Drop shall be constructed on the outside of the manhole using compatible PVC fittings to provide a smooth drop and a clean out leg as shown on the details.
 - 3. The drop pipe shall be encased with concrete unless otherwise directed by the Engineer. Concrete shall extend from the bottom of the manhole base up to the bottom of the inlet sewer pipe or as shown otherwise on the Drawings. Concrete shall also extend from the outside wall of the manhole beyond the drop tee with a minimum of six inches (6") on each side.
 - 4. Internal drops are not allowed unless type, design, materials, and manhole size are approved by the Engineer in writing beforehand.
- G. Pipe Connections
 - 1. Make airtight. All connections to be subject to manhole vacuum testing.

- 2. Field installation of stubouts 15-inch and smaller: Cutting of the manhole wall for installation of stubouts via compression connection (e.g. "Inserta Tee") shall be by means of a hole saw only. Openings for stubout attachment by fiberglass layup shall be no greater than 1/2-inch larger than the pipe diameter and shall be cut using masonry power saw. All other methods are not allowed unless approved in writing by the Engineer.
- 3. Field installation of stubouts 16-inch and larger is not allowed.
- 4. Doghouse connections at new manholes installed over existing pipe shall be sealed tight by working the foundation concrete over the top of pipe to a minimum depth of 6 inches. Install a 1-inch thick strip of butyl sealant rope (ASTM C990) around the pipe circumference outside the manhole wall prior to placement of concrete to provide a continuous waterstop between pipe and concrete.
- H. Exterior Pipe Support (Rigid Pipe)
 - 1. Provide pipe joint within 18 inches of manhole wall or support vitrified clay pipe on reinforced concrete cradle integral with manhole foundation to first joint on each side of manhole as indicated.
- I. Castings, frames, and fittings
 - 1. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed.
 - 2. The unit shall be protected until mortar or concrete is set.
- J. Coatings if required in the specifications or on the drawings shall be applied after Engineer's approval of structure.

3.04 ACCEPTANCE TESTS FOR SEWER PIPELINES

- A. General
 - 1. Lines shall be leak tested. A low pressure air test shall be used for leak testing unless a hydrostatic leak test is specifically permitted by the Engineer in writing.
 - 2. Acceptance of air test or exfiltration results will not preclude rejection of work if infiltration is measured and exceeds test limitation.
 - 3. After backfilling and removing debris from each section of sewer line, conduct a line acceptance test under observation of the Engineer. Copies of all test results shall be made available to the Engineer upon request.
 - 4. Perform test on piping systems including piping installed between or connected to existing pipe.
 - 5. Conduct tests on buried pipe after the trench is completely backfilled. If field conditions permit and if approved by the Engineer, partially backfill the trench and leave the joints open for inspection and for conducting the initial service leak test. Do not conduct the acceptance test until backfilling is complete.
 - 6. On exposed, non-buried piping, conduct the test after the piping is completely installed, including supports, hangers, and anchors, but prior to insulation.
 - 7. Do not perform testing on pipe with concrete thrust blocking until the concrete has cured at least five (5) days.
 - 8. Determine and remedy the cause of the excessive leakage for any pipe failing to meet the specified requirement for water or air tightness, and retest until the installation is proven satisfactory.
 - 9. Tests must be successfully completed and reports filed before piping is accepted. Provide copies of test reports to owner.
 - 10. Submit the plan for testing to the Engineer for review at least 10 days before starting the test.
 - 11. Remove and dispose of temporary blocking material and equipment after completion and acceptance of the piping test.

- 12. Repair any damage to the pipe coating.
- 13. Clean pipelines so they are completely free of debris, mud, or soil prior to final acceptance.
- 14. Test piping independently from tests on structures.

B. Low Pressure Air Test

- 1. Perform low-pressure air tests, using equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. Test is to conform to procedure described in ASTM F 1417.
 - a. Provide the equipment with an air regulator valve or air safety valve set to an internal air pressure in the pipeline that cannot exceed 6 psig. Monitoring pressure gauge shall have minimum divisions of 0.10 psi with an accuracy of ± 0.04 psi.
 - b. Pass air through a single control panel.
 - c. Provide pneumatic plugs that have a sealing length equal to or greater than the circumference of the pipe to be tested.
 - d. Provide pneumatic plugs that resist internal test pressures without requiring external bracing or blocking.
 - e. Provide an air compressor of adequate capacity for charging the system.
 - f. Introduce low pressure air until internal air pressure is 4.0 psi greater than the average back pressure of ground water above the pipe. Unless demonstrated otherwise in a test pit, ground water shall be assumed at the natural ground surface.
 - g. Allow two minutes for air pressure to stabilize.
 - h. The minimum allowable time for the pressure to drop from 3.5 psig to 2.5 psig greater than average back pressure of any ground water above the pipe shall be determined as follows:

$$T = \underline{0.085} \cdot \underline{D} \cdot \underline{K}$$
$$Q$$

Error! Bookmark not defined.

Where $K = 0.000419 \cdot D \cdot L$ or 1.0, whichever is greater

- T = time in seconds for the pressure to drop 1.0 psi
- D = average inside diameter in inches
- L = length of line of the same pipe size in feet
- Q = 0.0015 cubic feet per minute per square foot of internal surface.
- i. Alternately, the following table may be used to calculate allowable times based on the preceding formula:

Pipe Diameter (inches)	Minimum Time (i.e. K = 1.0) (seconds)	Length for Minimum Time (<i>i.e.</i> $K = 1.0$) (feet)	Time for Long Length <i>(i.e. K > 1.0)</i> (seconds)
6	340	398	0.854 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.418 (L)
15	850	159	5.342 (L)
18	1020	133	7.692 (L)
21	1190	114	10.470 (L)
24	1360	100	13.674 (L)
27	1530	88	17.306 (L)
30	1700	80	21.366 (L)

36	2040	66	30.768 (L)

- 3. Perform air test only on lines 36-inch diameter and smaller.
- 4. Check connections for leakage with a soap solution. If leaks are found, release the air pressure, repair the leak, and retest with soap solution until results are satisfactory, before resuming air test.
- C. Air Test for Individual Joints
 - 1. Lines 36 inches and larger may be tested at individual joints.
 - 2. The maximum allowable time for the pressure to drop from 3.5 psig to 2.5 psig is 10 seconds per joint for all pipe sizes.
- D. Hydrostatic Leak Test (by Engineer's approval only)
 - 1. Perform hydrostatic leak tests only if agreed upon or directed by the Engineer in writing. The test is to conform to the procedure described in ASTM C 1091.
 - 2. The length of the pipe to be tested shall be such that the head over the crown of the upstream end is not less than 2 feet or 2 feet above the ground water level, whichever is higher, and the head over the downstream crown is not more than 6 feet.
 - 3. Plug the pipe by pneumatic bags or mechanical plugs so that the air can be released from the pipe while it is being filled with water.
 - 4. Continue the test for one (1) hour and make provisions for measuring the amount of water required to maintain the water at a constant level during this period.
 - 5. Remove the jointing material, and remake the joint if any joint shows any visible leakage or infiltration.
 - 6. Remove and replace any defective or broken pipes.
 - 7. Maximum Allowable Leakage Rates:
 - a. Total exfiltration or infiltration shall not exceed 25 gallons per inch diameter, per mile of pipe, per 24 hours at a minimum test head of two feet above the crown of the pipe at the upstream manhole.
 - b. For construction within the 25 year flood plain, total exfiltration or infiltration shall not exceed 10 gallons per inch diameter, per mile of pipe, per 24 hours at a minimum test head of two feet above the crown of the pipe at the upstream manhole.
 - c. When pipes are installed below the groundwater level, an infiltration test shall be used in lieu of the exfiltration test provided groundwater is at least two feet above the top of pipe throughout the length of the pipe section to be tested.
 - 9. Determine the rates of infiltration by means of V-Notch weirs, pipe spigot, or plugs in the end of the pipe. Methods, times, and locations are subject to the Engineer's approval.
 - 10. Pipe with visible leaks or infiltration exceeding the maximum allowable leakage or infiltration is considered defective and must be corrected.
- E. Deflection Testing for Pipe
 - 1. Perform deflection tests on flexible and semi-rigid pipe in accordance with ASTM D3034.
 - Perform test by pulling a properly sized mandrel through the line to test for a maximum 5% allowable deflection of pipe measured as the reduction in vertical inside diameter unless specified otherwise.
 - b. Mandrel shall be sized at 95% of the manufacturer's stated ID for the pipe and be constructed as shown on the Drawing detail.
 - c. Conduct test after the final backfill has been in place a minimum of 30 days.
 - d. Thoroughly clean the lines before testing.
 - e. Use no mechanical pulling devices.
 - f. Uncover all irregularity or pipe deformation exceeding 5%. Replace all damaged pipe, re-round non-damaged pipe, and tamp the embedment and initial backfill.

- g. Any pipe removed shall be replaced by use of gasketed repair couplings having a rating equal to or exceeding the pipe being joined/repaired.
- h. Conduct deflection test in the presence of the Owner's or Engineer's representative.

3.04 ACCEPTANCE TESTS FOR SEWER MANHOLES

- A. Manhole Testing: Successful passage of a vacuum test shall be required for acceptance of sanitary sewer manholes and sanitary sewer structures, whether fiberglass or concrete. If a manhole fails a leakage test or visible leaks are observed, the manhole must be made watertight and retested.
 - 1. Vacuum testing shall be performed in accordance with the requirements of ASTM C-1244, Specification for Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
 - a. Perform test after installation with all connections in place. Final acceptance in accordance with the requirements of this specification will consist of a vacuum test of the completed and backfilled manhole including manhole, adjustment rings, and manhole frame and cover.
 - b. Materials: Vacuum testing apparatus shall consist of a minimum of the following: Engine, Vacuum Pump, Hose, Test Head device capable of sealing opening in manhole frame as required, and Pneumatic Test Plugs having a sealing length equal to or greater than the diameter of the connecting pipe to be sealed.
 - c. Test Procedure:
 - (1) The test head shall be placed at the top of the manhole frame in accordance with the manufacturer's recommendations.
 - (2) A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.
 - (3) The manhole shall be considered to pass the vacuum test if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in following table:

	DIAMETER (inches)				
DEPTH	42	48	54	60	72
(ft)	TIME (seconds)				
8	17	20	23	26	33
10	21	25	29	33	41
12	25	30	35	39	49
14	30	35	41	46	57
16	34	40	46	52	67
18	38	45	52	59	73
20	42	50	53	65	81
22	46	55	64	72	89
24	51	59	64	78	97
26	55	64	75	85	105
28	59	69	81	91	113
30	68	74	87	98	121

Minimum Test times for Various Manhole Diameters (ASTM C 1244)

(4) If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

d. Testing and Certification: Testing shall be done by the contractor and witnessed by the Engineer or his representative. All manholes and structures shall be tested as finished and completed for final acceptance. Any defective work or materials shall be corrected

or replaced by the Contractor and retested. This shall be repeated until all work and materials are acceptable.

3.05 SERVICE CONNECTIONS

- A. Install service connections at each dwelling or business place, or as directed by Engineer.
- B. Services wyes: Install wyes of minimum 4-inch diameter unless shown otherwise on plans. See standard details on the Drawings.
- C. Clean Outs: Provide clean out inside the Right of Way at the property line for each service line.
- D. Risers: Use risers in lieu of wyes for service connections where invert of sewer is 15 feet or more below ground surface or where shown on plans.
- E. Place suitable stopper in end of connection, cement stopper in place with cold bituminous joint compound.
- F. Backfill trench only after recording exact location of service connection. Place Engineerapproved marker tape above service piping in excavation within 3-feet of the surface.
- G. Make no connections to house sewers or extend service connections beyond the limits shown on the Drawings or indicated in the specifications without written permission of Engineer.
- H. Backfill trench only after entire service line and wye connection has been inspected and approved by Engineer. Compact as specified in Section 02221 TRENCHING, BACKFILLING AND COMPACTING.
- I. Street crossings shall have a minimum of 3 feet of cover to sub-grade.
- J. No payment for service lines will be made until all specified requirements have been met.

3.06 CONNECTIONS TO EXISTING DRAINS AND SEWER SYSTEM

- A. Connect existing sanitary service drains which cross new sewer line using Wyes of the same size as the new line and service drain.
- B. Connect no storm drains to new sewers.
- C. Connections to existing manholes:
 - 1. Cut hole in existing manhole at required elevation. Use appropriately sized hole saw when connecting to manhole. All other means of cutting are not allowed unless approved by the Engineer in writing.
 - 2. New pipe shall protrude from the manhole wall no more than 2 inches.
 - 3. At fiberglass manholes, complete using "Insert-a-Tee" type watertight compression connection or by fiberglass layup surrounding the entire connection on inside and outside of manhole. Fiberglass layup shall be in conformance with manhole manufacturer's standard recommendations.
 - 4. At concrete manholes, grout new pipe in place.
 - 5. Reconstruct manhole bottom to suit new connection.
- D. Connections to existing sewer:
 - 1. Build new manhole around existing sewer.
 - 2. Break out existing sewer inside of manhole and construct bottom to suit new connection.

PART 4 - MEASUREMENT AND PAYMENT

4.01 SANITARY SEWER PIPE

- A. Sanitary sewer, pipe fittings, or other pipe connections will be paid at the contract lump sum price, complete in place at various depths for the type, size and depth constructed.
- B. Compensation will be for furnishing all materials, labor, equipment, tools and incidentals required by the construction of the sanitary sewer pipe, all in accordance with the Drawings and specifications.
- C. If sanitary sewer pipe fails or does not pass appropriate mandrel test, Contractor shall remove and replace that part of the sewer pipe at no cost to the Owner.

4.02 SANITARY SEWER MANHOLE

- A. Sanitary sewer manhole will be will be paid at the lumps sum price at the various depths or as described in the bid proposal form. The size shall be the nominal inside diameter.
- B. Compensation will be for furnishing all materials, labor, equipment, tools and incidentals required including excavation, dewatering, concrete foundation, backfill, removal and disposal of excess material, frame and cover, manhole insert, grade rings, testing, and any specified protective coatings if not included as a separate pay item.

END OF SECTION

SECTION 02572 – COMBINATION AIR VALVES

1.00 PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Combination Air Release and Air and Vacuum valves for sewage including valves, fittings, and appurtenances.

1.02 SUBMITTALS

- A. Procedures for Submittals: Section 01300.
- B. Product Data: Manufacturer's product data sheets.
- C. Contract Closeout Submittals: Refer to Section 01700.
 - 1. Project Record Documents: Accurately record installed location of valves.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Storage: Store all valves and appurtenances in accordance with the manufacturer's written instructions. Protect from damage. Protect after installation until final acceptance.

2.00 PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Combination Air Valves:

- 1. A.R.I. Flow Control Accessories, stainless steel, Model D-020 (Short Version)
- 2. Or approved equivalent.

2.02 SIZE

A. Nominal 2-inch

2.03 MATERIALS

A. Combination Air Valve:

1.	Flushing Connection	Polypropylene
2.	Seal Plug Assembly	Reinforced Nylon + Rubber EPDM
3.	Float	Foamed Polypropylene
4.	Clamping Stem	Reinforced Nylon
5.	Body	Stainless Steel SAE 316 6. Crown Nut
		Stainless Steel SAE 316
7.	O-Ring	BUNA – N
8.	Stopper	Acetal
9.	Spring & Washer	Stainless Steel SAE 316 10. Stem, Clamp & Nut
		Stainless Steel SAE 316
11.	Base	Stainless Steel SAE 316

2.04 PRODUCT REQUIREMENTS

A. The valve shall be specially designed to operate with liquids carrying solid particles, which should not be expelled to the environment.

02572 - Page 1 of 2

- B. The valve shall have a conical shaped body with a cam lock back flush attachment as part of the working mechanism.
- C. The float mechanism shall be spring loaded to allow for system vibrations and turbulence.
- D. The operating mechanism shall be non-metallic and corrosion resistant.
- E. Working pressure shall be 3 150 p.s.i.
- F. The valve shall be capable of releasing large amounts of air, gases, and vapor during filling of the system and admitting large amounts of air when the system drains to prevent vacuum damage to the associated pipeline and accessories.
- G. The valve must be capable of releasing accumulated air, gas, or vapor from the system while the system operates under pressure, while maintaining an air pocket separation between the liquid and the working mechanism. The air release orifice will be 0.0186 square inch and will be an integral extension of the air and vacuum orifice, which shall be rectangular in shape.

2.05 ACCESSORIES

A. Ball Valves:

- 1. A polypropylene ball valve shall be mounted between the air/vacuum valve and the pipeline to allow for isolation and removal of the valve when necessary.
- 2. The ball valve shall have a pressure rating equal to or greater than the pressure rating of the pipeline itself.
- 3. Valve components and operating mechanism shall be non-metallic and corrosion resistant.

3.00 PART 3 - EXECUTION

3.01 PREPARATION

- A. Stake location of valve prior to installation for review by Engineer.
- B. Prior to installing valves, remove foreign matter from within the valves. Inspect the valves to verify that parts are in satisfactory working condition.

3.02 INSTALLATION

- A. Install valves in accordance with manufacturer's instructions at locations shown on Drawings. Set valves plumb and as detailed on Drawings.
- B. Install fiberglass manhole for valve vault in accordance with Section 02607.
- C. Refer to Section 15100 for pipe installation.

3.03 FIELD TESTING

A. Demonstrate proper operation of combination air release and pressure reducing valves after installation.

1.00 PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK

A. Provide polyurethane protective coating to the interior surfaces of manholes, wetwells, and other concrete and metal pipes as designated on plans or special conditions (except for fiberglass wetwells and manholes).

1.02 SUBMITTALS

- A. Manufacturer's Literature: Descriptive data of installation methods and procedures.
- B. Certificates: Manufacturer's certification that materials meet specification requirements.

2.00 PART 2 - PRODUCTS

2.01 COATING

- A. Material shall be Polybrid (TM) Protective Coatings as manufactured by Zemex Corporation or approved equal.
- B. Coating shall be of high build, anti-corrosive and anti-abrasive impact resistant, two component, 100% solids, non-solvent, hybrid polyurethane coating.
- C. The material shall have full bonding capacity to the surface.
- D. A shore "D" hardness of 57 at 77 degrees.
- E. Comply with ASTM-D1737 for flexibility using cylinder mandrel of 0.5 inches.
- F. Flash point of 450 degrees Fahrenheit open Zahn Cup.
- G. Light beige or cream color.
- H. Resistant to following:

SOLUTION CONCENTRATION

uric Acid	20%*
5%	
5%*	Nitric
	1%*
1%	
0.19	%
0.19	%
eases	
Oils	
	rric Acid 5%* 1% 0.1 eases Oils

*Volumetric percentages of concentrated CP grade reagents.

I. The complete coating shall be impermeable to sewer gases and liquids and nonconductive to bacterial or fungus growth.

J. The protective coating shall be capable of repair at any time during its life.

3.00 PART 3 - EXECUTION

3.01 GENERAL

A. Provide all labor, equipment and materials for complete installation.

3.02 SURFACE PREPARATION

- A. Water blast or sand blast surface as directed by Engineer to expose a good grade of firm concrete.
- B. All grease or residue shall be removed during surface preparation.
- C. Low pressure water blasting with detergent shall not be allowed.
- D. Prevent debris from surface preparation from entering sewer.
- E. Do not proceed to installation until Engineer approves surface preparation.

3.03 INSTALLATION

- A. The material shall be applied with airless spraying equipment at pressures of 2000 psi to 4200 psi.
- B. Thickness of coating shall be 90 mil or as otherwise specified.
- C. The coating contractor shall furnish two plugs to permit measurement of the thickness.
- D. Only workmen trained by and licensed as installers by the manufacturer shall be used.
- E. Take all necessary measures to prevent damage to installed coating from equipment and materials used in or taken through the work.
- F. All tools, excess materials, etc., shall be removed and the structure left in a clean and presentable condition.
- G. All men working in the area will wear the air support outfit as prescribed by the manufacturer.

4.00 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Polyurethane protective coating, as authorized, shall be subsidiary to other items of the bid. .

4.02 PAYMENT

A. When not listed as a separate contract pay item, polyurethane protective coating shall be considered as an incidental, and the cost thereof shall be included in such contract pay item as are provided in the proposed contract.

- B. Compensation, whether by contract pay item or incidental work will be for furnishing all materials, labor, equipment, tools and incidentals required by the work, all in accordance with the plans and these specifications.
- C. If the polyurethane protective coating fails to meet the specifications herein, the Engineer may order the material replaced at no cost to the Owner.
- D. The disposal of rejected material shall be at no cost to the Owner.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fence and gate framework, PVC coated fabric, fence line and terminal posts, and accessories.
- B. Excavation for post bases; concrete foundation for posts, and center drop for gates.
- C. Manual gates and related hardware.

1.2 RELATED SECTIONS

A. Section 16010 - Electrical Systems: Site Grounding Systems.

1.3 REFERENCES

- A. ASTM A116 Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
- B. ASTM A123 Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
- C. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- D. ASTM A392 Zinc-Coated Steel Chain-Link Fence Fabric.
- E. ASTM A428 Weight of Coating on Aluminum-Coated Iron or Steel Articles.
- F. ASTM A446 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
- G. ASTM A569 Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.
- H. ASTM C94 Ready-mixed Concrete.
- I. ASTM F567 Installation of Chain-Link Fence.
- J. ASTM F668 Poly (Vinyl Chloride) (PVC) Coated Steel Chain Link Fence Fabric.
- K. ASTM F669 Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence.
- L. ASTM F1083 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- M. ASTM F1234 Protective Coatings on Steel Framework for Fences.
- N. Chain Link Fence Manufacturers Institute (CLFMI) Product Manual.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

02831 – Page 1 of 4

- B. Samples: Submit two samples of fence fabric, 30 x 30 inch in size illustrating construction and colored finish.
- 1.5 QUALITY ASSURANCE
 - A. Material standards: Comply with Chain Link Fence Manufacturers Institute Galvanized Steel Chain Link Fence Fabric and Industrial Steel Specifications for Fence Posts, Gates and Accessories.
- 1.6 QUALIFICATIONS
 - A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

- 2.1 MATERIALS AND COMPONENTS
 - A. Materials and Components: Conform to CLFMI Product Manual.
 - B. Fabric Size: CLFMI Standard Industrial service.
 - C. Intermediate Posts: Type II round.
 - D. Terminal, Corner, Rail, Brace, and Gate Posts: Type II round.

2.2 MATERIALS

- A. General:
 - 1. Pipe sizes indicated are commercial pipe sizes.
 - 2. Tube sizes indicated are nominal flange dimensions.
 - 3. Roll form section sizes are nominal outside dimensions.
 - 4. Open seam material not allowed.
 - 5. Hot dip galvanizing for iron or steel components:
 - a. On pipe: Comply with ASTM-A53, 1.8 OZ/SF, minimum.
 - b. On square tubing: Comply with ASTM-A123, 2 OZ/SF.
 - c. On roll formed sections: Comply with ASTM-A53, minimum 1.8 OZ/SF.
 - d. On hardware and accessories: Comply with ASTM-A153, minimum 1.4 OZ/SF.
 - e. On fabric: Comply with ASTM-A392, Class 2, 2 OZ/SF, and withstand test of coating, as specified.
 - f. On barbed wire: Comply with ASTM-A585, Type I.
 - g. On miscellaneous items: Comply with ASTM-A53, minimum 1.8 OZ/SF.
- B. Chain Link Fabric:
 - 1. Woven 2 IN mesh of 9 GA wire.
 - 2. Steel wire: minimum tensile strength after coating: 70,000 PSI.
 - 3. Twisted and barbed at top selvages.
- C. Line Posts:
 - 1. 2-3/8 IN steel pipe, 5.79 LB/LF.
 - 2. Of sufficient length to permit minimum 42 IN to be set in concrete footing.
- D. Top, Mid and Bottom Rails:

- 1. 1-1/4 in steel pipe, 2.27 LB/LF.
- 2. Provide expansion couplings of outside sleeve type which provide rigid attachment and allow for anticipated movement.
- 3. Interrupt rails only at posts.
- Provide top and bottom rails only at 42 IN site fence. E. Terminal and Corner Posts:
- 1. 4 IN steel pipe, SCH 40.
- 2. Including end and pull posts.
- 3 Gate posts: 4 IN steel pipe.
- 4. Of sufficient length to permit minimum 42 IN to be set in concrete footing.
- 5. Gate post strength to support gate without sagging in open or closed position.
- F. Top Marcelled Tension Wire:
 - 1. 7 GA, comply with ASTM A-824.
- G. Bracing:
 - 1. Compression and tension members.
 - 2. Compression: 1-1/4 IN steel pipe, 2.27 LB/LF.
 - 3. Tension: 3/8 IN diameter steel truss rod with turnbuckles.
- H. Tension Bars:
 - 1. Minimum 3/16 x 3/4 IN, steel.
 - 2. One piece for full height of fabric.
- I. Metal Bands:
 - 1. Minimum 0.115 x 7/8 IN wide steel.
- J. Gates:
 - 1. Minimum 2-3/8 IN steel pipe, SCH 40, weld corners.
 - 2. Fasten fabric with adjustable hook bolts on every side.
 - 3. Provide tension rods.
 - 4. Fabricate with padlock hasp for Agency furnished padlock for swinging gates.
 - 5. Provide 3 strands of barbed wire fastened to extended verticals of gate frame.
- K. Concrete and Reinforcing: See Division 3.
- L. Tie Wire:
 - 1. 9 GA galvanized steel tie wires.

2.3 ACCESSORIES

- A. Caps: Aluminum alloy, sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
- C. Gate Hardware: Fork latch with gravity drop; two 180 degree gate hinges per leaf and hardware for padlock.

2.4 FINISHES

A. Components: Galvanized to ASTM A123; 2.0 oz/sq ft (600 g/sq m) coating.

- B. Fabric: Vinyl coating, color as selected by Owner from standard colors, over coating of 2.0 oz/sq ft (600 g/sq m) galvanizing.
- C. Vinyl Components: color as selected by Owner.
- D. Hardware: Galvanized to ASTM A153, 2.0 oz/sq ft (600 g/sq m) coating.
- E. Accessories: Same finish as fabric.

PART 3 - EXECUTION

- 3.1 INSPECTION
 - A. Verify suitability of areas to accept installation.
 - B. Correct unsatisfactory existing conditions.
 - C. Installation constitutes acceptance of responsibility for performance.
 - D. Install framework, fabric, accessories and gates in accordance with ASTM F567.
 - E. Place fabric on outside of posts and rails.
 - F. Set line terminal and gate posts plumb, in concrete footings with top of footing 2 inches (50 mm) above finish grade. Slope top of concrete for water runoff.
 - G. Line Post Footing Depth Below Finish Grade: four (4) feet.
 - H. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: four (4) feet.
 - I. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
 - J. Provide top rail through line post tops and splice with 6 inch (150 mm) long rail sleeves.
 - K. Install center and bottom brace rail on corner gate leaves.
 - L. Do not stretch fabric until concrete foundation has cured 28 days.
 - M. Stretch fabric between terminal posts or at intervals of 100 feet (30 m) maximum, whichever is less.
 - N. Position bottom of fabric 1 inch (25 mm) above finished grade.
 - O. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches (380 mm) on centers.
 - P. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
 - Q. Install bottom tension wire stretched taut between terminal posts.
 - R. Do not attach the hinged side of gate from building wall; provide gate posts.
 - S. Install gate with fabric to match fence. Install three hinges per leaf, latch, catches, drop bolt retainer and locking clamp.

T. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.2 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm).
- B. Maximum Offset From True Position: 1 inch (25 mm).
- C. Components shall not infringe adjacent property lines.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK COVERED

A. Mixing, placing, finishing and providing all related services necessary to construct all cast-inplace concrete work indicated on plans.

1.02 QUALITY ASSURANCE

- A. Comply with the latest published edition of the American Concrete Institute (ACI) and American Society of Testing and Materials (ASTM) standards and codes:
 - 1. ACI 315 Details and Detailing of Concrete Reinforcement.
 - 2. ACI 318 Building Code Requirements for Structural Concrete.
 - 3. ACI 347 Guide to Formwork for Concrete.
 - 4. ASTM A36 Carbon Structural Steel.
 - 5. ASTM C33 Concrete Aggregates.
 - 6. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens.
 - 7. ASTM C94 Ready-Mixed Concrete.
 - 8. ASTM C143 Slump of Hydraulic-Cement Concrete.
 - 9. ASTM C150 Portland Cement.
 - 10. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete.
 - 11. ACI 304 Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - 12. ACI 301 Specifications for Structural Concrete.
- B. Submit compliance submittals as specified in Division 1, including but not limited to the following:

bar schedule, bar details, shop drawings including size and location of openings, waterstops, joint systems and curing method.

C. Submit proposed concrete mix proportions to Engineer prior to placing concrete.

1.03 SUBMITTALS

- A. Conform to requirements of section 01300 SUBMITTALS.
- B. Manufacturer's Literature: Manufacturer's descriptive literature and recommended method of installation.
- C. Certificates: Manufacturer's certification that products meet specification requirements.

2.00 PART 2 - PRODUCTS

- 2.01 PORTLAND CEMENT
 - A. Type I, Type II or Type III conforming to ASTM C150.
 - B. Type I/II cement to be used.

- C. Except when Type II specified, Type III may be used when the anticipated air temperature for the succeeding 12 hours will not exceed 60°F.
- D. All cement used in a monolithic placement shall be of the same type.
- E. May be either bagged or bulk. Partially set or caked cement will be rejected.
- F. All types of cements shall be "low alkali" cements.

2.02 WATER:

- A. Clear, fresh, free from injurious amounts of oil, alkaline, acid or organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as C1 nor more than 1000 parts per million of sulfates as SO₄.
- B. Water of known potable quality requires no testing. Other sources shall meet the requirements of AASHTO T026-79-UL.
- C. Water shall have a pH of not less than 4.5 or more than 8.5.

2.03 FINE AGGREGATE

- A. Natural sand, manufactured sand or a combination of the two.
- B. The sand, or mixture of sand, comprising a single fine aggregate, shall consist of clean, hard, durable, uncoated grains and shall be essentially free from clay lumps, salt or alkali, and other foreign material.
- C. The maximum permissible percentage, by weight of deleterious substances shall not exceed the following:

Material removed by decantation 3.0%

Other deleterious substances such as coal, shale, coated grains and soft flaky particles

An additional loss of 2% by decantation may be allowed, provided this new additional loss is material of the same quality as specified for fine aggregate.

3.0%

D. Gradation, percent of weight retained:

Sieve Size	Percent Retained		
3/8 inch	0		
No. 4 0 -	5 No. 8 0 -		
20 No. 16 15	- 50		
No. 30	35 - 75		
No. 50	65 - 90		
No. 100	90 - 100		
No. 200	97 - 100		

E. Fineness Modulus:

1. For Grade 1 only - 2.3 minimum, 3.1 maximum.

2.04 COARSE AGGREGATE

- A. Crushed stone, gravel, crushed gravel, crushed blast furnace slag or a combination of these.
- B. Gravel and crushed gravel shall consist of clean, hard durable particles, free from adherent coating, thin or elongated pieces, soft or disintegrated particles, dirt, organic or deleterious substances, salt or alkali, and other foreign material.
- C. Crushed stone shall consist of the clean, dust free product resulting from crushing of stone. There shall be no adherent coatings, clay, loam organic or deleterious substances, salt or alkali, and other foreign material.
- D. The maximum permissible percentage, by weight, of deleterious substances shall not exceed the following:

Material removed b	by decantation		
1.00% Shale, \$	Slate or other similar ma	terial	
1.00%			
Clay lumps (0.25% Soft fragments	3.00%	
Other deleterious	substances, including fr	iable, thin,	
elongated or la	iminated		
pieces			3.00%
The sum of all d	eleterious substances e	exclusive of	
material remov	red by		
decant	ation, shall not exceed b	y weight	5.00%

- E. Coarse aggregates shall have a percent wear of not more than 45 when tested in accordance with Test Method Tex-410-A.
- F. Gradation, percent of weight retained on:
 - 1. Grade No. 1 Maximum Nominal Size 2 1/2-inches (63 mm)

Sieve	Percentage Retained
2 1/2-inches	0%
2-inches	
0 - 20% 1 1/2-inches	
15 - 50% 3/4-inches	
60 - 80%	
No. 4	95 - 100%

2. Grade No. 2 - Maximum Nominal Size 1 1/2-inches (37.5 mm)

Sieve	Percentage Retained
2-inches	0%
1 1/2-inches	0 - 5%
3/4-inches	30 - 65%
3/8-inches	70 - 90%
No. 4	95 - 100%

3. Grade No. 3 - Maximum Nominal Size 1-inch (25 mm)

Sieve	Percentage Retained
1 1/2-inches	0 - 5%
3/4-inches	10 - 40%
1/2-inches	40 - 75%
No. 4	95 - 100%

4. Grade No. 4 - Maximum Nominal Size 3/8-inch (9.5 mm)

Sieve	Percentage Retained
1/2-inches	0 - 5%
3/8-inches	5 - 30%
No. 4	75 - 100%

- G. Gradation Requirements maximum size of aggregate for structural concrete shall not exceed three inches, and shall be reduced in size to meet the following conditions:
 - 1. One-sixth (1/6) of the least dimension between forms of that part of the structure in which concrete is to be placed.
 - 2. Three-fourths (3/4) of the clear space between reinforcement.
 - 3. The maximum size aggregate is defined as the clear space between the sides of the smallest square openings through which 95 percent of the weight of the aggregate can be passed.
 - 4. Unless otherwise noted or restricted by above Grade No. 2, gradation shall be used.

2.05 PIT-RUN AGGREGATE

- A. Pit-run aggregate is the natural gravel and sand obtained from pits without the addition of other fine or coarse aggregates, and shall consist of hard, durable, uncoated pebbles or stone particles mixed with sand.
- B. Pit-run aggregate shall be free from lumps of clay and injurious amounts of dust, shale, soft or flaky particles, salt and alkali.
- C. Pit-run aggregate shall be well graded from coarse to fine when tested by standard laboratory methods and shall meet the following minimum requirements for percentages by weight:
 - 1. Retained on 1/4 in sieve 55 to 60%
- D. Pit-run aggregate shall not be used for high-strength concrete of 3000 psi and above.
- E. Pit-run aggregate may be used only for concrete cushion, cradle and protection for pipe.

2.06 ADMIXTURES:

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent watersoluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.

- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.07 REINFORCING STEEL

A. Reinforcing steel shall comply with Section 03200.

2.08 CURING MATERIALS

- A. Liquid Membrane: white pigmented chlorinated rubber, ASTM C309.
- B. Liquid Membrane: resin base, clear compound, permitting application of paint, W.R. Meadows, Inc. 1100 Clear or equal.
- C. Plastic Film: White pigmented, 0.00085-inches (minimum) thick.
- D. Burlap: jute fabric, lean, free of impurities.
- E. Surface Hardener: gray crystal, acidic fluosilicate base, slightly hygroscopic chemical surface hardener, SIKA Hardener, SIKA Chemical Corporation, or equal.

2.09 JOINT MATERIALS

- A. Joint Sealer: hot poured, non-extruding, elastic, ASTM D6690.
- B. Preformed Expansion Joint Filler: non-extruding, bituminous fiber, ASTM D1751.

2.10 WATERSTOP

- A. Hydrophilic, pre-formed rubber strip.
- B. Size to suit joinings.

2.11 FORM MATERIALS

- A. Use plywood, metal, metal framed plywood faced or other acceptable panel-type material.
- B. Coat forms with non-bonding, non-staining commercial compounds.

2.12 CONCRETE MIX DESIGN AND CONTROL

- A. Submit not less than 10 days prior to the start of concreting operations to the Engineer:
 - 1. Mix design, using a coarse aggregate factor acceptable to the Engineer.
 - 2. Sufficient samples of all materials to be incorporated into the mix for testing.
 - 3. Full description of the source of supply of each material component.

B. Coarse aggregate factor:

- 1. Not more than 0.82 when voids less than 48%.
- 2. Not more than 0.85 when voids exceed 48%.
- 3. Not less than 0.68.
- C. No changes or deviations from proportions or sources of supply without approval of Engineer.
- D. No concrete may be placed on the job site until the mix design has been approved by Engineer in writing to the Contractor.

2.13 CONCRETE QUALITY:

A. Consistency:

- 1. Mortar shall cling to the coarse aggregate.
- 2. The aggregate shall not segregate during transport.
- 3. The concrete and mortar shall show no free water when removed from the mixer.
- B. The consistency should allow the completion of all finishing operations with the addition of water to the surface.
- C. The concrete shall be uniform, workable, cohesive, possess satisfactory finishing qualities and be of the stiffest consistency that can be placed and vibrated into a homogeneous mass.
- D. Excessive bleeding shall be avoided.
- E. Slump requirements shall be as follows: Average Maximum

Slump

Slump Structural Concrete

4

- NOTE: No concrete shall be permitted with slump in excess of the maximums shown. Any concrete mix failing to meet the above consistency requirements, although meeting the slump requirements shall be considered unsatisfactory; and the mix shall be changed to correct such unsatisfactory conditions.
- F. The concrete shall comply with Table 1 below:

3

Class	Minimum	Minimum	Minimum	Maximum	Coarse
Of	Maximum	Compressive	Beam	Water	Aggregate
Concrete	SX Cement	Strength	Strength	Cement	Number
	Per CY	28-day p.s.i.	7-day p.s.i. ****	Item 2.1.1(c)(4)	
A	5.0	3000	500	6.5	2-3 -4
В	4.0	2000	330	8.0	2-3 -4
C *	6.0	3600	600	6.0	1-2 -3**
D	3.0	1500	250	11.0	2-3 -4
E	6.0	3000	500	7.0	2-3

TABLE 1 - CLASSES OF CONCRETE

F	6.5	4200	700	5.5	2-3
H***	6.5-8.0	As Spec'd On plans	N/A	5.5	3

*Entrained Air. **No. 1 coarse aggregate may be used in foundations only (Except ***ASTM C293 (Center Point).

2.14 GROUT:

A. Non-Shrink:

- 1. Use premixed non-shrink, Embeco Pre-Mixed Grout or Embeco Pre-Mixed Mortar by Master Builders Company or equal.
- 2. Keep water to a minimum for placing by the dry packing method.

3.00 PART 3 - EXECUTION

3.01 SUBGRADE

- A. Insure subgrade is true to line and grade and compacted as specified.
- B. Fill and recompact any ruts or depressions.
- C. Check cross section with a template. FORMS

3.02

- A. Provide forms for all concrete work including footings and base slabs.
- B. Construct forms so that completed concrete will conform to shapes, lines, grades and dimensions indicated and required.
- C. Forms shall be true, plumb and level with reasonably tight joints. Adequately support and brace forms.
- D. Place anchors, inserts, blots, sleeves and other devices indicated or required for the various portions of all the work.
- E. Oil temporary forms with non-staining form oil before reinforcing steel is placed.
- F. Rough form finish as defined by ACI 301 permitted for concealed concrete.
- G. Smooth form finish as defined by ACI 301 permitted for concealed concrete.
- H. Provide 3/4 inch chamfer on exposed corners and edges, and 1-foot below ground level.

3.03 REMOVAL OF FORMS

- A. Do not remove forms or supports until concrete has acquired sufficient strength to safely support its own weight and the superimposed loads.
- B. Remove formwork for columns, walls, beam sides and other parts not supporting the weight of the concrete as soon as the concrete has hardened sufficiently to resist damage from removal operations.

- C. Formwork for slabs, beam soffits and other parts supporting the weight of the concrete shall remain in place until the concrete has reached its specified 28-day strength.
- D. Protect concrete from damage prior to acceptance.
- E. Prohibit traffic until concrete is at least 10 days old.
- F. Cure areas previously covered by forms.

3.04 MIXING CONCRETE

- A. Maintain all equipment, tools, and machinery used for hauling materials and performing any part of the work to insure completion of the work underway without excessive delays for repairs or replacement.
- B. Mixing shall be done in a mixer of adequate size and type to produce uniform distribution of the material throughout the mass.
- C. The mixer shall have a plate affixed showing the manufacturer's recommended operating data and it shall be operated within the speed and capacity limits stated thereon.
- D. The absolute volume of the concrete batch shall not exceed the rated capacity of the mixer.
- E. The entire contents of the drum shall be discharged before any materials are placed.
- F. Improperly mixed concrete will not be placed.
- G. The mixing time shall be in accordance with the recommendations of the mixer manufacturer.
- H. Transit Mix Concrete:
 - 1. Sufficient transit mix equipment shall be assigned exclusively to the project as required for continuous operation.
 - 2. Satisfactory evidence shall be furnished so that the delivery of concrete shall be continuous at regular and uniform intervals, without stoppage or interruption.
 - 3. Concrete shall not be placed on the job after a period of 1 hour after the cement has been placed in the mixer, with mixer turning; 30 minutes without turning. I. Continuous Volumetric Mix Concrete:
 - 1. A mobile, continuous, volumetric mixer of the rotating puddle type may be used for when approved by Engineer.
 - 2. Mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.
 - 3. The mixers shall have adequate water supply and metering devices.
 - 4. Calibration of these mixers will be required.

3.05 PLACING CONCRETE

- A. The minimum temperature of all concrete at the time of placement shall not be less than 50°F.
- B. Clean transporting equipment, reinforcing and embedded items before placing concrete.
- C. Batch trucks or paving equipment not permitted on prepared subgrade unless authorized by the Engineer based on actual job conditions.
- D. Place no concrete until after inspection of forms by Engineer.
- E. The maximum time interval between the addition of cement to the batch, and the placing of concrete in the forms shall not exceed the following:

Air of Concrete Temperature	NonAgitated Concrete	Maximum Time
80°F or Above	26.6°C	15 minutes
35°F to 79°F	1.6ºC to 26.1ºC	30 minutes
Air of Concrete Temperature	Agitated Concrete	Maximum Time
90°F and Above	32.2°C	45 minutes
75°F to 89°F	23.9°C to 31.6°C	60 minutes
35°F to 74°F	1.6°C to 23.3°C	90 minutes

- F. Prevent segregation during placing.
- G. Consolidate flat work with one pass of a mechanical vibrator moving parallel to the centerline. Unusual sections and widths may be hand puddled and finished.
- H. Place concrete continuously so that each pour unit will be monolithic in construction and will terminate at an expansion, contraction or construction joint. Permit no more that 30 minutes between depositing adjacent batches.
- I. Place slab concrete over membrane waterproofing before waterproofing has become damaged or dirty.
- J. Concrete placement will not be permitted when impending weather conditions will impair the quality of the work.
- K. Slope horizontal surfaces of exterior concrete for drainage.
- L. Deposit concrete in forms in horizontal layers not deeper than 24 inches. . Avoid inclined construction joints. Place each layer while preceding layer is still plastic to avoid cold joints.
- M. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
- N. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to penetrate placed layer of concrete and at least 6-inches into preceding layer. Do

not insert vibrators into lower layers of concrete that have begun to set. Limit vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

3.06 PLACING CONCRETE IN WATER

- A. Concrete shall be deposited in water only when specified on the plans or with written permission of the Engineer.
- B. The forms or cofferdams shall be sufficiently tight to prevent any water current passing through the space in which the concrete is deposited.
- C. Water pumping will not be permitted during the concrete placing, nor until it has set for at least 36 hours.
- D. The concrete shall be placed with a tremie, closed bottom-dump bucket or other approved method.
- E. The concrete shall not be allowed to fall freely through the water nor shall it be disturbed after it has been placed. Its surface shall be kept approximately level during placement.
- F. The tremie shall consist of a water-tight tube 14-inches or less in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. The lower end of the tremie shall be submerged in the concrete at all times.
- G. Bottom-dump buckets used for underwater placing shall have a capacity of not less than onehalf cubic yard. It shall be lowered gradually and carefully until it rests upon the concrete already placed and raised very slowly during the upward travel; the intent being to maintain still water at the point of discharge and to avoid agitating the mixture.
- H. The placing operations shall be continuous until the work is complete.
- I. Unless otherwise specified, all concrete placed under water, except seal concrete, shall contain an additional sack of cement per cubic yard.

3.07 JOINTS

- A. Contraction Joints:
 - 1. Extend entirely across flat slabs at locations shown.
 - 2. Location where not shown; maximum spacing is:
 - a. Driveways: 10-feet.
 - b. Sidewalks: 4-feet.
 - c. Other flat slabs: 20 times slab thickness.
 - 3. Saw depth not less than 1/4 slab thickness.
- B. Filling Joints:
 - 1. Fill not later than 14 days after sawing.
 - 2. Fill immediately following cleaning.
 - 3. Fill to 1/8-inch of surface.

- 4. Remove excess while material is still pliable.
- 5. Refill low areas where necessary.
- 6. Omit filling sidewalk joints.

3.08 FINISHING EXTERIOR FLAT WORK

- A. Strike off and float as required.
- B. Check surface with ten foot straight edge, maximum variance allowed -1.8-inch.
- C. Drag concrete surface longitudinally with double thickness burlap drag after completion of straight edging unless noted otherwise.
- D. Use edger on edges of slab.
- E. Use hand finishing only when approved by Engineer.

3.09 FINISHING OTHER CONCRETE

- A. Slabs: smooth, steel-troweled finish; use edger on exposed edges. Grind smooth defects.
- B. Exterior walks and steps lightly broomed; finish transverse to traffic flow; use edger on exposed edges.
- C. Other surfaces:
 - 1. Remove fins, projections and loose material.
 - 2. Clean surfaces of form oil.
 - 3. Patch honeycomb, aggregate pockets, voids and holes as follows:
 - a. Chip out until sound concrete is exposed to minimum depth of 1-inch.
 - b. Prepare patching mortar with approximately two parts of normal Portland Cement, one part white cement, nine parts fine aggregate; vary proportions of aggregate as necessary to match color of adjacent concrete.
 - 4. Fill holes left by form ties to within 1-inch of surface with non-shrink grout. Fill remainder with patching mortar specified hereinbefore.
- D. Coordinate required finish with Engineer.

3.10 CURING

- A. Contractor shall inform the Engineer fully of the methods and procedures proposed for curing; shall provide proper equipment and in adequate amounts; and shall have approval of the proposed method, equipment and materials prior to placing concrete.
- B. All concrete shall be cured for a period of 4 curing days except as noted herein.
 - 1. Exceptions to 4-day Curing.
 - a. A curing day is defined as a calendar day when the ambient temperature, taken in the shade away from artificial heat, is above 50° Fahrenheit (10° C) for at least 19 hours, or the ambient temperature is 50° or less; and if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above 40° Fahrenheit (4.4° C) for the entire 24 hours.

- C. Form Curing:
 - 1. When forms are left in contact with the concrete, other curing methods shall not be required except for cold-weather protection.
- D. Water Curing:
 - All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet requirements for concrete mixing water. a. Wet Mat:
 - 1) Cotton mats shall be used for this curing method. The mats shall not be placed in contact with the concrete until such time that damage shall not occur to the surfaces.
 - Damp burlap blankets made from 9-ounce stock may be placed upon the damp concrete surface for temporary protection prior to the application of the cotton mats. 3) The mats may be placed by and wetted down after placement.
 - 4) Mat curing, except for continuous placements, shall commence not later than three hours after finishing of the roadway slab.
 - 5) The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible.
 - 6) The surfaces of the concrete shall be kept wet for the required curing time.
 - 7) Surfaces which cannot be cured by contact shall be enclosed with mats, anchored positively to the forms, or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.
 - b. Water spray:
 - 1) This method shall be accomplished by overlapping sprays or sprinklers, so that all unformed surfaces are kept continuously wet.
 - c. Ponding:
 - 1) This method requires the covering of the surface with a minimum of two inches (5 cm) of clean granular material, kept wet at all times; or water to a minimum depth of one inch (2.5 cm). Satisfactory provisions shall be made to provide a dam to retain the granular material or water.
- E. Membrane Curing
 - 1. Unless otherwise shown on the plans, Type 2 membrane curing compound may be used where permitted.
 - 2. Membrane shall be applied in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the Engineer, but not less than nine gallons per 210 feet (.0038M³ 63M) of area. Tests for acceptance shall be at this specified rate.
 - 3. Membrane curing shall not be applied to dry surfaces; but shall be applied to horizontal surfaces just before free moisture has disappeared.
 - 4. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.
 - 5. When a membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. A membrane which is damaged shall be corrected immediately by reapplication of membrane.
- 3.11 TESTING

A. Furnish at least three cylinders or beams from each 40 cubic yard, or portion thereof for test purposes unless otherwise directed by Engineer. Test one cylinder at 7 days, test second cylinder at 28 days and test third cylinder only if needed for confirmation of compression strength.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-in: fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Use non-shrink grout as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Equipment bases and foundations: provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing machines and equipment. Use non-shrink grout as shown on plans.
- C. Steel pan stairs: provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screen, tamp and finish concrete surfaces as scheduled.
- D. Reinforced masonry; provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes, for noncritical applications of concrete and for projects using small quantities of concrete. B. Related Sections include the following:

1. Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.

1.3 SUBMITTALS

- A. General: In addition to the following, comply with submittal requirements in ACI 301.
- B. Product Data: For each type of product indicated.
- C. Design Mixtures: For each concrete mixture.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- C. Comply with ACI 301, "Specification for Structural Concrete," including the following sections, unless modified by requirements in the Contract Documents:
 - 1. "General Requirements."
 - 2. "Formwork and Formwork Accessories."
 - 3. "Reinforcement and Reinforcement Supports."
 - 4. "Concrete Mixtures."
 - 5. "Handling, Placing, and Constructing."
- D. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials." PART 2 - PRODUCTS

2.1 FORMWORK

A. Furnish formwork and formwork accessories according to ACI 301.

SECTION 03301 - CAST-IN-PLACE CONCRETE (LIMITED APPLICATIONS)

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F. No more than 5%.
- B. Normal-Weight Aggregate: ASTM C 33, graded, 1-1/2-inch (38-mm) nominal maximum aggregate size.
- C. Water: ASTM C 94/C 94M; potable.

2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or selfexpanding cork.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

SECTION 03301 - CAST-IN-PLACE CONCRETE (LIMITED APPLICATIONS)

- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.7 CONCRETE MIXTURES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 - 4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of floor slabs to receive troweled finishes to exceed 3 percent.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
 - 2. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 3. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 4. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.3 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least onefourth of concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.4 CONCRETE PLACEMENT

- A. Comply with ACI 301 for measuring, batching, mixing, transporting, and placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Consolidate concrete with mechanical vibrating equipment.
- 3.5 FINISHING FORMED SURFACES
 - A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).
 - 1. Apply to concrete surfaces not exposed to public view.
 - B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm).
 - 1. Apply to concrete surfaces exposed to public view, or to be covered with a coating or covering material applied directly to concrete.
 - C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

03301 – Page 4 of 6

3.6 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
 - 1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
- 3.7 CONCRETE PROTECTING AND CURING
 - A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hotweather protection during curing.
 - B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
 - C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
 - D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.

- c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
- 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
- B. Tests: Perform according to ACI 301.
 - 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m) but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.

3.9 REPAIRS

A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. CAST-IN-PLACE CONCRETE: Section 03300.

1.02 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
- C. Samples: Submit samples, illustrating sealant colors for selection.
- D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.03 QUALITY ASSURANCE

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.
- B. Installer: A minimum of 5 years successful experience in applications of joint sealants specified.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.06 COORDINATION

A. Coordinate the work with all sections referencing this section.

1.07 WARRANTY

- A. Provide five year warranty under provisions of Section 01700.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

2.00 PART 2 - PRODUCTS

2.01 SEALANTS

- A. Elastomeric Sealants: at control joints and expansion joints, vertical walls and horizontal surfaces.
 - 1. One part acrylic polymer.
 - a. Provide manufacturer's standard, non-modified, one-part polymer based, air-curing, elastomeric sealant, complying with FS TT-S-00230C, Class A, nonsag grade/type.
 - b. Acceptable Manufacturers:

2.

- 1. Dynatrol; Pecora Corp.
- Sonolastic; Sonneborn/Contech
 - 3. General Electric
- c. Color: To be selected by Architect/Engineer from full range of manufacturers colors.
- B. Non-Elastomeric Sealants: at roof flashings
 - 1. Butyl Rubber Sealant
 - a. Provide polymerized butyl rubber and insert fillers (pigments), solventbased with minimum 75% solids, nonsag consistency, tack-free time of 24 hours or less, paintable, nonstaining, comply with FS TT-S-001657.
 - b. Manufacturer:

BC-158 Butyl Rubber; Pecora Corp. 707 Butyl; Protective Treatments, Inc. Butyl Sealant; Tremco, Inc. Euco Synthetic Rubber; Euclid Chemical Co.

2.02 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Sealant Backer Rod: Provide compressible rod stock of polyethylene foam, polyurethane foam, or polyethylene jacketed polyurethane foam, as recommended by sealant manufacturer for back-up of, and compatible with, sealant or caulking compound. Backer Rod shall be oversized 30 percent larger than joint width. Where used with hot-applied sealant, provide heat-resistant type which will not be deteriorated by sealant application temperature as indicated.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

3.00 PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- A. Remove loose materials and foreign matter which might impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions.
- D. Protect elements surrounding the work of this section from damage or disfiguration.

3.03 INSTALLATION

- A. Install sealant in accordance with manufacturer's instructions except when more stringent requirements are shown or specified.
- B. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- C. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.
- D. Install bond breaker tape where indicated and where required by manufacturer's recommendations to ensure that liquid-applied sealants will perform as intended.
- E. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps, sags or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, tool joints to a slightly concave shape, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, tool joint to form a slight cove, so that joint will not trap moisture and dirt.
- F. Install liquid-applied sealant to depths as shown, or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) sections of beads; (not applicable to sealants in lapped joints):
 - 1. For normal moving joints sealed with elastomeric sealants, not subject to traffic, fill joints to a depth equal to 50% of joint width, but never more than 1/2" deep nor less than 1/4" deep.
 - 2. For joints sealed with non-elastomeric sealant, fill joints to a depth in the range of 75% to 125% of joint width.
- G. Spillage: Do not allow sealants or compounds to overflow from confines of joints, or to spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

3.04 CURE AND PROTECTION

- A. Cure sealants in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength, and surface durability.
- B. Advise contractor of procedures required for cure and protection of joint sealers during the construction period, so that they will be free of embedded matter, and undamaged (other than normal wear and weathering) at time of substantial completion.
- C. Cure and protect sealants in a manner which will minimize increases in modulus of elasticity and other accelerated aging effects.
- D. Replace or restore sealants which are damaged or deteriorated during construction period.

END OF SECTION

1.00 PART 1 - GENERAL

- 1.01 SCOPE OF WORK
 - A. Furnish all labor, materials, equipment and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless and galvanized steels, as specified herein.
 - B. It is the intent of these Specifications to shop coat all exposed ferrous metals listed below:
 - 1. Structural steel
 - 2. Miscellaneous steel
 - 3. Doors Frames
 - 4. Steel hatches
 - 5. Sluice gates
 - 6. Operators
 - 7. Posts
 - 8. Pipe
 - 9. Fittings
 - 10. Valves
 - 11. Pumps

All other work obviously required to be painted unless otherwise specified and minor items not mentioned in the schedule of work, shall be included in the work of this Section where they come within the general intent of the specifications as stated herein.

1.02 RELATED WORK NOT INCLUDED

A. Field coatings is included in Section 09900.

- 1.03 SUBMITTALS
 - A. Submit to the Engineer for approval, as provided in Section 01300, shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thickness.
 - B. Submit representative physical samples of the proposed primers, if required by the Engineer.

2.00 PART 2 - PRODUCTS

- 2.01 MATERIALS
 - A. All painting materials shall be equal to those manufactured by the Tnemec Company, Inc., or Sherwin Williams or equal. The painting schedule has been prepared on the basis of Tnemec products (unless otherwise noted) and Tnemec recommendations for application. No brand other than those named will be considered for approval unless the brand and type of paint proposed for each item in the following schedule together with sufficient data substantiated by certified tests conducted at no expense to the Owner, to demonstrate its equality to the paint(s) named, is submitted to the Engineer

in writing for approval within 30 days after the signing of the Contract Agreement. The type and number of tests performed shall be subject to the Engineer's approval.

- B. All painting materials shall be delivered to the fabrication site in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration and mixed, thinned, and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.
- C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used.
- D. No paint containing lead will be allowed. Oil shall be pure boiled linseed oil.
- E. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations.

2.02 PAINTING SCHEDULE

- A. All colors will be selected by the Engineer based on the color shown herein. The following surfaces shall have the types of paints specified below applied at the minimum dry film thickness (DFT) in mils per coat.
- B. The following types of paints by Tnemec, unless otherwise indicated, have been used as a basis for the paint schedule:
 - 1. Hi-build Epoxoline (Series 66) Epoxy-Polyamide Coating
 - 2. Versare Primer (Series 4) Modified Alkyd Rust-Inhibitive Primer
- C. All ferrous metals shall be shop coated according to the following areas of placement:
 - 1. Process:
 - a. Submerged 1 Coat Series 66 (4.0-6.0 DFT)
 - b. All Non-Submerged 1 Coat Series 66 (3.0-4.0 DFT)
 - 2. Non-Process
 - a. 1 Coat Series 4 (2.0-3.0 DFT)
- D. Non-Primed Surfaces Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rustresistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.
- E. Compatibility of Coating Systems Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09900 for use in the field and which are recommended for use together.

3.00 PART 3 - EXECUTION

3.01 A. Surface Preparation and Priming

- 1. Non-submerged components scheduled for printing, as defined above, shall be sandblasted clean in accordance with SSPC- SP-6, Commercial Blast Cleaning immediately prior to priming.
- 2. Submerged components scheduled for priming, as defined above, shall be sandblasted clean in accordance with SSPC-SP-10, Near White Blast Cleaning, immediately prior to priming.
- 3. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
- 4. Shop prime in accordance with approved manufacturer's recommendations.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

SECTION 09900 - FIELD COATING

1.00 PART 1 - GENERAL

1.01 INTERIOR PIPE LINING FOR DUCTILE PIPING

- A. Surface Preparation: All surfaces shall be dry, clean and free of all containments, traces of grease, oil asphalt and other soluble containments. Abrasive blast all surfaces with fine abrasive to remove all loose annealing oxides, rust, dirt and other foreign matter. Only slight stains and tightly adhering oxides are allowed to remain on the surface. Any area where rust reappears before application shall be reblasted. Any dust or other contaminants remaining after blasting shall be removed with dry, oil free compressed air or by vacuum cleaning. Anchor pattern shall be angular with profile of at least 3.0 mils.
- B. Coating System: Tnemec Series 431 Perma-Shield PL applied 40.0 dry mils nominal thickness.

1.02 DUCTILE IRON PIPING, VALVES & FITTINGS IN IMMERSION

- A. Surface Preparation
 - a. Clean all surfaces as per NAPF 500-03-01 Solvent Cleaning to remove all oil, grease, factory-applied tars and/or bitumastic coatings and all other soluble contaminants.
 - b. Prepare ductile iron pipe as per NAPF 500-03-04 Abrasive Blast Cleaning for ductile iron pipe providing a minimum 1.5 mil angular anchor profile.
 - c. Prepare ductile iron valves and fittings as per NAPH 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
 - d. If existing ductile is factory coated with Tnemec Series N140, please follow recoat windows listed on the current product data sheet.
- B. Coating System
 - a. One Coat: Tnemec Series 431 Perma-Shield PL or Series 435 Perma-Glaze applied 30.0 dry mils nominal thickness. Total minimum dry film thickness shall be **30.0** mils.

1.03 CONCRETE

- A. Surface Preparation: Allow new concrete to cure 28 days. Level protrusions and mortar spatter. Abrasive blast as per SSPC-SP13/NACE 6 for "Severe Service," achieving a surface profile equal to ICRI CSP-5. Fill voids and bugholes with Tnemac Series 218 MortarClad.
- B. Coating System
 - a. First Coat: Tnemec Series 218 MortarClad applied at a minimum of 1/16" nominal dry film thickness.
 - b. Second Coat: Tnemec Series 436 Perma-Shield FR applied at 80.0 dry mils.
 - c. Total minimum dry film thickness shall be **140.0** mils.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Requirements of this Section apply to all equipment provided on the Project including that found in Divisions 11, 15 and 16, even if not specifically referenced in individual "Equipment" articles of those Specifications.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 11060 Pumping Equipment: General Requirements.
 - 2. Section 11322 Submersible Lift Station
 - 3. Section 16010 Electrical: Basic Requirements.

1.02 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Bearing Manufacturers Association (ABMA).
 - 2. American Gear Manufacturers Association (AGMA).
 - 3. American Society for Testing and Materials (ASTM) F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 4. Institute of Electrical and Electronics Engineers (IEEE)112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - 5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment.
 - b. ICS 6, Enclosures for Industrial Control and System.
 - c. MG 1, Motors and Generators.
 - 6. National Fire Protection Association (NFPA): a. 70, National Electrical Code (NEC).
- B. Miscellaneous:
 - 1. A single manufacturer of a "product" to be selected and utilized uniformly throughout Project even though:
 - a. More than one manufacturer is listed for a given "product" in Specifications.
 - b. No manufacturer is listed.
 - c. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall FULLY comply with specific NEC area and NEMA 250 and ICS-6 designations shown on the Contract Drawings and defined in Section 16010.
- 1.03 DEFINITIONS

- A. Product: Manufactured materials and equipment.
- B. Major Equipment Supports Supports for Equipment: Located on or suspended from elevated slabs with supported equipment weighing 2,000 lbs. or greater, or:
 - 1. Located on or suspended from roofs with supported equipment weighing 500 lbs. or greater, or:
 - 2. Located on slab-on-grade or earth supported with equipment weighing 5000 lbs. or more.
- C. Equipment: One or more assemblies capable of performing a complete function. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection. Not limited to items listed under "Equipment" article within specifications.
- D. Installer or Applicator: Installer or applicator is the person actually installing or applying the product in the field at the Project site. Installer and applicator are synonymous.

1.04 SUBMITTALS

- A. Shop Drawings: Refer to Section 01300.
- B. General for all equipment:
 - 1. Acknowledgment that products submitted comply with the requirements of the standards referenced.
 - 2. Manufacturer's delivery, storage, handling, and installation instructions.
 - 3. Equipment identification utilizing numbering system and name utilized in Drawings.
 - 4. Equipment installation details:
 - a. Location of anchorage.
 - b. Type, size, and materials of construction of anchorage.
 - c. Anchorage setting templates.
 - d. Manufacturer's installation instructions.
 - 5. Equipment area classification rating.
 - 6. Shipping and operating weight.
 - 7. Equipment physical characteristics:
 - a. Dimensions (both horizontal and vertical).
 - b. Materials of construction and construction details.
 - c. Equipment factory primer and paint data.
 - 8. Manufacturers recommended spare parts list.
 - 9. Equipment lining and coatings.
 - 10. Equipment utility requirements include air, natural gas, electricity, and water.
- C. Mechanical and process equipment:

- 1. Operating characteristics:
 - a. Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
 - b. Brake horsepower requirements.
 - c. Copies of equipment data plates.
 - 2. Piping and duct connection size, type and location.
 - 3. Equipment bearing life certification.
 - 4. Equipment foundation data:
- a. Equipment center of gravity.
- b. Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
- D. Electrical and control equipment:
 - 1. Electric motor information:
 - a. Nameplate data.
 - b. Service factor on motors 1/2 HP and above.
 - c. Motor enclosure type.
 - d. NEMA frame size.
 - e. NEMA design code.
 - f. Insulation type.
 - g. Locked rotor current.
 - h. Efficiency and power factor at full load, 3/4 load, and no load.
 - 2. Control panels:
 - a. Panel construction.
 - b. Point-to-point wiring diagrams.
 - c. Scaled panel face and subpanel layout.
 - d. Technical product data on panel components.
 - e. Panel and subpanel dimensions and weights.
 - f. Panel access openings.
 - g. Nameplate test.
 - h. Panel anchorage.
- E. Operation and Maintenance Manuals: Refer to Section 01730.
- F. Miscellaneous Submittals:
 - 1. Sample form letter for equipment field certification.
 - 2. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
 - Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
 - 4. Field noise testing reports if such testing is specified in narrow scope sections.

- 5. Field vibration testing reports if vibration testing is specified in narrow scope sections.
- 6. Notification, at least one (1) week in advance, that motor testing will be conducted at factory.
- 7. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
- 8. Motor test reports.
- 9. Certification prior to Project closeout that electrical panel drawings for manufacturersupplied control panels truly represent panel wiring including any field-made modifications.

2.00 PART 2 - PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS
 - A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Submersible Pumps Refer to Section 11322.
 - B. Submit requests for substitution in accordance with Section 01300.

2.02 ACCESSORIES

- A. Cast-in-place anchorage:
 - 1. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment and support systems.
 - 2. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
 - 3. Provide two nuts for each bolt.
- B. Drilled anchorage:
 - 1. Epoxy grout.
 - 2. Threaded rods same as cast-in-place.
- C. Data Plates:
 - 1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
 - 2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.
- D. Lifting Eye Bolts or Lugs:
 - 1. Provide on all equipment 50 LBS or greater.

SECTION 11005 – EQUIPMENT: GENERAL REQUIREMENTS

2. Provide on other equipment or products as specified in the narrow specifications.

2.03 FABRICATION

- A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.
- B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.
- C. Furnish like parts of duplicate units to be interchangeable.
- D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.
- E. Furnish equipment requiring periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.
- F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option. Provide drain connection for 3/4 IN PVC tubing.
- G. Machine the mounting feet of rotating equipment.
- H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that can not be properly prepared and painted. When such back to back fabrication can not be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.

2.04 SHOP OR FACTORY PAINT FINISHES

- A. Electrical Equipment:
 - 1. The standard factory-applied paint coating system(s) of the approved manufacturers of the following equipment are acceptable: a. Panel boards.
 - b. Electrical panels.
 - c. Safety switches.
 - d. Motor starter equipment.

3.00 PART 3 - EXECUTION

- 3.01 INSTALLATION
 - A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.
 - B. Utilize templates for anchorage placement for slab-mounted equipment.
 - C. DO NOT construct foundations until major equipment supports are approved.
 - D. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings.

- E. Construct subbases, either concrete, steel or cast iron, level in both directions. Particular care shall be taken at hold-down bolt locations so these areas are flat and level.
- F. Machine Base:
 - 1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.
 - a. Size blocks and shims to provide solid support at each anchor bolt location. Area size of blocks and shims shall be approximately 1-1/2 times area support surface at each anchor bolt point.
 - b. Provide blocks and shims at each anchor bolt. Blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.
 - c. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.
 - d. Do not use nuts below the machine base on anchor bolts for base leveling.
- G. Couplings:
 - 1. Align in the annular and parallel positions.
 - a. For equipment rotating at 1200 rpm or less, align both annular and parallel within 0.001 inch tolerance for couplings 4 inches in size and smaller. Couplings larger than 4 inches in size: Increase tolerance 0.0005 inch per inches of coupling diameter, i.e., allow 6 inch coupling 0.002 inch tolerance, and allow a 10 inch coupling 0.004 inch tolerance.
 - b. For equipment rotating at speeds greater than 1200 rpm allow both annular and parallel positions within a tolerance rate of 0.00025 inch per inch coupling diameter.
- H. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
- I. Check surfaces for runout before attempting to trim or align units.
- J. Grouting:
 - 1. After machine base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or formwork shall be placed around base to contain grouting. Extend dam or formwork at least 1/2 inch above the top of leveling shims and blocks.
 - 2. Saturate top of roughened concrete subbase with water before grouting. Add grout until entire space under machine base is filled to the top of the base underside. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
 - 3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
 - 4. When the grout has fully hardened (after a minimum of 7 days) tighten all anchor bolts and recheck driver-driven unit for proper alignment.

3.02 INSTALLATION CHECKS

- A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation. In each case, representative(s) shall be present during placement and startup of equipment and as often as necessary to resolve any operational issues which may arise.
- B. Secure from equipment manufacturer's representative(s) and provide to Owner's Representative a written report certifying that equipment:
 - 1. Has been properly installed and lubricated.
 - 2. Is in accurate alignment.
 - 3. Is free from any undue stress imposed by connecting piping or anchor bolts.
 - 4. Has been operated under full load conditions and that it operated satisfactorily.
- C. No separate payment shall be made for installation checks. All or any time expended during installation check does not qualify as O&M training or instruction time when specified.
- D. Wiring Connections and Termination:
 - 1. Clean wires before installing lugs and connectors.
 - 2. Terminate motor circuit conductors with copper lugs bolted to motor leads.
 - 3. Connections to carry full ampacity of conductors without temperature rise.
- E. Field Quality Control:
 - 1. Furnish equipment manufacturer services as specified in the individual equipment specifications.
 - 2. Inspect wire and connections for physical damage and proper connection.
 - 3. Check rotation of motor before connection to driven equipment, before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated.
 - 4. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs and cross member that are cast welded or bolted, shall be tested for a natural frequency of vibration after equipment is mounted. Keep the ratio of the natural frequency of the structure to the frequency of the disturbing force out of the range from 0.5 to 1.5.

3.03 DEMONSTRATION

A. Demonstrate equipment in accordance with the requirements of these specifications.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pumping appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Forms of Contract, Bond and Proposal.
 - 2. General Specifications.
 - 3. Section 11005 Equipment: General Requirements.
 - 4. Section 11322 Submersible Lift Station
- 1.02 QUALITY ASSURANCE
 - A. Referenced Standards:
 - 1. Hydraulic Institute (HI):
 - a. Standards for centrifugal, rotary and reciprocating pumps.
 - b. Fully coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

1.03 SUBMITTALS

- A. Shop Drawings: Refer to Section 01300.
- B. Product technical data including:
 - 1. Performance data and curves with flow (gpm), head (ft), horsepower, efficiency, NPSH requirements, submergence requirement.
 - 2. Pump accessory data.
 - 3. Bearing supports, shafting details and lubrication provisions.
 - 4. Solids passage information.
- C. Certifications:
 - 1. Certified pump performance curves.
 - 2. Statement relative to installation and start-up per paragraph 3.02-A.4.
- D. Test reports: Factory hydrostatic test.

2.00 PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Mechanical seals:
 - a. Chesterton.
 - b. Garlock.
- 2.02 ACCESSORIES
 - A. Refer to Section 11005.
 - 1. Each Unit:
 - a. Lifting eye bolts or lugs.

SECTION 11060 – PUMPING EQUIPMENT: GENERAL REQUIREMENTS

- b. Plugged gage cock connection at suction and discharge nozzles.
- c. Tapped and plugged openings for casing and bearing housing vents and drains.
- d. Fittings for properly adding flushing lubricant.
- e. Pressure relief fittings for grease lubrication.
- B. Packing Seal:
 - 1. Provide unless mechanical seal specified in narrow-scope pump sections.
 - 2. Minimum of five rings graphite impregnated synthetic packing.
 - 3. Provide minimum 1/4 inch diameter supply tap and 1/2 inch diameter minimum drain tap.
 - 4. Provide split Teflon or bronze water seal ring.
 - 5. Adjustable split follower cast iron or bronze gland.
- C. Mechanical Seals: Provide as specified in the narrow-scope pump sections.

2.03 FABRICATION

- A. Pump Support:
 - 1. Design base to support weight of drive, shafting and pump.
 - 2. Comply with HI vibration limitations.
 - 3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
 - 4. Mount vertical pumps on single piece pedestal baseplate.
 - 5. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.04 SOURCE QUALITY CONTROL

- A. If specifically required in the individual pump specification sections, provide factory tests.
- B. All units: Hydrostatic test at 150 percent of shutoff head for a minimum of 5 minutes.
- C. Constant speed units:
 - 1. Head (ft) versus flow (gpm) pump curves.
 - 2. Efficiencies along curve.
 - 3. Brake horsepower along each curve.
- D. Results certified by a registered professional engineer in the State of Texas.
- E. Statically and dynamically balance each pump per HI standards.

3.00 PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Section 11322.

- 1. Submersible Units:
- a. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange. Realign as necessary, install flange bolts and make equipment connection.
- b. Pumps shall be shop coated as per manufacturer's recommendations.
- c. Provide pressure gage on discharge of all pumps and on suction of all non-submersible units.

3.02 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:

- 1. Inspect equipment covered by these Specifications.
- 2. Supervise pre-start adjustments and installation checks.
- 3. Conduct initial startup of equipment and perform operational checks.
- 4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
- 5. Instruct Owner's personnel for a minimum 4 (four) hours at the jobsite on operation and maintenance of pumping equipment.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

PART 1. GENERAL

- 1.01 This specification shall govern for all work necessary for furnishing, installing and placing into initial operation the submersible pumps, accessories, and control panel for the Lift Station.
- 1.02 GENERAL DESCRIPTION

The pumps shall be designed for handling a raw unscreened wastewater. The equipment shall be designed such that the pump unit can be automatically and firmly connected to the discharge piping when lowered into place on a mating discharge connection permanently installed in the wet pit. The pumps should be easily removable from the lift station, without the need for personnel to enter the wet pit, for inspection or maintenance.

1.03 QUALITY ASSURANCE

- A. The pumps shall be furnished by a manufacturer engaged in the production of the specific type of pump for a minimum of 10 years. The manufacturer shall have furnished similar pumps for a least 5 other installations in Texas performing similar duty. Each installation shall have performed satisfactorily for at least 5 years and are still in operation.
- B. All manufacturer parts and components shall be engineered for long, continuous and uninterrupted service. Provisions shall be made for easy lubrication, adjustment, or replacement of all parts.
- C. Where like items are incorporated into equipment systems (i.e. motors, push buttons, etc.) such items must be identical to achieve standardization for appearance, operation, maintenance, spare parts, and service. Corresponding parts of multiple units shall be interchangeable.
- D. All stages of the manufacturing process shall be carefully inspected at the factory by factory inspectors who shall use whatever means necessary to assure the proper fit of all field connections and compliance with all material and fabrication requirements of the specifications.
- E. The pump, pump monitoring, and level control panel shall be factory wired and assembled. Assembly and wiring shall be to the point where the only field interconnections to numbered terminal blocks are required.
- F. It is absolutely imperative that parts be available within 160 miles of the project site for immediate repairs should repairs become necessary. Unless it can be demonstrated that parts and service have been available at a service center within 160 miles of the project site through the same financially sound firm on a continuing basis for at least 10 years, the spare parts listed in these specifications must be furnished with the pumps at no additional cost to the City.

1.04 PERFORMANCE (Operating Conditions)

A.	One pump running duty point	
----	-----------------------------	--

1494 gpm @ 51.1' tdh 78.3%

B. Duty point efficiency

C.	Max. Active Motor Input Power	
1. D.	Design duty point Max. Total Motor Input Power	1490 gpm @ 51 TDH
1.	One pump running duty point	30.0 HP
Ε.	Max pump speed	1765 rpm
F.	Max NPSHR	
1.	One pump running duty point	24.1 Feet
G.	Voltage/Cycle/Phase	460/60/3
Н.	Motor design Type	NEMA B
I.	Motor Service Factor	1.15
J.	Motor Insulation	Class H
К.	Max. Motor pole number	4 Pole
L.	Max. Rated current (FLA)	38 Amps
М.	Min. Rated power factor	0.62
N.	Max. Locked rotor current	267 Amps
О.	Max. NEC Code Letter	Н
Ρ.	Min. Pump discharge size	6 Inches

1.05 WARRANTY

A. General

- 1. Pump manufacturer will pay cost of parts and labor during the warranty period, provided that the pump, with cable attached, is returned prepaid to an authorized repair facility for repairs. Coverage of parts and labor will be provided for periods indicated below.
- 2. This warranty shall not apply to any product or part of product which has been subjected to misuse, misapplication, accident, alteration, neglect, or physical damage and monitoring equipment has been bypassed or removed.
- 3. Warranty does not cover costs for standard and/or scheduled maintenance or parts that, by virtue of their operation require replacement through normal wear, unless a defect in material or workmanship can be determined by manufacturer.
- 4. Warranty period shall be as follows and from the date of shipment from the factory or other manufacturer approved point in time but no later than startup and beneficial use of pumping system.
 - a. 0 24 months warranty is 100%.
 - b. 25 39 months warranty is 50%
 - c. 40 60 months warranty is 25%

PART 2. PRODUCTS

- 2.01 PUMPS
 - A. Manufacturers
 - 1. Pumps shall be NP3171 MT 3- 435 (explosion proof), the product of Xylem Water Solutions USA, Inc.-Flygt Products.
 - 2. Engineer approved pump manufacturer.
- 1. General
- a. Major pump components shall be of gray cast iron, Class 35, with smooth surfaces devoid of blowholes and other irregularities.
- b. Exposed nuts and bolts shall be AISI type 316 stainless steel or brass construction.
- c. All surfaces, other than stainless steel, shall be factory sprayed with alkyd primer and synthetic resin enamel rubber paint finish.
- d. All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber o-rings.
- e. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.
- 2. Impeller
 - a. The impeller shall be of 25% chrome cast iron, ASTM A-532 (Alloy III A), dynamically balanced, semi-open, multi vane, backswept, non-clog design.
 - b. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a machined spiral groove located on the stationary insert ring maintaining an unobstructed leading edge.
 - c. The impeller shall have induction hardened, screw shaped leading edges and shall be capable of handling solids, fiberous materials, heavy sludge and other matter found in wastewater.
 - d. Impellers shall be locked to the shaft and shall be coated with alkyd resin primer.
 - e. Impellers shall be trimmed to specifically meet the conditions of operation.
- 3. Insert Ring
 - a. A hardened, replaceable insert ring made of 25% chrome cast iron, ASTM A532 (Alloy III A), having an integral machined spiral shaped groove shall be installed in the pump volute.
 - b. The clearance between the insert ring and the impeller shall be adjustable.
- 4. Flush Valve
 - a. Furnish and install a Flygt flush valve to mix the wastewater automatically. The valve is to be mounted directly on the pump volute to direct part of the pumped discharge to flush solids into suspension at the start of each pumping cycle. The valve shall be positioned on the pump volute to provide a non-clogging flow operation
 - b. The pump volute must have a special mounting flange to allow for the proper flow exit angle and to strengthen the volute wall in order to withstand the shock loads imposed by the valve. The valve and the volute location is specific to certain pump models. The valve manufacturer and the pump manufacturer must both certify the use of the valve on the pump being used. A letter in writing must be provided by each manufacturer certifying the use of the valve on the pump, including a written warranty. The pump shall have a boss on the volute to accept the valve.
 - c. The valve shall be open at the beginning of each pumping cycle and close under full pump discharge pressure after a pre-selected time. The valve shall be operated be the liquid being pumped through a self-contained hydraulic system. No external power source should be required to operate the valve. The valve shall be controlled by hydraulic pressure from the pump, external electrical, hydraulic or pneumatic lines shall not be allowed. A means of adjustment should be provided to achieve a 30 second flushing period for different head and flow conditions.
- 5. Volute

- a. Pump volutes shall be single piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as indicated herein.
- b. Minimum inlet and discharge size shall be as indicated herein.
- 6. Motor
 - a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, water tight chamber.
 - b. The submersible motor shall be FM or UL Listed for Class I, Division 1, Groups C and D explosionproof hazardous locations.
 - c. The stator windings shall be insulated with moisture-resistant Class H insulation for 180 degrees C. The motor shall be designed for continuous duty capable of fifteen (15) evenly spaced starts per hour. Automatic reset, normally closed thermal sensors shall be imbedded in each phase of the motor windings to provide overheating protection.
 - d. The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.
 - e. The motor shall be designed for continuous duty while handling pumped media of up to 104 degrees F.
 - f. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of fastening devices used to hold or locate the stator and that penetrate the stator housing are not acceptable.
 - g. The motor service factor shall be 1.15. The motor shall have a voltage tolerance of +/- 10%.
 - h. The motor shall be designed for a continuous operation in up to a 40 degree C ambient and shall have a NEMA Class B maximum operating temperature rise of 80 degrees C.
 - i. Motor horse power shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out.
 - j. Motor shaft shall be one-piece, extending through the pump and motor. Extension couplings shall not be acceptable. Shaft shall be ASTM A572 Grade 50 carbon steel shaft material. If shaft is exposed to the pumped media it shall be constructed of 431 stainless steel. Shaft sleeves shall not be acceptable.
 - k. The power cable entry seal design shall preclude specific torque requirements to insure a watertight seal and shall allow simple field changing of power and pilot cables without affecting pump or motor warranty. The cable entry assembly shall consist of a seal flange designed and machined to provide precise compressions of cylindrical elastomer grommets flanked by stainless steel washers all having a close tolerance fit against the outside diameter of the cable and the inside diameter of the entry body. Cable sizing shall conform to NEC requirements for portable power use.
 - I. A separate junction chamber shall be provided inside the pump for connection of power and pilot cables to stator leads. The chamber shall be sealed by a nonmetallic terminal board bolted to a machined surfaced and utilizing an O-ring to obtain a watertight seal.
 - m. Power shall be multi-conductor externally jacketed with oil resistant chloroprene rubber. Internal tinned copper conductor's insulation shall be ethylene propylene rubber and shall be color coded to identify each power lead.
- 7. Mechanical Seal
 - a. Pumps shall be provided with a mechanical seal system consisting of two totally independent seal assemblies operating in an oil chamber between the pump volute and motor chamber for seal lubrication and cooling. The oil shall be a white paraffin based oil meeting the standards of FDA 172.87B.
 - b. The lower seal shall act as the primary unit to prevent entry of pumped liquid to the oil chamber. The upper seal shall act as a secondary unit to prevent pumped liquid or oil from entering the stator housing. The seal system shall allow continuous pump operation with the motor exterior totally dry.

- c. Each seal unit shall consist of a positive driven rotation ring, a stationary ring and an independent spring to maintain interface contact. The upper and lower seals for all pumps shall have tungsten carbide rotation and stationary rings.
- 8. Bearings
 - a. The pumps shall be equipped with grease lubricated bearings with a system B-10 life of 100,000 hours at any point along the pump curve at maximum speed.
 - b. The upper bearings shall be roller bearings.
 - c. The lower bearings shall be two angular contact ball bearings.
- 9. Pump protection devices
 - a. The pump manufacturer shall provide a pump monitoring system which shall consist of pump protective devices and monitoring unit mounted back plate of control panel.
 - b. Pump protective devices

1). Three thermal switches in the stator coils.

- 2). A leakage sensor shall be provided in the stator housing to detect water intrusion.
- Monitoring and Status Unit
 - 1). The monitoring and status unit shall be designed to mount on the back plate or swing out door of the control panel.
 - 2). All monitoring devices shall connect to the control and monitoring unit.
- 10. Accessories

c.

- a. The pump manufacturer shall furnish all station hardware and accessories for use with the pumps furnished or for any future requirements or revisions as may be indicated in the Plans or other sections of the Contract Specifications.
- b. All items inside the wet well shall be stainless steel or aluminum as indicate below.
- c. To insure compatibility, all access covers in structures containing submersible pumps shall be provided by the supplier of the submersible pumps. Guide rail system shall consist of no less than two bars. Each bar shall be minimum Schedule 40 wall thickness pipe to assure future availability for replacement. Guide bars shall be 2 or 3 inch as indicated on the Plans. Guide bars spanning 20 feet or less between upper and lower supports shall not require intermediate bracing. Guide bar material shall be stainless steel, type 316.
- 11. Testing
 - a. A certified factory performance test shall be performed on each pumping unit, larger than 10 horse power, in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.
 - b. Results of the performance tests shall be certified by a Texas Registered Professional Engineer and submitted for approval before final shipment.
 - .02 <u>Mechanical Accessories:</u>
 - A. General:
 - 1. The Pump Manufacturer shall furnish and be responsible for coordinating proper fit and suitability of all station hardware and accessories for the use with the pumps furnished or for any future requirements or revisions as may be indicated on the Drawings or other sections of the Contract Specifications. All items furnished shall be guaranteed, to the Owner, suitable for the intended use and shall be warranted against defective workmanship, materials and excessive corrosion for a period of two years after startup and/or beneficial use by the Owner.

- B. Guide Rail Brackets:
 - 1. Dual rail upper guide rail brackets shall be provided by the pump supplier for each pump. Each bracket shall have two 3/16" hooks for supporting pump power cables and lifting assemblies. The upper guide rail bracket shall be constructed of 316 stainless steel.
 - 2. Dual rail intermediate guide rail brackets shall be provided by the pump supplier for guide rails which exceed 20 feet in length. Intermediate guide rail brackets shall be located at each 20' increment of guide rail or at midpoint of guide rail span. The intermediate guide rail bracket shall be constructed of 316 stainless steel.
- C. Float Cable Racks:
 - 1. Level sensor floats shall be suspended in the wet well from a cable rack bolted to the access opening or cover frame. Each rack shall be provided with six, 3/16" minimum diameter hooks over which the level sensor cables shall be looped. The cable rack shall be 316 stainless steel.
- D. Power Cable Supports:
 - 1. A stainless steel or non-metallic cable grip shall be provided for each pump power and pilot cable. The grip shall have a loop on one end, which will hang from a hook provided on the upper guide bar bracket.
- E. Pump Lifting Assembly:
 - 1. Each pump shall be supplied with a stainless steel chain that has a working load limit equal to 50% greater than the pump weight. Minimum length shall be depth of lift station plus 5 feet.
 - 2. Chains and attachment hardware shall be of stainless steel material certified and approved for overhead lifting.
- F. Lift Station Hardware:
 - 1. All nuts, bolts, washers, anchor bolts or any attachment hardware used inside the wet well shall be constructed of 316 stainless steel.
- 2.03 <u>Electrical Control Panel</u>:
 - 1.0 The Pump Manufacturer shall provide and be responsible for proper electrical protection and control operation. The Pump Supplier shall supply the pump control panel in order to assure unit responsibility for equipment selection, component compatibility, startup and operational checks and future service. Electrical equipment supplied must comply with all requirements of Division 16 Electrical and with the Electrical Drawings.

PART 3.0 EXECUTION

- 3.01 Installation
- A. Installation of the pumps shall be in strict accordance with the manufacturer's instructions and recommendations.
- B. The locations of the discharge piping is shown on the construction drawings.

The location of the pumps, access covers, and discharge connection are approximate. The precise placement and alignment of anchor bolts, discharge assembly, guide rails, access cover and associated connections shall be in accordance with the supplemental construction details provided by the pump manufacturer. The manufacturer shall check alignment during start up field testing. Improper alignment shall be corrected by the Contractor prior to continuation of testing.

- 3.02 Startup and Field testing
 - A. After the pumps have been completely installed and wired, the Contractor shall remove the pumps to the wet pit top deck and an authorized representative of the pump manufacturer shall inspect each pump for proper installation.
 - 1. Megger stator and power cable
 - 2. Measure and record stator and power cable resistance
 - 3. Check for proper rotation
 - 4. Check power supply voltage
 - 5. Measure Motor no load current
 - 6. Check level control operation and sequence
 - 7. Review recommended operation and maintenance procedure
 - 8. Review warranty with Owner's personnel
 - B. After initial inspection, the Contractor shall lower the pumps into place in the wet pit and provide water for an initial operation check. The manufacturer's service representative shall supervise lowering and connection of the pumps to the discharge connection confirming proper guide rail and discharge connection alignment. The service representative shall then perform an initial operation check of each pump including:
 - 1. Motor current in each phase
 - 2. Supply voltage with one, two and three pumps running
 - 3. Vibration
 - 4. Discharge connection seating
 - C. On completion of initial inspection and operational checks, the pump manufacturer shall furnish the Engineer with a written report of the findings and data determined with regard to the pumps, motors, accessories, level control and electrical protection devices. The final report shall bear the stamp and signature of a Registered Professional Engineer employed or retained by the pump supplier to indicate engineering review and approval of field test data. A copy of the report shall be included in the operation and maintenance manuals.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.00 PART 1 - GENERAL

1.01 SUMMARY

- A. The control system shall be designed to operate the required number of pumps specified on the drawing at 480V / 3PH, 60HZ.
- B. The control function shall provide for the operation of the pumps under normal conditions, and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the pumping capacity of the lead pump, subsequent pumps shall automatically start to handle the increased flow. As the flow decreases, the pumps shall cut off at the elevations as shown on the plans.
- C. The control shall function as described below. The equipment listed below is a guide and does not relieve the supplier from supplying a system that will function as required.

1.02 MECHANICAL

- A. The enclosure shall be a NEMA 4X Stainless steel enclosure. The enclosure shall be a rack mount type with a minimum depth of 10" sized to adequately house all the components. Enclosures larger than 60"high x 36" wide shall be provided with 12" high leg stands. The enclosure door gaskets shall be rubber composition with a retainer or seamless foamed in place to assure a positive weatherproof seal. The gasket material shall not retain memory. The door shall open a minimum of 180 degrees.
- B. A polished aluminum dead front inner door shall be mounted on a continuous aircraft type hinge and shall contain cutouts for mounted equipment and provide protection of personnel from live internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, and other operational devices shall be mounted on the external surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.
- C. The back plate shall be manufactured of 12 gauge sheet steel and be finished with a primer coat and two 2 coats of baked on white enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified using engraved name plates. Use of DYMO type labels is not acceptable

1.03 ELECTRICAL

- A. The panel power distribution shall include all necessary components and be completely wired with tinned, stranded copper conductors rated at 90 degrees c. All conductor terminations shall be as recommended by the device manufacturer.
- B. Branch circuit breakers shall be heavy duty thermal magnetic or motor circuit protectors similar and equal to SQUARE D type HDL. Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 18,000 amps at 480 VAC. The control circuit shall individually be controlled by a heavy duty breaker.
 - 1. Circuit breakers shall be indicating type, providing "on-off-trip" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating "trip".

- 2. Thermal magnetic motor breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time characteristics secured through the use of bimetallic tripping elements supplemented by a magnetic trip.
- 3. Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.
- 4. A main circuit breaker shall be supplied for incoming power of type molded case with electronic trip. A breaker for each motor as well as controls and auxiliary equipment.
- C. Motor starters shall be open frame, across the line NEMA rated with individual class 10 overload protection in each leg. Motor starter contact and coil shall be replaceable from the front of the starter without removing from its mounted position. Overload heaters shall be block type, utilizing melting alloy spindles, and shall have visual trip indication. Overload shall be sized for the full load amperage draw of the pumps. Definite purpose contactors, fractional size starters and IEC contactor relays shall not be acceptable. Overloads shall be resettable without opening the inner door.
- D. Control transformers shall be provided to provide the 120 VAC and/or 24 VAC for control circuits when required. Transformers shall be fused on the primary and secondary circuits. The secondary windings shall be grounded. A 2 kVA is control transformer required and protected on secondary with breakers.
- E. A surge protecting device with tell-tale warning lights on each phase to indicate loss of protection on the individual phases shall be provided. The device shall be solid state with a response time of less than 5 nanoseconds with withstanding surge capacity of 6500 amperes. Unit shall be instant recovery, long life and have no holdover currents.
- F. The Phase Monitor shall be a 12 pin, plug in style unit. The Phase Monitor shall monitor Under Voltage, Phase Reversal, Loss of Power and Phase Imbalance. The motor starter circuits shall be deenergized upon sensing of any of the faults and shall automatically restore service upon return to normal power. The Phase Monitor shall be available to monitor Over Voltage. The output relay shall be DPDT rated at 10A at 480 VAC. The Phase

1.04 ALARM SYSTEM /AUTODIALER

- A. The alarm light shall be a weatherproof, shatterproof, red light fixture to indicate alarm conditions. The alarm light shall be turned on by the high level alarm and flash until the condition has been corrected. An open contact shall be provided for remote monitoring. The Alarm light shall be as manufactured by Federal Signal LP3M-012-048R, or equal.
- B. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide a signal of not less than 90db at 10 feet. The alarm horn shall not degrade the listing of the enclosure. An alarm silence switch shall deactivate the alarm horn; however, the alarm light will flash until the alarm condition ceases to exist. At that time the alarm reset function will reset for normal operation.
- C. The alarm shall be operated by an Alarm Charger and 12vdc battery for alarming on power loss. A Battery Operated Alarm with Charger as manufacture by MP Electronics shall be supplied, or equal.
- D. The wireless, web-based alarm detection and notification system shall consist of a RACO AlarmAgent Model 900AA-102DCRT with Model 802AA-PANC18 cable and antenna kit and oneyear prepaid standard service agreement or approved equal. All materials, equipment, labor, and services necessary to achieve the monitoring functions described herein shall be provided to interface the alarm detection and notification system with the triple redundant AlarmAgent secure

network server. The easy to install wireless RTU shall provide robust monitoring and control functionality via custom user templates and straightforward user interface. Equipment status shall be visible via the front panel indicators and shall also be available 24/7 via a web enabled device or by calling a toll-free number. The dedicated website system dashboard shall allow for on-demand of status of system and alarms as well as custom reporting capability to include alarm status/history and battery status. Provide on-site training and remote technical assistance in order to support the Owner with necessary understanding of the function and operation of the website and cellular monitoring system. The cellular monitoring system shall interface with the gas detector controller and send an alarm when a high level of gas has been detected.

1.05 LEVEL CONTROL SYSTEM

A. An automatic electronic alternator shall be provided to change pump sequence after each operating cycle. The alternator shall be equipped with a three-position switch to allow automatic alteration or to lock in a 1-2 on 2-1 sequence. LED indicators shall be provided to show lead pump position. Coil voltage shall be 120 volt. Contact rating shall be 10 amp resistive at 120 volts. The alternator unit shall be UL listed. The alternator shall be a Sta-Con 008-120-12S or approved equal. B. A 120v surge arrestor shall be included for added protection. C. Current transformers shall be included for pump monitoring.

1.06 ANCILLARY EQUIPMENT

- A. A three position HOA switch shall be provided for each pump. The switch shall be NEMA 4x rated with 25 amp contacts except when provided on a dedicated controller kit. A position indicating legend plate shall be provided. The HOA switches shall be mounted on the inner dead front door unless provided in the controller units.
- B. A green run pilot indicator shall be mounted on the dead front door. Pilot lights shall be full size NEMA 4 oil tight as manufactured by squared class 9001, or equal.
- C. An elapsed time meter shall be mounted on the dead front door. The meter shall operate on 120 VAC and shall indicate in hours (6 digits) and tenths and shall be non-resettable.
- D. The alternator shall be a plug in, solid state unit with lead-lag-auto selector and test switches except when provided in a dedicated control device. The unit shall operate on 120 vac and provide double pole, double throw ten amp rated contacts. Two LEDs shall indicate the next position to run as lead pump.
- E. A thermal heater and thermostat shall be installed to maintain the internal temperature of the enclosure above the dew point.
- F. Control wiring shall be copper, tinned, UL1015, 18ga. minimum.
- G. One Mini-Cas 120 unit shall be supplied for each pump to monitor the pump for over-temperature and moisture leakage. The unit shall have an 11pin, round base to mate with a standard 11 pin socket. The unit shall also be flanged in order to allow deadfront door mounting with use of 11 pin reverse socket, Omron part number P3GA-11.
 - a. The unit is to be able to be powered by 24VAC, 24VDC, or 120VAC, and to contain LED indication for power on, over-temp, and leakage conditions. The unit shall contain an over-temp reset bush-button to reset the unit after the fault has cleared, as well as a selector switch that that allows the selection of manual or automatic reset.

- b. Full size pilot lights shall indicate moisture and over temperature conditions for each pump.
- c. The sensor input circuitry is to contain both hardware and software filters for noise immunity, as well as sensor input short circuit protection. The Mini-Cas 120 unit shall be model 14-407129, as supplied by Flygt Corporation.
- H. A mechanical float switch shall be supplied for back up level control and be suspended at the desired height from its own cable. The float switch case shall be made of polypropylene and the cable is sheathed with a special PVC compound. The float switch cables shall be supplied with 50' of cable.

1.07 MANUFACTURER

A. Miscellaneous:

- a. A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. Schematics shall be done in ladder logic with wire numbers and line numbers. Real time cross referencing of relay contact to line numbers shall be given as well as written description of component function on each circuit of the drawings. From and to wire and termination reports shall be shown on the as built drawings. Drawings shall be available in HTML format. Terminal strip layouts shall be provided for ease of connecting external devices.
- b. All component parts in the control panel shall be permanently identified with engraved legend plates as designated on the drawings. A list of all legends shall be available in Excel format and attached with the schematics on the panel door.
- c. All equipment shall be tested to the operational requirements. Each control function shall be activated to check for proper indication.
- d. All equipment shall be guaranteed for a period of one year from the date of project substantial completion. The guarantee is effective against all defects in workmanship and/or defective component.
- e. The manufacturer shall be a UL508 shop and provide evidence on the end product. The panel shall be as manufactured by Xylem Flygt part number 130528 or approved equal.
- f. Provide pump control panel with SCADA ready module.

1.08 SPARE PARTS

A. Provide spare parts as recommended by pump and control manufacturer.

END OF SECTION

SECTION 13450 – PORTABLE HOIST

1.0 PART 1-GENERAL

1.01 Furnish all materials, labor, and equipment and install hoist as shown on the Drawings and as specified herein.

2.0 PRODUCTS

- 2.01 PORTABLE HOIST:
 - A. The portable hoist shall be series DB as manufactured by Halliday Products Inc. of Orlando, Florida or approved equal.
 - B. The unit shall be sized to facilitate equipment placement and removal.
 - C. The portable hoist shall be all T-304 stainless steel construction with marine grade brake winch and 30 feet (9m) of 1/4" (7mm) T-304 stainless steel cable with galvanized safety hook.
 - D. The davit arm shall adjust in 1inch increments from 24 to 36 inches (610 to 914mm) and the overall unit height shall be 60" (1.5m) (1.5m).
 - E. The hoist shall have a load capacity of 1000 pounds.

3.00 PART 2-GUARANTEE

- 3.01 GUARANTEE:
 - A. The portable hoist shall be guaranteed against defects in material and or workmanship for a period of 3 years.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- 1.2 SUMMARY
 - A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: **Stainless steel, 0.025-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

- 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 4. Fasteners: Stainless-steel rivets or self-tapping screws.
- 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. B.

Plastic Labels for Equipment:

- 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8** inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- 2. Letter Color: Black.
- 3. Background Color: **Black**.
- 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 7. Fasteners: Stainless-steel rivets or self-tapping screws.
- 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2

mm) thick, and having predrilled holes for attachment hardware. B. Letter Color: Black.

- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering twothirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: **Fiberboard or metal**.
 - 2. Stencil Paint: Exterior, gloss, **acrylic enamel** black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, **acrylic enamel** in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: **Stainless steel, 0.025-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
- 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 9 Section.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels **with painted** on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of **50 feet** along each run. Reduce intervals to **25 feet** in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels. D. Pipe

Label Color Schedule:

- 1. Domestic Water Piping:
 - a. Background Color: White.
 - b. Letter Color: **Black**.
- 2. **Sanitary Waste** Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose

connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 2 inches square.
 - b. Hot Water: **2 inches square**.
 - c. Sanitary Sewer Force Main: 2 inches square.
- 3.5 WARNING-TAG INSTALLATION
 - A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

1.00 PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.
- B. All valves and appurtenances shall be of the size shown on the Drawings and as far as possible all equipment of the same type shall be from one manufacturer.
- C. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
- D. All exposed valves, where applicable, shall have "open-closed" position indicators. The position indicators shall be conveniently located for easy visibility.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Piping is specified Division 2.

1.03 DESCRIPTION OF SYSTEMS

All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water and domestic wastewater.

1.04 QUALITY ASSURANCE

All of the types of valves and appurtenances shall be products of well established reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

1.05 SUBMITTALS

- A. Submit to the Engineer within 15 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.
- B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of the General Conditions.

1.06 TOOLS

Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

2.00 PART 2 - PRODUCTS

2.01 RESILIENT SEATED GATE VALVES

- A. Gate valves shall be resilient seated, manufactured to meet or exceed the requirements of AWWA C509 (valves 12-inch and smaller) or AWWA C515 (valves larger than 12-inch) or latest revision and be UL listed and FM approved. All valves shall be rated for 250 psi working pressure and be tested in strict accordance with AWWA C509/C515. The valves shall be tested and certified to ANSI/NSF 61. Valve shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.
- B. The valve body, bonnet, stuffing box and disc shall be ASTM A-126, Class B grey iron or ASTM A395 or A536 ductile iron. Flanges shall conform to ANSI B16.1 Class 125.
- C. All ferrous surfaces inside and outside shall have a fusion-bonded epoxy coating, 10 mils minimum.

- D. The valves are to be non-rising stem (NRS) with the stem made of cast, forged, or rolled bronze per AWWA C509/C515. The stem shall have at least one "anti-friction" thrust washer above and below the stem collar to reduce operating torque. The design of the NRS valve stem shall be such that if excessive input torque is applied, stem failure shall occur above the stuffing box at such a point as to enable the operation of the valve with a pipe wrench or other readily available tool. Valves with two-piece stem collars do not meet the requirements of AWWA C509/C515 and are unacceptable.
- E. The valves shall have bolts and nuts for the stuffing box and bonnet fabricated of ASTM A307, Grade B zinc plated steel or type 316 stainless steel. Refer to Paragraph 3.01.
- F. The NRS valves shall have a stuffing box that is o-ring sealed. Two o-rings shall be placed above and one o-ring below the stem thrust collar. The thrust collar shall be factory lubricated. The thrust collar and its lubrication shall be isolated by the o-rings from the waterway and from outside contamination providing permanent lubrication for long term ease of operation. Valves without a stuffing box are unacceptable. Valves without at least three stem o-rings are also unacceptable.
- G. The sealing mechanism shall consist of disc and guide lugs completely encapsulated in SBR ASTM D2000 rubber material. The peel strength shall not be less than 75 pounds per inch. Guide caps of an Acetal bearing material shall be placed over solid guide lugs to prevent abrasion and to reduce the operating torque. Guide lugs placed over bare metal are not acceptable. The resilient sealing mechanism shall provide zero leakage at the water working pressure when installed with the line flow in either direction.
- H. Non-buried valves shall have an arrow cast on the handwheel showing opening direction. Buried valves shall be provided with a 2" square operating nut, and the bolt that attaches the operating nut to the stem shall be recessed into the operating nut so as not to interfere with valve wrench operation. All valves shall turn counter-clockwise to open, and clockwise to close.
- I. Tapping valves where indicated on the drawings shall have an inlet flange conforming to ANSI B16.1 Class 125 for attachment to a tapping sleeve or cross. In addition, the valve inlet flange shall have a machined projection or raised face complying with MSS SP-60 for accurate alignment to the mating recess in the tapping sleeve flange. The seat opening of the tapping valves shall be at least .30" larger than the nominal pipe size to permit full size shell cutters.
- J. The valves shall be warranted by the manufacturer against defects in materials or workmanship for a period of ten (10) years from the date of manufacture. K. Valves shall be Mueller A2360 or A2361 Series or approved equal.

2.02 VALVE STEM EXTENSIONS

- A. Extension stems shall be provided as necessary to situate the operating nut no greater than 18 inches below the valve cover.
- B. Extension stems shall be equipped with stem guides affixed to the valve box at intervals not to exceed ten feet.
- C. Stem guides shall be considered a part of the extension. Extension stems and stem guide shall be manufactured items or approved equal.

2.03 VALVE BOXES

- A. All buried valves shall have cast-iron three piece valve boxes as shown on the Draw.
- B. Valve boxes shall be provided with suitable heavy bonnets and be set to finished grade.
- C. The barrel shall be two-piece, sliding type, having 5-inch shaft. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be complete with cast iron covers.

- D. Covers shall have "WATER" cast into the top for all water mains and "SEWER" cast into the top of all wastewater lines.
- E. All valves shall have actuating nuts extended to top of valve boxes.
- F. Valve boxes shall be provided with concrete base.

2.04 CHECK VALVES

- A. Check valves for PVC and ductile iron pipelines shall be resilient disc swing type suitable for cold working pressures of 250 psig in water and wastewater and shall conform to ANSI/AWWA C508 standards. Valve shall be hydrostatically tested at 1.5 times the rated cold working pressure.
- B. The valves shall be ductile iron body conforming to ASTM A536 Grade 65-45-12. Body shall have full flow area equal to the nominal pipe diameter. The seating surface shall be on a 45 degree angle to minimize disc travel. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line.
- C. Top access shall be full size, allowing removal of the disc without removing the valve from the line. The cover shall be domed in shape to provide flushing action over the disc for operation in lines containing high solids content.
- D. Resilient disc shall be one-piece construction of precision molded Buna-N (NBR), conforming to ASTM D2000-BG, with an integral o-ring type sealing surface. Disc shall have steel and nylon reinforcement in the hinge. Non-slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator. The flex portion of the disc shall be warranted for twenty-five (25) years.
- E. Disc accelerator shall be one-piece, stainless steel construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place by being captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface.
- F. Valve shall be cycle tested 1,000,000 times with no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. Manufacturer shall have 5 years minimum experience in the manufacture of resilient disc check valves.
- G. Ends shall have Class 125 ANSI B16.1 flanges.
- H. Valve shall have mechanical disc position indicator remaining in continuous contact with the disc under all operating conditions.
- I. Provide screw-type backflow actuator of rising-stem design with a stainless steel T-handle to allow opening of valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a bronze bushing.
- J. Exterior and interior of the valve shall be coated with an NSF 61 approved fusion bonded epoxy shop coating.
- K. Valve shall be Surgebuster[™] Series #7200 as manufactured by Val-Matic Valve & Manufacturing Corporation, Elmhurst, IL, or approved equal.

2.05 COMBINATION AIR/VACUUM VALVES FOR SANITARY SEWER SERVICE

- A. The air-vacuum release valves for use in sanitary sewer force mains shall be installed as shown on the Drawings.
- B. Valve shall release air and gases at a flow equal to or greater than the pumping capacity during filling of the system and admit air under vacuum conditions. Valve shall maintain an air pocket separation between the pumped liquid and the working mechanism.

- C. The operating mechanism shall be non-metallic and corrosion resistant. The valve body, floats, float guide, and stem shall be of stainless steel Type 316. The resilient seat shall be of Buna N.
- D. The valve shall be suitable for 230 PSIG working pressure. Valve shall have standard NPT inlets and outlet ports. Provisions shall be made for back-flushing the valve with clean water via cam lock attachment.
- E. Provide valve with 316 stainless steel ball valve of equal size to the air valve inlet to permit removal of the valve while maintaining the pumping system in service.
- F. The air release valve for sanitary sewer service shall come with a five year warranty.
- G. Valve shall be as manufactured by ARI Flow Control, Model D-020 or approved equal.

2.06 BACKFLOW PREVENTERS

- A. Reduced pressure backflow prevention assemblies shall be installed on water service line entrances at all sanitary sewer lift stations to prevent backflow due to backsiphonage and/or backpressure.
- B. The assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Seats and seat discs shall be replaceable in both check modules and the relief valve.
- C. There shall be no threads or screws in the water way exposed to line fluids. Service of all internal components shall be through a single access cover secured with stainless steel bolts.
 D. Assembly shall include two resilient seated isolation valves, four resilient seated test cocks and an air gap drain fitting.
- E. Provide 3/4-inch size for service lines 1-inch and smaller.
- F. The assembly shall meet the requirements of USC Manual 8th Edition; ASSE Std. 1013; AWWA Std. C511; and CSA B64.4. Assembly shall be Series 009QTSH as manufactured by Watts Regulator Company, Andover, MA or equal.

2.07 SHOP PAINTING

Ferrous surfaces of valves and appurtenances shall receive a coating of rust inhibitive primer as specified in Section 02556 for ductile iron. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

3.00 PART 3 - EXECUTION

3.01 INSTALLATION

- A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.
- B. Pipe for use with flexible couplings shall have plain ends.
- C. Flanged joints shall be made with 316 stainless steel bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.
- D. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and out-side of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the

bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

- E. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8 inches. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. The other pipe end shall be inserted into the middle ring and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares. After the bolts have been inserted and all nuts have been made up finger tight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.
- F. Air Valve Locations: The Contractor shall install the air release valves as shown on the plans. The connection to the main shall be by a stainless steel flange connection, or as shown on the Drawings.
- G. Valve boxes with concrete bases shall be installed as shown on the Drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place cast iron box over each stem with base bearing on compacted fill and top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on cover shall be parallel to pipe. Remove any sand or undesirable fill from valve box.
- H. Backflow Preventer Installation: Install backflow assembly 1½ feet above natural ground. Encase vertical water service piping to and from the backflow assembly in concrete-filled 4inch steel pipe similar to the standard detail for lawn hydrants shown on the Drawings.

END OF SECTION

THIS SHEET INTENTIONALLY LEFT BLANK

1.00 PART 1 - GENERAL

- 1.0 THE GENERAL CONDITIONS, SPECIAL PROVISIONS and applicable requirements of DIVISION 1 GENERAL REQUIREMENTS are hereby made a part of this section.
- 1.1 SCOPE: This section covers excavation and supporting systems for trenches necessary to protect the safety of workers. This specification shall govern for construction of all types of trenches except where the requirements of this section are explicitly revised or superseded by another section. Additional requirements as set forth by federal, state, and local government regulations will be applicable and must be followed. The contractor shall be responsible for the design, placement, and inspection of all trench safety systems in conformance with the Occupational Safety and Health Administration (OSHA) standards as contained in Subpart P, Part 1926, Title 29 of the Code of Federal Regulations (29 CFR 1926). Other OSHA construction standards shall also apply.
- 1.2 Section 01420 contains a geotechnical engineering study with boring logs for your information. It is the Contractor's responsibility to determine and evaluate soil conditions at the site and design adequate trench safety systems. The Contractor will be responsible for detecting varying soil conditions which may be hazardous and take appropriate action. The contractor, at his expense, shall be responsible for obtaining any geological data required for his design of the trench safety system.
- 1.4 APPLICABILITY: These specifications apply to any trench excavation which is over five (5) feet in depth from the ground surface, or trench excavations that are less than five (5) feet in depth located in areas where unstable soil conditions are present (Ref. OSHA Safety and Health Regulations, Part 1926, Subpart P, Paragraph 29 CFR 1926.652, Subparagraph (a)).
- 1.5 LIABILITY: It is the Contractor's responsibility that all excavation work and site conditions are within the regulations as established by OSHA. Any property damage or bodily injury (including death) that arises from use of the trench safety systems, from the Contractor's negligence in performance of the contract work, shall remain the sole responsibility and liability of the Contractor.
- 1.6 EXISTING UNDERGROUND INSTALLATIONS: Underground installations are shown in approximate locations on the Drawings. It is the Contractors responsibility to verify the size, locations and elevations of all existing utilities in the construction area prior to commencement of excavation operations.
- 1.7 SURCHARGE LOADS: The Contractor's trench safety system shall be designed to take into account all surcharge loads including, but not limited to adjacent structures, contractor's equipment and heavily loaded truck traffic which will be routed near the work site.
- 2.00 PART 2 MATERIALS Not applicable.
- **3.00 PART 3 INSTALLATION** Not applicable.
- 4.00 PART 4 MEASUREMENT & PAYMENT
- 4.1 MEASUREMENT/ PAYMENT: Trench Excavation Protection shall be measured by the lump sum for the trenching and excavations shown or implied in the plans.

19000 - Page 1 of 2

SECTION 19000-TRENCH PROTECTION

- A. Payment shall include all components for design and construction of the Trench Protection System which can include, but not be limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage. Payment shall also include the additional excavation and backfill required, any jacking, jack removal, and removal of the trench supports after completion.
- B. Payment of all work prescribed under this item shall be full compensation for all additional excavation and backfill; for furnishing, placing and removing all shoring, sheeting, or bracing; for dewatering or diversion of water; for all jacking and jack removal; and for all other labor, materials, tools, equipment and incidentals necessary to complete the work.

END OF SECTION

19000 - Page 2 of 2

SECTION 16012

ELECTRICAL WORK

PART 1 GENERAL

1.00 CONDITIONS

A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

B. Contractor shall comply with Section 1.07, D of this specification before bidding.

- C. Contractor shall verify compliance with Section 2.01, F before bidding.
- D. Contractor to conform to Section 1.06, Contractor Qualifications, of this specification before bidding.
- E. Generator Contractor is solely responsible for coordinating all electrical requirements of all equipment installed under this contract. Electrical Sub-Contractor shall confirm this with General Contractor before bidding.
- F. This specification section is an inherent part of all work performed on this project and its contents shall apply for any and all electrical power, control and instrumentation related work. Contractor shall advise all Sub-Contractors and Vendors accordingly.
- 1.01 DESCRIPTION
 - A. The work shall include providing materials and equipment required for installation of a complete and functioning electrical system as specified and as shown on the drawings.
 - B. This section is an integral part of all Specification Sections related to electrical, control and instrumentation construction under this contract. Contractor shall check all other plans and specifications for this project and include items and circuits accordingly. The total set of construction documents make up the requirements for work for this project and shall be included in Contractor's bid at no additional cost to Owner or Owner's Representative.
 - C. All Plans & Specifications for this project are representative of the design intent and may not contain minute details normally associated with normally accepted electrical construction, as described in applicable codes or as described in manufacturer=s literature. Contractor shall provide all appurtenances normally associated with a particular equipment or device, and as required for a proper operating system. Where discrepancies occur between various plans or specifications for this project and where clarification is not made prior to bidding, the most stringent request shall be included in the Contractors bid price. Electrical Sub-Contractor shall review all specifications with electrical requirements prior to building and shall include most stringent and higher cost requirements in bid price.
- 1.02 MAJOR ITEMS OF WORK AS FOLLOWS
 - A. Installation of Lift Pump Control Panel.
 - B. Installation of SCADA RTU and antenna mast.

- C. Installation of Pump Motor Feeders and Terminal Boxes.
- D. Installation of Electrical Service Equipment.
- E. Installation of Autosensory Controls.
- F. Installation of Manual Transfer Switch and Generator Connector.
- G. Provide Portable Generator, Ready to Operate.
- 1.03 CONTROL SYSTEM
 - A. The Contractor shall furnish and install a complete operating control system. The control system shall include but shall not be limited to all circuit breakers, motor starters, contactors, indicating lights, elapse time meters, selector switches, surge protector, phase failure relays, programmable controllers, alarm light and horn, push buttons, control transformer, electronic devices, sensors, interlock wiring, control relays, blocks, snubbers, valves, nameplates, and all other associated items required to provide a workable system. All control circuits to be Afail-safe@ type. All motor starters are to have ETM, HOA, and Run light as a minimum. All autosensory controls to have block and bleed valves. Bleed line shall be routed outside of building.
 - B. Provide circuit conductors, conduits, circuit breakers, and related devices for furnishing power to all motor heaters, instruments, devices, lights, controls, and other equipment provided by vendors, or others for this project.
 - C. Control diagrams shown on plans are illustrative in nature and may require additional devices such as time delays, relays, and other devices required for the intended control functions.
 - D. All controls shall be fully tested in shop for proper and satisfactory operation, prior to installation at site. Contractor to provide written certification before delivery to site. Any installations without certification notice are done at risk by Contractor, who shall be obligated to make all necessary corrections in field at no additional cost to owner.
 - E. Where any equipment includes a Manufacturer furnished control panel the Equipment Vendor or Manufacturer shall be responsible for all interconnecting wiring at related devices.
 - F. Provide interlock circuits between Vendor furnished equipment control panels. Coordinate with each Vendor. Do not submit MCC or control panels until interlocks are coordinated. Failure to do so will be at expense of Contractor and at no additional cost to Owner.
 - G. Install all level transmitters and switches at elevation in control panel that is no higher than the source elevation tap at GST or other equipment. Provide block and bleed valves for level and pressure devices. Route bleed line to outside building.

1.04 SUBMITTALS

A. Submit all products covered under all sections for Engineer=s approval. Any items not submitted are the total responsibility of the Contractor. If it is not submitted, it is not approved. Requirements of this section apply to all other electrical instrumentation and control related specifications for this project.

- B. Where submittals for a particular equipment, device or material item vary from that specified or shown on plan drawings, and where that item is not specifically noted as acceptable and, where installation of submitted item results in improper or undesirable operation of the system, Contractor shall be liable for removal and/or replacement of that item with the item specified or shown on plan drawings at no additional cost to Owner. Such items submitted as substitutions shall be listed separately and clearly noted as ASubstituted Item@.
- C. Where various equipments interface or have wiring inter-connections, submittals for all of the equipment shall be made simultaneously. For example MCC and controls, telemetry and controls, etc. No sections, equipment or devices shall be omitted. Submittals not complying shall be returned, unchecked, marked ARejected@.
- D. Submittals of motor control and electronic device shop drawings will require a minimum of two (2) weeks for review from time of receipt by Electrical Engineer. Contractor shall submit all shop drawings in time to account for this period of review.
- E. Provide CAD files of diagrams, equipment views, and material & device schedules on CD and include with submittals. Only one (1) copy required for Electrical Engineer.
- F. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- G. Contractor is fully responsible for submitting correct operating voltage, horsepower, and phase requirements of all equipment furnished and installed under this contract. Shop drawing review by Engineer does not remove this responsibility. Incorrect submittal information is at risk of Contractor and at no additional cost to Owner. Refer to 1.01, C and 1.07, E of this specification section.
- H. All submittals for motor control centers, control panels, control sections, SCADA panels, lift pump panels, and Vendor furnished panels must contain statement of UL certification and identifying name and number of UL certification for fabricating shop. All submittals without this information will be rejected. Any MCC's or panels installed without UL listing will be replaced at cost of Contractor.
- I. Submittals shall contain statement that all controls for this project have been coordinated in respect to interlock circuits. List each system and name of Vendor for each system who was contacted for coordination.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall provide (6) complete sets of hard-covered ring-bound loose-leaf O&M manuals. In addition to Aas-built@ system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all components provided under this section. The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
- The O&M manual shall be professionally composed and compiled and shall not be an assembly of "cutsheets". Engineer shall have sole discretion of acceptance of O&M manual contents and composition.
- B. The contents of the O&M manuals shall be generally organized as follows:
 - 1. System Hardware/Installation

- 2. System Software
- 3. Operation (step-by-step procedures)
- 4. Maintenance and Troubleshooting
- C. Where Electrical and Instrumentation Equipment is to be installed under this contract or where existing and noted, the Contractor shall further provide a complete set of as-built plans, diagrams, parts and materials list, parts source, operational instructions, programming data, maintenance and trouble shooting instructions, service data, calibration data, testing data, required service and programming instruments and wiring diagrams sufficient for complete operation, service and programming and maintenance of the Electrical and Instrumentation Equipment by plant technicians and operators or by outside service technicians.

This information shall be provided on CD in AutoCAD 14, or later version, and in Word format and shall be arranged in final order for insertion into Electrical and Instrumentation Equipment files. Coordinate overall layout and contents with Engineer and with Electrical and Instrumentation Equipment Programmer.

Allow adequate man-hours for adjustment of layout and contents during Electrical and Instrumentation Equipment testing and Owner review. All data submitted will be reviewed by Engineer for acceptance and where deemed insufficient by Engineer, data will be resubmitted at no additional cost to Owner.

1.06 CONTRACTOR QUALIFICATIONS

- A. Contractor shall be experienced with all types of electrical systems covered under this contract. No work shall be undertaken where Contractor=s firm, project supervisors and project electrical workers have not had recent experience in similar projects in area of project location. Contractor will be required to furnish proof of experience where requested by Owner or Engineer or their Representatives.
- B. Contractors Project Manager or his Assistant shall be familiar with types of electrical construction required by this project in order to determine that all subcontractors and vendors work is in conformance with the plans and specifications.
- C. Electrical Contractor shall have Master Electrician License for City or County, in which project is located, where applicable. Contractor to have State Electricians License as recently required by State of Texas

1.07 CONTRACTORS RESPONSIBILITIES

- A. Contractor shall coordinate electrical power, telephone, data or special purpose line installation with utility companies. Within 30 days after award of contract, contractor shall contact utility company and Owner and shall request service needed. It is Contractors sole responsibility to assure that utility company and Owner are notified and are kept aware of requirements.
- B. Contractor shall provide all conduit, conductors and termination equipment as needed for utilities and shall coordinate with utility companies for installation requirements and shall provide installation constructed according to the utility company standards whether or not such is shown in detail or plans.
- C. Contractor shall review all sections of the plans and specifications for this project and shall note all electrical requirements for devices and equipment shown or implied, and shall provide service accordingly for a complete operating control system.

- Any discrepancies in Electrical or Mechanical requirements noted in various plans and specifications shall be brought to the attention of the Engineer prior to ordering equipment or materials or prior to starting construction related to the item in question. Coordination of all equipment and systems is Contractor=s sole responsibility. Failure to coordinate all equipment requirements shall be the responsibility of the Contractor, at no additional cost to Owner.
- D. Unless specifically noted otherwise, Contractor shall furnish all software. Programming of SCADA RTU's will be done by the Contractor where programming is required. Programming will be performed by the Contractor at no additional cost to the Owner. Contractor shall provide all installation, set-up, adjustments and testing of devices or equipment included under this contract.
- E. Contractor is specifically responsible for coordination of all electrical and mechanical and process systems, devices and equipment provided or installed under this contract and shall assure that all requirements by all trades are met such as to insure a complete and operating electrical, control, process or instrumentation system. Special attention shall be given to coordination of motors supplied, MCC components supplied, mechanical systems supplied, and voltage and phase requirements of each. This includes verification of compatibility of all interfacing connectors and devices at new, existing, and Owner furnished equipment. Notify Engineer of any discrepancies before ordering equipment. Failure to do so may result in additional cost to Contractor.
- F. Contractor shall assure that all systems have been properly installed, adjusted and tested prior to final inspection, unless, Engineer has been duly notified in writing that certain equipments are not ready for final testing and such is acceptable with Engineer.
- G. Contractor shall fully inspect all motors and nameplates, controls, conduit, wiring devices and other items before starting work, ordering materials or submitting shop drawings in order to verify existing conditions are as shown on plans and, shall immediately notify Engineer of any discrepancies between plans & specifications and existing conditions. Failure to do so may result in Contractor=s responsibility for any required changes in construction. This includes verification of compatibility of all interfacing connectors and devices for new, existing, and Owner or Contractor furnished equipment. Notify Engineer of any discrepancies before ordering equipment. Failure to do so may result in additional cost to Contractor.
- Where Manufacturer's delivered motor sizes varies from design size shown on one-line diagram, or described in specifications, Contractor shall provide conductors, conduits, and all motor control devices sized for the delivered motor size at no additional cost to Owner.
- Where motor current transformers are required for use by Manufacturer control panels, Contractor to provide current transformers and conductors sized by Control Panel Manufacturer at no additional cost to Owner.
- H. At completion of project and before final inspection, Contractor shall provide the Electrical Engineer with full size blue prints, red-lined to reflect the AAs-Built@ electrical installation. Any variation from plans shall be shown on each applicable plan sheet.
- I. When work involving modifications or additions to existing plant will interrupt normal service, Contractor shall make provisions for continuous electrical service thru Contractor furnished standby generator power. Where a standby generator exists but, will be temporarily out of service during construction, Contractor shall provide substitute generator power for duration of outage. In no event shall plant be without operating power or, without standby generator service.

Include all transfer switches, fuel tank, fuel, attendance and appurtenances required for a complete power system as needed for interim plant operation.

- J. Where work disrupts power and/or control to new or existing equipment, furnish temporary bypass circuits, as required, to maintain equipment operation.
- K. Where work involves additions, modification, demolition or renovations to existing facilities, Contractor shall remove, relocate and extend existing installations to accommodate new construction.
- L. Provide electrical circuits to all equipment as required by manufacturer. Verify location and characteristics of all equipment shown on plans and in specifications and size circuits accordingly. All conductors and conduits to comply with NEC Article 250 and Article 310. All terminations to vendor furnished control panels shall be done by Vendors Representative unless Contractor is specifically authorized to make such terminations. All panel calibrations and adjustments shall be done by Vendors Representative.

Provide electrical circuits to all equipment, devices, controls, controllers, and other items shown on plans, or described in specifications. Provide circuit breaker, conductor, local disconnects, and connections to equipment in compliance with National Electrical Code. All circuits may not be shown on plans and must be verified and installed accordingly.

- M. Equipment, instruments, controllers, VFD=s, conduits and related appurtenances are shown in approximate locations. Contractor shall field select optimum location and where necessary, relocate up to ten (10) feet from location shown on plans to accommodate installation, at no additional cost to Owner.
- N. Where circuit problems such as breaker trips, relay trips, controls failure, etc. develop within the one (1) year warranty period, contractor shall furnish a power line recording device with all appurtenances for a total period of 60 days and, shall include setup and data retrieval. Work shall be performed when requested by Engineer and shall be at no additional cost to Owner.
- O. Where any motor performance does not conform to specifications or, where in Engineers opinion, motor parameters are out of tolerance or erratic in performance, the Contractor shall remove and replace motor at no additional cost to Owner.
- P. Location of outlets and equipment shown on Drawings is approximate. Field verify exact location. Minor modification in location of outlets and equipment is considered incidental up to distance of 10 feet with no additional compensation.
- Q. Where training is required by any specification sections, Contractor shall provide training manuals for Operators. Manuals shall be approved as substantial quality by Engineer. All training manuals must be pre-approved by Engineer. Instructors shall be pre-approved by Engineer as qualified for training.
- R. Provide fail and problem alarms from controls, generators, and Manufacturer's equipment. Route circuits to autodialer and/or SCADA systems, where present. Provide circuits, relays, expansion modules and programming. Fail signal only shall be run to autodialer.
- S. Contractor shall provide the equipment necessary for locating all underground pipes, conduits, and structures before digging. All locating of intersection shall be properly staked and identified. Locating all underground lines is the sole responsibility of the Contractor and shall be at no

additional cost to Owner. Any damage to underground lines is the responsibility of the Contractor.

- T. Power and control requirements for all valve actuators or Manufacturer's furnished panels shall be provided according to the specification for that equipment. This includes all starters, breakers, controls and devices for a complete electrical system.
- U. Motor operated valves shall be furnished complete with dual voltage (240/480) controls and motors and shall be coordinated with Electrical Contractor and other trades before ordering equipment or materials and before starting work. Verify voltage and phase and provide power and control circuit and devices accordingly.
- V. Provide local disconnect switches for all MOV's, motors, heaters, and electrical equipment required for this project per NEC.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials provided under all sections of the specifications shall be new and the standard products of manufacturers regularly engaged in the production of such equipment. All materials shall conform to the National Electrical Code and shall be approved and listed by the Underwriters' Laboratories. Materials described by manufacturer's name and catalog number are selected to set a definite standard of design and quality to be required. There is not any intention to discriminate against a product of another manufacturer which is equally durable in construction, similar in design, and will serve the purpose for which it is intended.

Within 30 days after award of the contract and before any materials and equipment are placed on order, the Contractor shall submit shop drawings to the Engineer for approval per Section 1.04.

- B. Materials and equipment specifications are general in coverage and may contain reference to construction items that apply in only particular situations and may not apply as a general rule for materials installed on this project.
- C. All equipment and devices shall be installed according to Manufacturer's instructions. Coordinate installation with manufacturer's representative to assure correct installation methods have been applied. All equipment and materials shall be rated for the harsh Industrial, Electrical, and Mechanical environment in which installed and shall be warranted by manufacturer accordingly.
- D. Outdoor equipment shall not have exposed devices or controls, unless specifically called for on plans. The outer door shall cover all such items. No see thru windows are allowed unless specifically approved. All outer doors to have locking hasp. Keyed handles only acceptable where specifically approved. All NEMA 4X enclosure doors to have quick release latches.
- E. All PLC=s, controllers, VFD's, instruments and electronic equipment installed outdoors or in unconditioned spaces shall have means of cooling to allow satisfactory operation in local environment and at conditions required by equipment manufacturer=s specification. All motor starters over 100 horsepower shall have forced fan cooling in the starter section.
- F. All Control Panels (not including SCADA or telemetry panels) and Motor Control Centers that are not standard manufacture, off the shelf products shall be manufactured in accordance with plans

and specifications with high quality materials and components and shall bear a U.L. listed label or, be constructed by a U.L. listed shop. The following manufactures are acceptable:

- 1. Weimar Manufacturing
- 2. Systems
- 3. Prime Controls
- 4. Hydro-Con
- 5. Trac-N-Trol, Inc.
- 6. MOV Controls
- 7. Or pre-approved equal
- G. Equipment ratings shown on plans are "minimum" acceptable sizes. All Equipment Manufacturer's products may not be available in the exact rating shown, in which case next greater available size shall be provided.
- H. Generator connectors installed at transfer switches shall be male type and mating cable connector shall be female type. Supply connectors mounted at generator shall be female type. Contractor shall coordinate connector's style and size with Owner's existing connectors to assure compatibility.
- I. All control panels and MCC's shall have single piece door with door mounted devices mounted directly to door. Auxiliary mounting plates shall not be used to mount devices to door. All panels must be fabricated in a neat and professional manner. Metal work shall be performed with proper commercially available tools, with no hacksaw or nibbler cuts allowed.
- J. All transmitter displays to be in actual unit values and not percent scale.
- K. All motor operated valves to have local control station with starter contacts, selector switches, and limit switches, indicators, and all other devices required to function as indicated on plans and in specifications.
- L. Door-mounted operating mechanisms for circuit breakers are not allowed for MCC's or control panels.
- M. All components inside enclosures shall be fastened down with proper hardware. All cable shall be bundled and bound with waxed cord or nylon ty-raps manufactured for that purpose. Adhesive tie down blocks are not allowed. Provide threaded press-in or welded studs for nylon cable clamps as required. All work shall be done in a neat and professional manner.

2.02 PLANS AND SPECIFICATIONS

A. Electrical plans and specifications are not intended to discriminate against any particular manufacturer. Specific values shown for a particular manufacturer's product may vary slightly for another product. Work required under this contract consists of each and every item, equipment, material and device shown on any of the Civil, Structural, Mechanical, Process, Electrical or other plan sheets contained in the contract documents and includes items shown in details, schedules, diagrams, sections or other means of illustration presented. If an item is shown on a single sheet at any place, it is to be included under this contract unless specifically noted otherwise and, all piping, wiring and connections for operation of the item shall be included at no additional cost to Owner. If there is any doubt or questions, Contractor shall request a "clarification" from Engineer before bidding.

- The Electrical Engineer reserves the right to interpret the electrical specifications and to make judgment as to acceptance of a product, regardless of minute details in the specifications or on the plans.
- B. Specifications shall be reviewed for applicability of materials under certain conditions and in certain environments and, where not shown otherwise on plan drawings, these application directions shall be adhered to.
- C. Where a particular reference on drawing plans does not conform to standard acceptable construction methods for a particular type project, the Contractor shall immediately notify the Engineer and request a clarification before ordering materials or starting construction.
- D. Plans are general in nature and may not show minute details of existing conditions or proposed work. Existing conditions may include undocumented buried pipes, conduits and structures that lie in the route, or at location, of equipment or conduit installation required for this project.
- These uncertainties shall be accounted for in the Contractors Bid. Contractor shall adjust conduit routes, equipment pads and equipment mountings, as required, for a satisfactory installation for the conditions imposed and at no additional cost to the Owner.
- E. Electrical site plan drawings shall only be scaled when "Scalable Drawing" appears on the drawing sheets.
- F. All electrical equipment, controls, and devices used in this project shall have self protection features that prevent damage of that equipment from overload, overvoltage and undervoltage conditions. Any failures caused by lack of this provision shall be at full cost to Contractor and at no additional cost to Owner. Where Engineer determines this to be the case and where Contractor disagrees, Contractor shall provide full evidence of failure cause at their own expense.

PART 3 EXECUTION

3.01 WORKMANSHIP

- A. All wiring shall be installed in accordance with current NEC and local codes. Field select routing of conduits to avoid underground piping, conduit or structures that may not be shown on plans.
- B. All construction and equipment fabrication shall be of highest quality and installed in a professional manner. All devices shall be manufactured specifically for the purpose installed and shall be installed according to Manufacturer's recommendations.
- C. Adjust route of electrical conduits and ductbanks below proposed or existing buried piping. Provide minimum 24" clearance vertically and horizontally. This work shall be performed in a satisfactory manner and at no additional cost to Owner.
- D. A fish wire shall be left in all conduits in which the permanent wiring is not installed.
- E. All fixtures, switch, and receptacle locations shall be approved by Engineer.
- F. Refer to other sections of this specification for controls. Under this section of the specifications, the Contractor shall install the control devices and provide control wiring switches, outlet boxes, and shall make all final connections. Control wiring and interlocks shall conform to wiring diagrams furnished by equipment manufacturers.
G. Seal all conduits entering motor control centers, control panels and equipment enclosures with CSBE seals. Sealing glands shall be selected specifically for each conduit and conductors.

3.02 AS-BUILT DRAWINGS

- A. As-Built Drawings
 - 1. Prior to final inspection, Contractor shall provide complete set of legibly marked up drawings showing all deviations from contract drawings. This shall include conduit routing and sizes, wire sizes, detail changes, etc. Markup shall be in red pencil on black line or blue line plan sheets.

As built drawings are to be maintained on site during construction and changes shall be marked as work progresses. Plans shall be available for Engineer and/or Owner=s review during the course of construction. Final inspections will not be conducted until as-built drawings are received by Engineer.

3.03 ELECTRICAL SYSTEM ACCEPTANCE

- A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:
 - 1. When as-built drawings have been submitted, reviewed and approved in writing by Engineer.
 - 2. All O&M documentation has been submitted, reviewed and approved.
 - 3. The complete electrical system has been fully inspected and has successfully been started up, tested and accepted by the Engineer.
 - 4. All Owner's staff personnel training programs have been completed.
 - 5. Owner/Engineer sign a document indicating electrical installation has formally been accepted.

3.04 EXCAVATION AND BACKFILL

A. All underground conduits shall be buried to a minimum depth of 24-inches below finished grade. All trenches shall be uniform width and shall be backfilled and compacted to 95% that of original density.

Any damage to underground conduits caused by other Contractor=s shall be repaired by this Contractor and shall be compensated accordingly by the party or parties responsible for the damage.

B. Do not cut paved driveways, sidewalks, etc. Bore under such construction, maintaining a minimum of 24" below the underside of the pavement or concrete.

3.05 CLEAN UP

A. The Contractor shall upon completion of the work, remove all materials, empty containers, and any other materials that are not incorporated into the work.

3.06 WARRANTY

A. In addition to labor, equipment, devices, hardware, software and materials warranty, Contractor shall provide full one (1) year service warranty on overall installation. This warranty shall begin at date of written final acceptance of electrical systems.

Contractors warranty shall guarantee 24 hour service response time and shall provide whatever labor, work or materials needed to maintain plant operation when replacement parts are on order. In no case shall plant electrical systems be out of service for over 24 hours from time Owner calls for warranty. This shall be at no additional cost to Owner.

All materials and equipment installed shall have full warranty from manufacturer that guarantees equipment is rated for the harsh Industrial Electrical/Mechanical environment in which it is installed. Warranty shall be for a one (1) year period after date of written acceptance by the Owner and Engineer and shall include all labor, equipment and materials. Where manufacturer's products fail prematurely, manufacturer shall be fully responsible for replacement and shall not have option of declaring that failures were caused by environment and its affect on the product. Contractor is fully responsible for assuring that product manufacturers are aware of this condition and that warranty statement is included in shop drawings. Failure to do so will be at full expense of Contractor and at no additional cost to Owner. Where warranty requirements are shown in other sections, the more stringent requirement shall have precedence.

3.07 TRAINING

A. The Contractor shall provide services of his Engineer or a factory trained technician to instruct plant operating personnel for a period of at least two (2) full days after completion of the contract work. Training requirements in specific specification sections shall have precedence over requirements of this section.

CONDUIT, FITTINGS AND BODIES

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SECTION INCLUDES
 - A. Specification for conduit, fittings and bodies.
- 1.02 REFERENCES
 - A. American National Standards Institute (ANSI).
 - 1. ANSI C80.1: Rigid Steel Conduit Zinc Coated.
 - 2. ANSI C80.4: Fittings for Rigid Metal Conduit.
 - B. Federal Specifications.
 - 1. W-C-58C: Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron.
 - 2. W-C-1094: Conduit and Conduit Fittings Plastic, Rigid.
 - 3. WW-C-566C: Flexible Metal Conduit.
 - 4. WW-C-581D: Coatings on Steel Conduit.
 - C. National Electrical Manufacturers Association (NEMA).
 - 1. NEMA RN1: Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.
 - 2. NEMA TC2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - 3. NEMA TC3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - D. National Fire Protection Association (NFPA), ANSI/NFPA 70 National Electrical Code (NEC).
 - E. Underwriters' Laboratories (UL).
 - 1. UL 1: Flexible Metal Electrical Conduit.

- 2. UL 6: Rigid Metal Electrical Conduit.
- 3. UL 514B: Fittings for Conduit and Outlet Boxes.
- 4. UL 651: Schedule 40 and 80 Rigid PVC Conduit.
- 5. UL 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit.
- 6. UL 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- 1.03 SUBMITTALS
- A. Submit all products covered under this specification for Engineer=s approval.
 - 1. Manufacturer's cut sheets, catalog data, with selected products clearly marked.
 - 2. Installation, terminating and splicing procedure.
 - 3. Instruction for handling and storage.
 - 4. Dimensions and weight.
- B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.04 QUALITY ASSURANCE
 - A. Tests:
 - 1. Rigid steel conduit shall pass the bending, ductility, and thickness of zinc coating tests described by ANSI C80.1.
 - 2. Flexible conduit shall pass the tension, flexibility, impact, and zinc coating test described by UL 1.
 - 3. Nonmetallic conduit and fittings shall pass the test requirements of NEMA TC2, UL 651 and 651A and Federal Specification W-C-1094A.

1.05 DELIVERY STORAGE AND HANDLING

- A. Package conduit in 10-foot bundles maximum with conduit and coupling thread protectors suitable for indoor and outdoor storage. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage. Package plastic-coated rigid conduit, fittings, and bodies in such a manner as to protect the coating from damage during shipment and storage.
- B. Store conduit above ground on racks to prevent corrosion and entrance of debris.
- C. Protect plastic conduit from sunlight.

PART 2 PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS
 - A. Rigid Steel Conduit.
 - 1. Allied Tube and Conduit
 - 2. Triangle Wire and Cable, Inc.
 - 3. Wheatland Tube Company
 - B. PVC Coated Steel Conduit.
 - 1. Occidental Coating Company (O-Cal Blue)
 - 2. Robroy Industries, Inc. (Rob-Roy Red)

C. PVC Rigid Conduit.

- 1. Cantex
- 2. Carlon Industries, Inc.
- 3. Robroy Industries, Inc.
- D. Conduit Fittings and Bodies.
 - 1. Appleton Electric
 - 2. Crouse-Hinds
 - 3. Killark Electric Manufacturing Company
 - 4. O-Z/Gedney
- E. Liquidtight Flexible Conduit.
 - 1. Anamet, Inc.
 - 2. Electriflex Company
 - 3. Triangle Wire and Cable, Inc.
- 2.02 MATERIALS AND EQUIPMENT
 - A. Design Conditions. Use electrical conduit, fittings, and bodies designed for service in areas as specified within this section to form a continuous support system for power, control, and instrument cables.

- B. Conduit and Fittings
 - 1. Rigid Steel Conduit and Fittings.
 - a. Rigid steel conduit, rigid steel conduit bends, nipples, and bodies shall be hotdipped galvanized and shall comply with the latest ANSI C80.1, UL 6, Federal Specification WW-C-581D, and NEC Article 346-15.
 - b. Mild steel tubing shall be used for conduit, nipples, and couplings, and shall be free of defects on both the inner and outer surfaces.
 - c. Fittings, bodies, and covers for rigid steel conduit shall be steel or cast-iron and shall comply with ANSI C80.4, UL 514B, and Federal Specification W-C-58C.
 - 2. PVC-Coated Rigid Steel Conduit and Fittings.
 - a. PVC-coated conduit, fittings, bodies, and covers shall conform to NEMA RN1 (Type A). Rigid steel galvanized conduit and fittings before coating shall conform to Federal Specification WW-C-581D, ANSI C80.1, and UL 6. Conduit bodies shall conform to UL 514B and Federal Specification W-C-58C. Provide sufficient coating for touch up after installation.
 - b. PVC-coated couplings shall be of the ribbed type.
 - c. Condulet covers shall have encapsulated stainless steel thumb screws.
 - d. Condulets and covers shall be of malleable iron or feraloy material before coating.
 - e. PVC coating shall be a minimum of 2 mil thickness on the interior of the conduit and the interior of fittings, condulets, covers and bodies.
 - 3. Flexible and Liquidtight Flexible Metal Conduit and Fittings.
 - a. Use liquidtight flexible metal conduit manufactured in accordance with UL 1 and Federal Specification WW-C-566C.
 - b. Fittings used with liquidtight flexible metal conduit shall be the PVC- coated type and of such design as to thoroughly ground the conduit to the fittings, and through it to the box or enclosure to which it is attached.
 - c. Flexible couplings and fittings for use in hazardous areas shall comply with UL 886, NEC Article 501-4 (a&b), and Federal Specification W-C-586C.
 - 4. PVC Conduit and Fittings. Use PVC conduit, bends, and fittings, which comply with NEMA TC2, W-C-A, and NEC Article 347-17 for above ground and underground installation. Conduit shall be Schedule 80, unless shown or noted otherwise on drawings or in other specifications.

PART 3 EXECUTION

3.01 PREPARATION

- A. Confirm submittal of shop drawing with conduit and conduit fitting, sizes, types and routing shown.
- B. Ensure that the conduit system to be installed is sized properly for the cable and wire requirements.
- C. Verify the actual physical conduit route from the conduit plan drawings and prepare the conduit support system.
- D. Verify the equipment locations to which the conduit will be connected and determine detail requirements for connections.
- E. Submit layout of all conduit stub-ups for Engineers review before installing conduits.

3.02 INSTALLATION

- A. Install PVC-coated conduits in all outdoor locations at wastewater facilities, inside valve vaults; in wet well slabs, in corrosive and wet environments and, where specifically noted on drawings.
- B. Install rigid galvanized steel (RGS) conduits in dry inside locations and in all outdoor locations for water facilities and, where specifically noted otherwise on drawings.
- C. Install PVC conduits in duct banks. For stub-ups, use PVC-coated rigid steel elbows or rigid steel elbows as applicable in A and B above or where specifically noted on drawings. Rigid steel stub-up shall have minimum 3 layers of mylar tape up to 1" above slab where conduit is in contact with concrete.
- D. Run exposed conduit parallel or perpendicular to walls, ceilings or main structural members. Group multiple conduits together where possible. Do not install conduit where it interferes with the use of passageways, doorways, overhead cranes, monorails, equipment removal areas or working areas. In no case shall conduit routing present a safety hazard or interfere with normal plant operating and maintenance procedures. Maintain a minimum overhead clearance of 8'-0" in passageways. Except where absolutely impossible, all conduits are to be installed in or under concrete slab, in walls and ceilings.
- Any exposed conduit installed otherwise may be relocated at Contractor=s expense where directed by Engineer or Owner. Exceptions, where specifically noted otherwise on plans.
- E. Installation and support of conduit shall be from steel or concrete structures in accordance with the standard detail drawings. Furnish necessary conduit straps, clamps, fittings and support for the conduit in accordance with the standard details and consistent with the grade and type of conduit being installed.
- F. Identify conduit at termination points like MCC, light fixtures, control panels, receptacles, and junction boxes.

- G. Not more than 3 equivalent 90 degree bends will be permitted between outlets. Provide bonded expansion fittings at building expansion joints.
- H. Install conduit runs so that they are mechanically secure, mechanically protected from physical harm, electrically continuous, and neat in appearance. The interiors of conduit shall provide clean, smooth raceways through which conductors may he drawn without damage to the insulation. Make threaded connections wrench tight.
- I. Cut conduit square with a power saw or a rotary type conduit cutter designed to leave a flat face. Do not use plumbing pipe cutters for cutting conduit. Ream the cut ends of conduit with a reamer, designed for the purpose to eliminate rough edges and burrs.

Cut threads with standard conduit dies providing 3/4-inch taper per foot, allowing the proper length so that joints and terminals may be made up tight and the ends of the conduit not deformed. Keep dies sharp and use a good quality threading oil continuously during the threading operation. Remove metal cuttings and oil from the conduit ends after the threads are cut and paint threads before connections are made. Use zinc rich, brush-on compound on the threads of steel conduit before connections are made. Use only tools specifically made for bending and installing PVCcoated or PVC conduit when installing these materials.

- J. Use strap wrenches only to tighten joints in plastic coated rigid steel conduit. Replace all conduit and fittings with damage to the plastic coating, such as cuts, nicks and threader chuck jaw marks.
- K. Make up changes in direction of conduit using elbows or fittings. Do not use pull boxes to make direction changes unless specifically designated otherwise.
- L. Field fabricated bends shall be free of indentations or elliptical sections. The radius of the bend shall not be less than 6 times the smallest diameter of the raceway.
- M. Protect all conduit terminations from mechanical injury. Prevent the entry of moisture and foreign matter into the conduit system by properly capping terminations.
- N. Avoid trapped runs of conduit, if possible. When they are necessary, provide drainage using a "tee" condulet equipped with a drain. Conduit is likely to pass through areas with a temperature differential of 20 degrees F or more. Seal penetrations with a proper seal fitting at the wall or barrier between such areas. For conduit passing through walls separating pressurized areas from non-pressurized areas, install sealing fittings at the wall on the non-pressurized side.
- O. Fit conduit crossing building or structure expansion joints with approved expansion fittings, except that fittings will not be required when conduit crossing an expansion joint is supported on trapeze hangers in such a way that at no time will the conduit be under stress due to expansion. Install bonding jumpers around expansion joint fittings.
- P. Where conduit terminates in sheet metal enclosures and where no threaded hubs are provided, fit the conduit with double locknuts and bushings. Sheet metal enclosures located outside or in any other wet, damp or corrosive areas shall be furnished with threaded hubs. Restrict side penetrations to the lower one third of the enclosure.

- Q. Provide flexible metallic conduit where necessary to allow for movement or to localize sound or vibration, at transformers, at motors and any other rotating equipment unless shown otherwise on Drawings.
- R Seal openings or holes where conduits pass through walls or floors. When conduits are passing through a firewall or fire-rated floor into different rooms, cabinets, or enclosures, use a fire-rated seal as shown in the typical detail included in the Drawings. Certain walls, as indicated on the Drawings, require environmental (air-tight) seals; seal as shown.
- S. Install explosion-proof seals in conduit runs crossing or entering a hazardous classified area, as shown on Drawings. Install type CSBE removable sealing fittings to seal pump cables in the wet well and at the first junction box outside the well.
- T. Unless otherwise indicated on the Drawings, install expansion fittings every 300 feet within a straight conduit run and where conduit crosses building expansion joints, using bonding straps to ensure ground continuity.
- U. Parallel runs of conduit may be supported by structural steel racks. When two or more racks are arranged one above the other, provide vertical separation of not less than 12 inches between racks, unless otherwise indicated on the Drawings.
- Space conduits on the racks at least enough to provide 1/4-inch clearance between hubs on adjacent conduits at terminations and to allow room for fittings.
- V. Fill conduit racks no more than 75 percent of their capacity, providing usable space for future conduit. To ensure this, conduits leaving the rack horizontally shall be offset up or down so that future conduits may be installed in the space remaining. Construct conduit racks to permit access for wire or cable pulling at all pull points, even when future conduits are added to fill the racks.
- W. Where conduit racks are supported on rods from beam clamps or by some other non-rigid suspension system, install rigid supports at no more than 50-foot intervals to give lateral stability to the rack.
- X. Conduit racks or hangers must in no way interfere with machinery (or its operation), piping, structural members, process equipment, or access to anticipated future equipment. Refer to architectural, structural, equipment layout and piping drawings to ensure that this requirement is met.
- Y. Label high voltage conduit with the circuit phase-to-phase voltage by means of a firmly attached tag or label of approved design at each conduit termination, on each side of walls or barriers pierced and at intervals not exceeding 200 feet along the entire length of the conduit.
- Z. Support conduit sizes 2 inches and larger at spacings not exceeding 10 feet and conduit sizes 1-1/2 inches and smaller at spacings not exceeding 8 feet.
- AA. The means of fastening conduit to supports shall be: by one hole malleable iron conduit straps secured by wood screws to wood and by bolts with expansion anchors to concrete or masonry; by "Korn" clamps or U-bolts to other surfaces. Use "clamp backs" when strapping conduits to walls, column faces, or other such surfaces.

- BB. Support conduit runs with conduit clamps, hangers, straps and metal framing channel attached to structural steel members. Conduits of 1-1/2 inch size or less may be supported by one-hole conduit straps on concrete, tile or steel work, but for larger size conduit, use 2-hole straps. Use clamps of galvanized malleable iron for rigid galvanized conduit and PVC-coated or stainless steel for PVC-coated conduit. Metal framing channel straps used for PVC-coated conduit shall be type 316 stainless steel.
- CC. Install conduits supported from building walls with at least 1/4-inch clearance from the wall to prevent the accumulation of dirt and moisture behind conduit.
- DD. Size and space embedded conduits in structural slabs in accordance with the Uniform Building Code. Conduits should occupy no more than one-third the thickness of the slab and should not be closer than 3 times the largest diameter on center without additional reinforcement.
- EE. Do not cut paved driveways, sidewalks, concrete foundations, etc. to install conduits unless specifically noted on plans. Bore under such construction and maintain a minimum of 24 inches below underside of paving or concrete. Repair any cutting or damage to original condition and to satisfaction of Engineer and Owner.
- FF. All conduits for fiber optic cables are to have wide tube radius compatible with cable manufacturer=s requirements.
- GG. Damaged conduits shall be replaced at no additional cost to Owner where Engineer deems necessary because of extent of damage or, where conductors are damaged by defective conduit installation.
- HH. Seal all conduits entering motor control centers, control panels and equipment enclosures with CSBE seals. Sealing glands shall be selected specifically for each conduit and conductors.

INSTRUMENTATION CABLE

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SECTION INCLUDES
 - A. Specifications for instrumentation cable.
- 1.02 REFERENCES
 - A. American Society for Testing and Materials (ASTM).
 - 1. ASTM B3: Soft or Annealed Copper Wires.
 - 2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.
 - 3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
 - B. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
 - C. Insulated Cable Engineers Association (ICEA).
 - 1. ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).
 - 2. ICEA S-66-524: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7).
 - 3. ICEA S-68-516: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8). D. Underwriters' Laboratories (UL).
 - 1. UL 44: Rubber Insulated Wires and Cables.
 - 2. UL 83: Thermoplastic Insulated Wire and Cables.
 - E. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No.
 70 National Electrical Code (NEC), Chapter No. 3 Wiring Methods and Materials, Article 725
 Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits.
- 1.03 SUBMITTALS

- A. Submit all products covered under this Section for Engineers approval.
 - 1. Completed engineer's data sheets from this specification or manufacturer's data sheets, cut sheets, and catalog data.
 - 2. Installation, terminating and splicing procedure (including bending radius and pulling tension data).
 - 3. Instruction for handling and storage.
 - 4. Dimensions and weight.
- B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.04 QUALITY ASSURANCE

- A. Tests
 - 1. Cable shall be tested at the factory to confirm that the cable complies with requirements of ICEA Section 7.7.9 of S-66-524 or 7.5.9 of S-68-516.
 - 2. Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ship cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 PRODUCTS

- 2.01 MANUFACTURERS
 - A. Alpha Wire Corporation
 - B. Belden Division, Cooper Industries, Inc.
 - C. Cablec Continental Cables Company
 - D. General Cable Company
 - E. Manhattan Electric Cable Corporation

F. Okonite Company

2.02 MATERIALS AND EQUIPMENT

- A. Design. Provide cable with the following design characteristics. The cable shall consist of multiple conductors. The cable assembly shall be UL listed, flame, oil and sunlight resistant, and certified for continuous operation at the temperature specified in wet or dry locations while installed in underground duct, conduit, or cable tray. The number and size of conductors supplied in each cable shall correspond to the quantities specified. Each conductor shall be individually insulated. Pairs and triads shall have conductors which are twisted together with a drain wire, shielded, and covered with a jacket. Multi-pair/triad cables shall consist of the required number of electrically isolated, shielded pairs or triads, which are bundled together and covered by an overall jacket as specified.
- B. Conductors. Provide conductors which are Class B, concentric stranded, annealed tinned copper whose physical and electrical properties comply with ASTM B3, B8 or B33 and Part 2 of ICEA S-61402, S-66-524, or S-68-516, unless otherwise specified.
- C. Insulation. Each conductor shall be insulated as specified in compliance the requirements of Part 3 of ICEA S-61-402, S-66-524, or S-68-516.
- The average insulation thickness shall not be less than the dimensions shown in Table 7-32 or 7.5.1 of ICEA S-66-524 or S-68-516 for 600-volt insulation unless otherwise specified. The minimum insulation thickness shall not be less than 90 percent of the value given in the table.
- D. Drain Wire. Provide drain wire which is Class B, seven-stranded, tin-coated copper in accordance with ASTM B3, B8, or B33 and as specified. The drain wire shall not be less than two AWG sizes smaller than the insulated conductor's size, except for multiple pair triad drain wires, which shall not be less than the insulated conductor size.
- E. Shielding. Provide shielding consisting of laminated, non-burning, mylar-backed aluminum tape applied helically around a twisted pair or triad with the aluminum side in continuous contact with the drain wire unless otherwise specified. Wrap the tape around each twisted pair or triad with a 25 percent minimum overlap unless otherwise specified.
- F. Jacket. The physical and electrical properties of the jacket used to cover single or multi-pair or triad cables shall meet the requirements of section 7.7.7 or ICEA S-66-524 or section 7.5.6 of ICEA S68-516. Jacket material as specified. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516. The jacket material as specified. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516.
- G. Armor. Where requested, use instrumentation cables protected by an interlocked metal tape armor coating made of galvanized steel which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524, unless otherwise specified.
- H. Conductor Identification. Use individual conductors in single-pair and single-triad cables which are color coded black and white; and black, white and red, respectively. Multi-pair-triad cables shall have one conductor in each pair or triad colored white, and all other conductors are color coded in sequence according to Table L-2 of Appendix 2 of ICEA S-66-524, and as specified. Cable Marking. Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with color sharply contrasting the jacket color.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete cable raceway systems, underground duct banks and cable support systems before installing cables.
- B. Verify sizing of raceways and pull boxes to ensure proper accommodation for the cables.
- C. Check the length of the cable raceway system against the length of cable on the selected reel.
- D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 degrees F.
- E. Clean conduits of foreign matter before cables are pulled.
- F. Provide at least 30 percent spare conductors or pairs

3.02 INSTALLATION

- A. Cable in Conduit and Ductbank
 - Install cables in accordance with the manufacturer's instructions and NEC Article 725 -Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.
 - 2. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket.
 - 3. Conduits carrying low level signal cables shall be PVC-coated rigid steel.
- B. Cable in Tray. Install instrument and signal cable in cable tray only when the tray is dedicated for this type cable and cables are approved for tray installation.
- C. Termination
 - 1. Do not splice conductors. For termination use crimp-on type ring tongue non-insulated tin plated copper lugs.
 - 2. For shielded control cable, terminate the shield and ground it at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables.
 - 3. If splicing is required, maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.

- 4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp or base of the terminal.
- D. Tests
 - 1. Before connecting the cables, test insulation integrity and conductor continuity.
 - 2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.
- E. Termination. After the 600-volt cable has been tested with satisfactory results, the cable can be terminated at both ends to their designated terminal points.

DEVICE, PULL AND JUNCTION BOXES

PART 1 GENERAL

1.00 CONDITIONS

- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SECTION INCLUDES
 - A. Specifications for device, pull, and junction boxes.
- 1.02 REFERENCES
 - A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA).
 - 1. FB1 Fittings and Support for Conduits and Cable Assemblies
 - 2. 250 Enclosures for Electrical Equipment (1000 volts maximum)
 - B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA70 - National Electrical Code (NEC) - Article 370 - Outlet Device, Pull and Junction Boxes, Conduit Bodies and Fittings.
 - C. Underwriters Laboratories (UL):
 - 1. 50 Safety Cabinets and Boxes
 - 2. 508 Safety Industrial Control Equipment
 - 3. 514B Safety Fittings for Conduit and Outlet Boxes
 - 4. 886 Safety Outlet Boxes and Fittings for Use in Hazardous Areas

1.03 SUBMITTALS

- A. Submit all products covered under this specification for Engineer=s approval.
 - 1. Manufacturer's cut sheets, catalog data
 - 2. Instruction for handling and storage
 - 3. Installation instructions

- 4. Dimensions and weights
- B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph.

Identify applicable drawing sheet number and specification section on front of each submittal cover.

- 1.04 DELIVERY, STORAGE AND HANDLING
 - A. Pack and crate boxes to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS
 - A. Sheet Metal Boxes
 - 1. Hoffman Industrial Products
 - 2. Pauluhn Electric Manufacturing Company
 - 3. Hennessy
 - 4. Tanco
 - 5. Tejas
 - 6. Circle A.W.
 - B. Cast Device Boxes
 - 1. Appleton Electric Company
 - 2. Crouse-Hinds, Division of Cooper Industries
 - 3. Killark Electric Manufacturing Company

2.02 MATERIALS AND EQUIPMENT

- A. Sheet Metal Boxes
 - 1. Provide UL-approved junction boxes and pull boxes manufactured from stainless steel sheet metal and meeting requirements of NEMA 4X for corrosive and wet area, NEMA 250 and NEC Article 370.
 - 2. Provide boxes with a stainless steel continuous hinge, closure hasps and all- stainless steel hardware.
 - 3. Furnish the door with neoprene gasket and provision for padlock.

B. Device Boxes

- 1. Provide UL-approved boxes designed and manufactured to house electrical devices like receptacles and switches, and in conformance with NEMA FB1 and NEC Article 370.
- 2. Supply boxes that are hot-dip galvanized on cast iron suitable for corrosive and wet atmosphere.
- C. Hardware
 - 1. Mounting Hardware: Stainless steel
 - 2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or pre-approved equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Review the drawings and determine how many boxes of each kind are required and check if supplied quantity is sufficient.
- 3.02 INSTALLATION
 - A. Boxes described in this specification shall be used both in dry and wet, corrosive areas, both inside and outside locations.
 - B. Install boxes in accordance with NEC Article 370 in locations indicated on the Drawings.
 - C. Install junction and pull boxes in readily accessible places to facilitate wire pulls, maintenance and repair.
 - D. Plug unused conduit openings.
 - E. Make conduit connections to sheet metal boxes with watertight conduit connectors.

This Page is Intentionally Left BLANK

CABINETS, BOXES AND FITTINGS

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Section Includes:
 - 1. Outlet and device boxes.
 - 2. Pull and junction boxes.
 - 3. Floor boxes and service fittings.
 - 4. Cabinets.
 - 5. Hinged door enclosures.
 - 6. Boxes and fittings for hazardous locations.
 - B. Conduit-body-type electrical enclosures and wiring fittings are specified in Section 16111.
- 1.02 REFERENCES
 - A. American Society for Testing and Materials (ASTM):

1. ASTM A167-91 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

- B. Underwriter's Laboratory (UL):
 - 1. UL 50-88 UL Standard for Safety Cabinets and Boxes.
 - 2. UL 514A-91 UL Standard for Safety Metallic Outlet Boxes.
 - 3. UL 514B-89 UL Standard for Safety Fittings for Conduit and Outlet Boxes.
 - 4. UL 886-85- UL Standard for Safety Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
- C. National Electrical Manufacturer's Association (NEMA):

- 1. NEMA ICS 6-88 Enclosures for Industrial Control and Systems.
- NEMA OS 1-89 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- 3. NEMA 250-85- Enclosure for Electrical Equipment (1,000 v maximum).

1.03 DEFINITIONS

- A. Cabinets: Enclosure designed either for surface or for flush mounting and having frame, or trim in which door or doors may be mounted.
- B. Device Box: Outlet box designed to house receptacle device or wiring box designed to house switch.
- C. Enclosure: Box, case, cabinet, or housing for electrical wiring or components.
- D. Hinged Door Enclosure: Enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with walls of box.
- E. Outlet Box: Wiring enclosure where current is taken from wiring system to supply utilization equipment.
- F. Wiring Box: Enclosure designed to provide access to wiring systems or for mounting of indicating devices or of switches for controlling electrical circuits.
- 1.04 SUBMITTALS
 - A. Submit all products covered under this specification for Engineer=s approval.
 - B. Product Data: Submit for cabinets and enclosures with classification higher than NEMA 1.C. Shop Drawings: Submit to Engineer for approval.
 - D. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.05 QUALITY ASSURANCE

- A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

- B. Regulatory Requirements:
 - 1. National Electrical Code: Components and installation shall comply with NFPA 70.

PART 2 PRODUCTS

- 2.01 CABINETS, BOXES, AND FITTINGS, GENERAL
 - A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for use and location. Provide items complete with covers and accessories required for intended use. Provide gaskets for units in damp or wet locations.

2.02 MISCELLANEOUS MATERIALS AND FINISHES

- A. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
- B. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
- C. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.
- D. Finishes:
 - 1. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
 - 2. Interior Finish: Where indicated, white baked enamel.
- 2.03 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES
 - A. General:
 - 1. Conform to UL 514A and UL 514B.
 - 2. Boxes shall be of type, shape, size, and depth to suit each location and application.
 - B. Steel Boxes: Conform to NEMA OS 1. Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
 - C. Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.
- 2.04 PULL AND JUNCTION BOXES

- A. General: Comply with UL 50 for boxes over 100 cu in. volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Galvanized Steel Boxes: Flat rolled, code gauge, sheet steel with welded seams. Where necessary to provide rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- C. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A167. Where necessary to provide rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
- D. Cast-Iron Boxes: Molded of cast iron alloy with gasketed cover and integral threaded conduit entrances.
- E. Boxes Approved for Classified Locations: Cast metal or cast nonmetallic boxes conforming to UL 886 listed and labeled for use in specific location classification, and with specific hazardous material encountered. Conduit entrances shall be integral threaded type.

2.05 CABINETS

- A. Acceptable Manufacturers
 - 1. Hennessey Products, Inc.
 - 2. Hoffman Engineering.
 - 3. The EMF Company.
 - 4. Rose Enclosure.
 - 5. Weigman Company.
 - 6. N.E.M.A. Enclosure Mfg. Co.

B. Indoor Control Cabinets

- 1. Enclosure: NEMA 250, Type 12; unless shown otherwise on plans.
- 2. Enclosure Size: As indicated on Drawings; or, if not indicated, as required to mount equipment indicated to U.L. Standards.
- 3. Backboard for Mounting Terminal Blocks and Components and Inner Door: 12 gauge steel, finished in white enamel.
- 4. Fronts: Steel pan-type doors with concealed stainless steel piano hinges, held closed by stainless steel 3-point latch operable by pistol-grip handle.

- 5. Provide solid metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.
- 6. Clean surfaces to remove dirt and corrosion residue. Phosphatize for corrosion protection. Prime with two coats, and finish with one coat, of factory-applied textured polyurethane, minimum 5 mils thickness, color as selected by City Engineer from manufacturer's standard colors.
- 7. Panel Construction: Provide panel stiffeners and bracing. Fully gasket doors. Weld seams and grind smooth.
- 8. Conduit Entrances: Bottom entry unless otherwise indicated on Drawings.
- 9. Material: Minimum 12 gauge steel.
- 10. Finish: Enamel; gray outside, white inside.
- 11. Provide thermostat controlled strip-type space heater (150 watts maximum), convenience outlets and internal fluorescent lighting (where shown on drawings.)
- 12. Nameplates: On the outside of each cabinet=s inner door, provide motor data nameplate information for each pump motor; copy all information exactly as shown on each motor nameplate. Provide engraved laminated plastic nameplates; black letters with white background; fasten to outside of cabinet door of each motor starter section with stainless steel screws.
- 13. Install wiring in open-slot plastic wiring duct.
- 14. On indoor panels install a 4-inch passive vent in the side near the top and near the bottom of an adjacent side panel. These vents shall have removable filters to resist dust and insect entry.
- C. Outdoor Control Cabinets
 - 1. Enclosures: NEMA 4X 316 stainless steel.
 - 2. Enclosure Size: As indicated on Drawings, or if not indicated, as required to accommodate equipment and as indicated in UL standards.
 - 3. Material: Exterior and interior enclosure doors, shelves and component enclosures: Fabricate of 14 gauge type 316 stainless steel.
 - 4. Doors: Stainless steel pan-type construction, with full-length stainless steel piano hinge (for stainless steel or aluminum). Equip exterior door with padlock, heavy-duty locking pistol-grip handles and 3-point latching mechanism of the draw roller type (0.750 inch minimum diameter rollers). Handles shall be 3/4 inch minimum diameter stainless steel. Equip interior doors with flush quarter-turn closure devices. Equip interior and exterior doors with neoprene gaskets.

- 5. Space Heaters: Provide minimum 150 watt strip-type space heaters with an individual thermostat in each section. Use heaters rated for 240V, producing the required wattage when operated at 120V.
- 6. Provide rain shield with 1 inch drip lip for outdoor cabinets to protect against direct sun radiation and rainfall. Design shield to provide 1 foot of cover front and back and 2 inches of cover on the sides. Design shield to provide no more than 1 foot peak height above the top of the panel with 1 inch air flow clearance from the top of the control panel. Shielding material: Type 316 stainless steel.
- 7. Nameplates: On the outside of each cabinet=s inner door, provide motor data nameplate information for each pump motor; copy all information exactly as shown on each motor nameplate. Provide engraved laminated plastic nameplates; black letters with white background; fasten to outside of cabinet door of each motor starter section with stainless steel screws.
- In each cabinet section, provide a 120V convenience outlet and a switched 40 watt minimum fluorescent light fixture, with 0 degrees F ballast in each section (where shown on plans.)
- 9. Inside and outside of cabinet shall be smooth and free from burns.
- 10. NEMA 4X enclosures shall have all bolt holes gasketed.
- 11. A divider of same material and thickness as the cabinet shall be added to divide electrical components and wiring from instrumentation and pneumatic components and wiring.

PART 3 EXECUTION

- 3.01 INSTALLATION, GENERAL
 - A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
 - B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
 - C. Sizes shall be adequate to meet current NEC volume requirements, but in no case smaller than sizes indicated.
 - D. Remove sharp edges where they may come in contact with wiring or personnel.
- 3.02 APPLICATIONS
 - A. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types for each location in conformance with following requirements unless otherwise noted:

- 1. Interior Dry Locations: Sheet steel, NEMA type 1 for flush mounting and feraloy Type FS or FD cast boxes with threaded conduit hubs for surface mounting.
- Locations Exposed to Weather or Dampness: Galvanized, cast metal, NEMA Type 3R.
- 3. Wet Locations: Stainless Steel, NEMA type 4X enclosures.
- 4. Corrosive Locations: Stainless Steel, NEMA type 4X enclosures.
- 5. Hazardous (Classified) Locations: NEMA type listed and labeled for location and class of hazard indicated.
- B. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location.
- 3.03 INSTALLATION OF OUTLET BOXES
 - A. Gasketed Boxes: At following locations use cast metal, threaded hub type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where exposed to moisture laden atmosphere.
 - 3. Where indicated.
 - B. Mounting: Mount outlet boxes for switches with long axis vertical or as indicated. Mount boxes for receptacles vertically. Gang boxes shall be mounted with long axis horizontal.
 - C. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
 - D. Set boxes in concealed conduit runs, flush with wall surfaces, with or without covers as required.
 - E. Set outlet boxes parallel to construction, securely mounted and adjusted to set true and flush with finished surface.
 - F. Provide outlet box divider barriers between 277/480 v and 120/240 v devices as required and per current NEC.
- 3.04 OUTLET BOX LOCATIONS
 - A. Locate flush mounted wall boxes in corner of nearest brick or block to keep cutting to minimum.
 - B. Location of outlets and equipment as shown on Drawings is approximate and exact location to be verified and shall be determined by:

- 1. Construction or code requirements.
- 2. Conflict with equipment or other trades.
- 3. Equipment manufacturer's drawings.
- C. Minor modification in location of outlets and equipment considered incidental up to distance of 10 ft with no additional compensation, provided necessary instructions given prior to roughing in of outlet.
- D. Mounting heights for devices and equipment to be measured from finished floor to centerline of device unless otherwise noted on Drawings.

3.05 INSTALLATION OF PULL AND JUNCTION BOXES

A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-in. square by 4in. deep. Do not exceed 6 entering and 6 leaving raceways in single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed following:

Size of Largest Conductors in Box	Maximum No. of Conductors in Box
No. 4/0 AWG	30
250 MCM	20
500 MCM	15
Over 500 MCM	10

- 1. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 in. inside boxes.
- 2. Size: Provide pull and junction boxes for telephone, signal, instrumentation, control, and other systems at least 50% larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.
- 3.06 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES (NOT APPLICABLE)

3.07 GROUNDING

- A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes grounding conductor, provide grounding terminal in interior of cabinet, box or enclosure.
- B. Ground in accordance with Section 16452.

3.08 CLEANING AND FINISH REPAIR

- A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using zinc-rich paint recommended by manufacturer.
- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

WIRING DEVICES

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 SECTION INCLUDES

- A. Specifications for wiring devices including:
 - 1. Receptacles.
 - 2. Wall switches.
 - 3. Wall plates and cover plates.

1.02 REFERENCES

- A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):
 - 1. NEMA WD1 General Purpose Wiring Devices.
 - 2. NEMA WD6 Dimensional Requirements.
- B. Federal Specifications (WC-596F).
- C. American National Standards Institute/National Fire Protection Association (NFPA):
 - 1. NFPA No. 70 National Electrical Code (NEC), Articles 210 Branch Circuits, 250 Grounding and 410, Paragraphs 56, 57 and 58.

1.03 SUBMITTALS

- A. Submit all products covered under this specification for Engineer=s approval:
 1. Manufacturer's product literature and specifications including dimensions, weights, certifications and instructions for handling, storage and installation.
- B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.04 DELIVERY, STORAGE AND HANDLING

A. Pack and crate devices to permit ease of handling and protect from damage during shipping, handling and storage.

PART 2 PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS
 - A. Bryant Electric
 - B. Crouse-Hinds, Arrow Hart Division
 - C. Hubbel Inc. Wiring Devices Division
 - D. Leviton Manufacturing Company
 - E. Pass & Seymour/Legrand.
- 2.02 MATERIALS AND EQUIPMENT
 - A. Standards: Conform to NEMA WD1 for general requirements and NEMA WD6 for dimensional requirements.
 - B. Manufacture devices to heavy-duty industrial specification grade with brown nylon bodies (orange for isolated-ground receptacles) back and side wiring provisions and green-colored grounding screws.
 - C. Receptacles:
 - 1. Duplex-type receptacles: Rated 20 amps at 120 volts.
 - 2. Contacts: Brass or phosphor bronze.
 - 3. Receptacle grounding system: Extend to the mounting strap unless isolated ground is indicated or required.
 - 4. GFI or GFCI (ground fault circuit interrupter) receptacles: Provide feed-through type with test and reset button.
 - D. Wall Switches:
 - 1. Toggle switches: Rated 20 amps at 120/277 volts AC rated for both resistive and inductive loads.
 - 2. Contacts: Silver cadmium oxide construction to prevent sticking, welding and excessive pitting.
 - E. Cover Plates:
 - 1. In outdoor, corrosive and wet areas, provide cover plates of cast metal, gasketed with spring-loaded hinged covers and stainless steel hardware.

2. All other plates: Type 302 stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that device boxes are correctly placed.
- B. Verify that the correct quantity, size and type of wires are pulled to each device box.
- C. Verify that wiring has been checked at both ends.
- D. Prepare wire ends for connection to devices.
- E. Inspect each wiring device for defects.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top.
- E. Connect wiring device grounding terminal to outlet box with bonding jumper.
- F. Connect wiring devices by wrapping conductors clockwise around screw terminals.
- G. Install cover plates on switch, receptacle and blank outlets in finished areas.
- H. Energize and test devices for proper operation.

This Page is Intentionally Left BLANK

ELECTRIC MOTORS

PART1 GENERAL

1.00 CONDITIONS

A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 SUMMARY

- A. Description of Work:
 - 1. Motors furnished under other sections of these Specifications as part of equipment items shall conform to requirements of this section except as noted otherwise in that section or indicated otherwise on Drawings or schedules.
 - 2. Submersible well motor shall be supplied in accordance with other sections of this specification.

1.02 REFERENCES

- A. Refer to latest addition of following standards.
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1-Motors and Generators.
 - b. NEMA MG 1 Part 31
 - 2. Institute of Electrical and Electronic Engineers (IEEE):
 - a. IEEE Standard 112-Standard Test Procedure for Polyphase Induction Motors and Generators.
 - 3. Anti-Friction Bearing Manufacturers Association (AFBMA):
 - a. AFBMA Standards for Ball and Roller Bearings and Balls.
 - 4. National Electrical Contractors Association (NECA):
 - a. Standard of Installation.

1.03 SUBMITTALS

- A. Submit all products covered under this specification for Engineer=s approval.
- B. Include motor submittal as part of equipment submittal for equipment specified in other sections.

- C. Include identification of equipment by name and tag number as indicated in Specifications or on Drawings.
- D. Submit in accordance with General Conditions and other applicable sections of the Contract Documents.
 - 1. Complete nameplate data in accordance with NEMA standards. Include space heater wattage and voltage.
 - 2. Full load power factor and maximum correction capacitor kVA for motors 5 hp and larger.
 - 3. Nominal efficiency in accordance with IEEE 112 for motors 5 hp and larger.
 - 4. 1600 Volt insulation in accordance with NEMA MG 1, Part 31.
 - 5. Motor dimensions and frame size.
 - 6. Manufacturer's printed data on each motor type being provided to indicate compliance with specified performance and construction.
 - 7. Service manual to include storage and alignment instructions.
 - 8. Complete motor characteristic data required for programming motor protection units. See other specifications for additional requirements. Coordinate with all Motor Controller Manufacturer's and with SCADA System Programmer.
 - 9. All motor data required for programming Multilin motor protection where described in specifications or where shown on plans. Submittals without this data will be rejected in entirety. Data to include:
 - a. Motor full load current
 - b. Locked rotor current
 - c. Locked rotor time-hot
 - d. Locked rotor time -cold
 - e. Hot: colt safe stall ratio
 - f. Service factor
 - g. Overload/thermal damage curves
 - h. Running cool time
 - i. Stopped cool time
- 10. No motor data shall be submitted until motor horsepower, voltage, and phase have been coordinated with MCC and Control Manufacturers. Failure to do so will be at expense of Contractor and at no additional cost to Owner.

- E. Operation and Maintenance (O&M) Data:
 - 1. Submit in accordance with General Conditions and other applicable sections of the Contract Documents.
- F. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph.

Identify applicable drawing sheet number and specification section on front of each submittal cover.

- 1.04 QUALITY ASSURANCE
 - A. Source Quality Control:
 - 1. Perform individual motor test on motors over 1 hp.
 - 2. Test shall be standard NEMA routine production test in accordance with MG 1-12.51, and consisting of following.
 - a. No load running current.
 - b. Locked rotor current.
 - c. High potential test.
 - d. Bearing inspection.
 - 3. Provide motor data to motor control center (MCC) or motor starter supplier at time MCC is ordered to assure coordination of overcurrent protective devices.
 - B. Regulatory Requirements:
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA No. 70 National Electrical Code (NEC).
 - 2. Underwriters Laboratories, Inc. (UL).
 - 3. Local codes and ordinances.
- PART2 PRODUCTS
- 2.01 GENERAL
 - A. Use of manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired.
 - B. Unless otherwise specified, meet or exceed following.

- 1. High efficiency, equivalent to U.S. Motors premium efficiency for motors 5 hp and above.
- 2. Motors 1/2 hp and Larger: 3-ph, 60 Hz, 230/460 V.
 - a. Squirrel cage type, NEMA B.
 - b. Motor Housing and Bearing Brackets: Cast grey iron with tensile strength of 30,000 psi. Do not provide rolled steel and aluminum.
 - c. Secure bearing brackets to motor cast iron housing. Do not use bolt clamping methods.
 - d. Provide dual voltage windings, 230/460 V.
- 3. Motors Less than 1/2 hp: 1-ph, 60 Hz, 115/230 V.
 - a. Provide dual voltage windings, 115/230 V.
- 4. Suitable for continuous operation with line voltage variation within 10% of rated voltage.
- 5. Suitable for continuous operation in 40°C ambient with 80°C temperature rise.
- 6. Copper motor windings.
- C. Design for frequent starting. Coordinate with programming of motor protection devices, such as Multilin, for number of starts limitations.
- D. Provide internal, 120 Vac, heaters sized per manufacturer=s recommendations based on use and location. Provide stamped stainless steel nameplate with space heater wattage and voltage. Install heaters in lower winding area of vertical motors.
- E. Provide RTD=s where required by specifications, by motor manufacturer or, where shown on drawings. Provide RTD=s for upper and lower bearings and for three phase windings. (Not applicable for submersible motors.)
- F. Where used in conjunction with electronic variable speed drive units such as VFD=s, coordinate with drive equipment manufacturer to provide a matched motor and drive system. Motor shall be capable of safe operation, without over heating, throughout full speed range of VFD. Failure to coordinate will result in any additional charges to be paid by Contractor at no additional cost to Owner.
- G. Contractor to coordinate motors and MCC to assure starter, MCP and breaker sizes are satisfactory. Where required by high efficiency or high inrush motor design criteria, all devices shall be adjusted as required. Failure to coordinate will result in any additional charges to be paid by Contractor at no additional cost to Owner.
- 2.02 MANUFACTURERS
 - A. U.S. Motors
- B. General Electric
- C. Marathon
- D. As indicated in equipment specifications.
- E. Or equal, as approved by Engineer.
- 2.03 ENCLOSURES
 - A. Open Dripproof (ODP): Indoor areas where clean, dry, and well ventilated.
 - B. Totally Enclosed, Fan Cooled (TEFC): Indoor or outdoor areas where exposed to corrosive vapors, driving rain or washdown activities.
- 2.04 INSULATION
 - A. Dripproof Motors: Class F, 1.15 service factor.
 - 1. Two extra dips and bakes of epoxy varnish.
 - B. Totally Enclosed Fan Cooled: Class F, 1.15 service factor.
 - 1. Two extra dips and bakes of epoxy varnish.
 - C. All Well Motors: 1600 volt insulation.

2.05 BEARINGS

- A. Ball or roller bearing type at manufacturer's option, unless specified in equipment sections of Specifications.
- B. Support side thrust loadings.
- C. Re-greaseable with alamite fittings extended to accessible location for Frame 250 and larger.
- D. AFBMA B10 bearing life rated (flexible coupled) at 50,000 hrs.

2.06 SPEED

A. As specified under equipment section.

2.07 TORQUE

- A. Breakdown torque shall be 200% or more of maximum torque load placed on motor shaft.
- B. Provide necessary WK₂ curves for special loads to coordinate with motors.
- C. Supply special motors where load requirements exceed standard design.
- 2.08 SLIDE RAILS AND SOLE PLATE

- A. As required for application.
- 2.09 SINGLE PHASE FRACTIONAL HP MOTORS
 - A. Capacitor or open split phase start, unless otherwise specified.
- 2.10 THREE PHASE MOTORS
 - A. Provide horizontal or vertical squirrel cage induction motors for standard duty.
 - B. Full voltage starting or as specified in equipment sections of Specifications or on Drawings.
 - C. Low pass filter protection for VFD driver motors 30 hp to 200 hp where conductor length between VFD and motor exceeds 50 feet.

2.11 SUBMERSIBLE ELECTRIC MOTOR

- A. Motor
 - 1. The motor shall be constructed of material suitable for their application from the standpoints of corrosion resistance and mechanical performance.
 - 2. The motor shall be of the squirrel-cage induction type, suitable for across-the-line starting, designed to directly couple to the bottom of the pump utilizing a NEMA flange. It shall be capable of continuous operation under water at the specified conditions.
 - 3. The motor shall be designed for water-filling, water-cooling, and water lubrication. Oil or grease lubricated motors are not acceptable.
 - 4. The stator shall be hermetically sealed canned type consisting of a core of resinimpregnated windings within a watertight stainless steel enclosure.
 - 5. The motor shall be filled with a mixture of water and propylene glycol, equipped with a diaphragm for pressure equalization, and a check valve to allow water into the motor.
 - 6. The motor temperature shall be rated no higher than the allowable operating temperature of the motor thrust, radial bearings, and upthrust bearings and in no case shall it exceed the temperature rating of the insulation class used to wind the motor.
 - 7. The bearings shall be of ample capacity to carry the weight of all parts plus the maximum hydraulic thrust generated by the submersible vertical turbine pump.
 - 8. Suitable precautions shall be taken to restrict sand, silt, or foreign material from entering the motor.
 - 9. The maximum motor diameter and the minimum inside diameter of the well=s conductor casing shall be in such relationship that under any operating condition the water velocity past the motor does not exceed 12 ft. per second and not less than 0.5 ft. per second.
 - 10. Motors to have service factor of 1.15.

11. Where Design B, high inrush, type motors are provided, pump vendor shall submit for approval prior to Bidding. Where these motors are furnished, pump vendor is to coordinate with electrical equipment vendor. Failure to do so will be fully at cost of Contractor at no cost to Owner.

B. Submersible Cable

- 1. Pump cable shall be sized to limit the voltage drop to no more than 5%. The flat cable shall consist of 3 or more separate insulated conductors, plus a ground or a single flat cable assembly consisting of 3 or more insulating conductors, plus a ground. Each conductor shall be insulated by plastic insulation or synthetic rubber suitable for continuous immersion in water.
- 2. Individual conductors and/or cable assembly must be jacketed with an oil- and-water resistant synthetic rubber, metal, or other suitable mechanically protective material.
- 3. The flat cable shall have sufficient conductor area to meet the ICEA code for operation in air. The connecting electrical cable from the starting equipment to the surface plate shall comply with local codes or the National Electric Code, whichever governs.
- 4. The flat cable shall be secured to the column pipe at 10 foot intervals with stainless steel clamps.
- 5. For every 50 feet of setting, 3 foot of extra flat cable shall be supplied plus an additional 10 feet beyond the surface plate shall be supplied.
- 6. The electrical conductors shall be protected by a corrosion resistant mechanical shield where they pass the pump bowl.
- 7. All cable fittings and terminals shall be watertight at the pressure encountered in use.
- 8. Cables shall not be spliced from point of entry into motor to point of exit at well head.

PART3 EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

3.02 ALIGNMENT

- A. Contractor furnishing motor shall be responsible for alignment.
- B. Check alignment of motors prior to startup.
- C. Motors over 50 hp shall have alignment and balance checked using test equipment specially designed for this purpose.

END OF SECTION

This Page is Intentionally Left BLANK

Section 16160

CABINETS AND ENCLOSURES

PART1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for cabinets and enclosures for housing of control panels and motor controls.
- 1.02 REFERENCES
 - A. National Electrical Manufacturers Association (NEMA).
 - 1. 250 Enclosures for Electrical Equipment (1000 volts maximum).
 - a. NEMA 3 Enclosures for outdoor use primarily to provide a degree of protection against wind-blown dust, rain, and sleet; undamaged by formation of ice on the enclosure.
 - b. NEMA 12 Enclosures for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids.
 - B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA 70 - National Electrical Code (NEC), Article 373 - Cabinets, Cutout Box, and Meter Socket Enclosures.
 - C. Underwriters Laboratories (UL), UL 50 Safety for Cabinets and Boxes.
- 1.03 SUBMITTALS
 - A. Submit the following under provisions of Section 01330 Submittal Procedures:
 - 1. Manufacturer's cut sheets and catalog data
 - 2. Instruction for handling and storage
 - 3. Installation instructions
 - 4. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

A. Have cabinets and enclosures packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART2 PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS
- A. The EMF Company
- B. Hennessey Products, Inc.
- C. Hoffman Industrial Products

STANDARD SPECIFICATION CABINETS AND ENCLOSURES

- D. Pauluhn Electric Manufacturing Company
- E. Weigman Company
- F. Rose Enclosure
- G. N.E.M.A. Enclosure Mfg. Co.
 - 2.02 MATERIALS AND EQUIPMENT
 - A. Sheet Metal Boxes
 - 1. Provide enclosures manufactured in accordance with NEMA 250 and NEC Article 373. Fabricate outdoor NEMA 3 panels from 0.125- inch thick type 5052 H32 aluminum or 14 gauge, 316 stainless steel. NEMA 12 indoor panels shall be painted steel.
 - 2. Dimensions and special features are shown on the Drawings.
 - 3. Construct outdoor enclosures with continuously welded seams ground smooth.
 - 4. Additional material thickness and bracing requirements shall be determined by the manufacturer to provide the strength required by the standard listed. The bracing shall be provided in such a way as to minimize the protrusion into the wiring and the equipment spaces.
 - 5. Install the door with a stainless steel continuous hinge, stainless steel padlock handle with gasket and stainless steel hardware.
 - 6. Furnish the door with oil-resistant neoprene gasket attached with oil-resistant adhesive and held in place with aluminum retaining strips.
 - 7. Use a single, 3/4-inch minimum, door handle that provides a 3-point latching through latch rods with rollers. Provide rollers with at least 3/4-inch diameter.
 - 8. Gasketed overlapping doors may be used instead of a center post.
 - 9. Provide heavy duty lifting eyes of suitable material.
 - 10. Fabricate the enclosure with a stud-mounted panel inside. Make panels from 12gauge steel painted with white enamel finish.
 - 11. Equip both NEMA 12 and NEMA 3 enclosures with thermostatically controlled space heaters and corrosion inhibitors. Provide heaters rated for 240V for 120V operation.
 - 12. Weld mounting feet to the enclosure if called for on the Drawing.
 - 13. Include a high impact plastic data pocket in the enclosure.
 - 14. Provide ground connections on the enclosures to enable grounding of the enclosure with a No. 2 AWG conductor.

- 15. Equip free-standing outdoor cabinets with inner and outer door restraint bars to prevent door swing during windy conditions.
- 16. Supply indoor enclosures with filtered passive air intake and exhaust openings, 4inch square in the side near the top and near the bottom of the adjacent side panel.

B. Hardware

- 1. Mounting Hardware: Stainless steel
- 2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal.

2.03 TESTING

A. Test cabinets and enclosures in accordance with UL 50 so unit qualifies for a UL label.

PART3 EXECUTION

3.01 PREPARATION

- A. Review Drawings and determine how many enclosures of each kind are required and check if supplied quantity is sufficient.
- B. Check the mounting pads or foundations for proper mounting dimensions and features, including grounding conductor stub-up.

3.02 INSTALLATION

- A. Use enclosures described in this specification only above grade.
- B. Install enclosures in accordance with NEC Article 373 in locations as indicated on the Drawings.
- C. Install enclosures in readily accessible locations to facilitate general operations, wire pulls, maintenance and repair.
- D. Plug unused conduit openings.
- E. Make conduit connections to the enclosures with watertight conduit connectors.

END OF SECTION

This Page is Intentionally Left BLANK

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Section Includes:
 - 1. Identification of electrical materials, equipment, and installations.
 - 2. Nameplate identifications on MCC's and control panels.

1.02 SUBMITTALS

- A. Submit all products covered under this specification for Engineer=s approval.
- B. Product Data:
 - 1. Submit for each type of product specified.
- C. Samples:
 - 1. Submit for each color, lettering style, and or graphic representation required for identification materials; samples of labels and signs.
- D. Miscellaneous:
 - 1. Schedule of identification nomenclature to be used for identification signs and labels.
- E. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. National Electrical Code: Components and installation shall comply with NFPA 70.
- B. Comply with ANSI C2.

PART 2 PRODUCTS

2.01 RACEWAY AND CABLE LABELS

- A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.
- B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
 - 1. Color: Black legend on orange field.
 - 2. Legend: Indicates voltage.
- C. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self adhesive vinyl tape not less than 3 mils thick by 1 to 2 in. wide (0.08 mm thick by 25 to 51 mm wide).
- E. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:
 - 1. Size: Not less than 6 in. wide by 4 mils thick (152 mm wide by 0.102 mm thick).
 - 2. Compounded for permanent direct burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed Legend: Indicates type of underground line.
- F. Tape Markers: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.
- G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 in. (0.4 mm) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
- I. Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 in. (0.05 mm) thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.
- J. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 in. (51 by 51 mm) by 0.05 in. (1.3 mm).

2.02 ENGRAVED NAMEPLATES AND SIGNS

- A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.
- B. Engraving stock, melamine plastic laminate, 1/16 in. (1.6 mm) minimum thick for signs up to 20 sq. in. (129 sq. cm), 1/8 in. (3.2 mm) thick for larger sizes.
 - 1. Engraved Legend: Black letters on white face.
 - 2. Punched for mechanical fasteners.
- C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 in. (6.4 mm) grommets in corners for mounting.
- D. Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 in. (1 mm), galvanized steel backing, with colors, legend, and size appropriate to application. 1/4 in. (6.4 mm) grommets in corners for mounting.
- E. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self extinguishing, 1 piece, self locking, Type 6/6 nylon cable ties with following features:
 - 1. Minimum Width: 3/16 in. (5 mm).
 - 2. Tensile Strength: 50 lb (22.3 kg) minimum.
 - 3. Temperature Range: Minus 40 to 185° F (Minus 4 to 85°C).
 - 4. Color: As indicated where used for color coding.
- B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 EXECUTION

- 3.01 INSTALLATION
 - A. Install identification devices according to manufacturer's written instructions.
 - B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

- C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Self Adhesive Identification Products: No allowed.
- F. Identify feeders over 600 V with "DANGER-HIGH VOLTAGE" in black letters 2 in. (51 mm) high, stenciled with paint at 10 ft (3 m) intervals over continuous, painted orange background. Identify following:
 - 1. Entire floor area directly above conduits running beneath and within 12 in. (305 mm) of basement or ground floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to conduits concealed within wall.
 - 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.
 - 4. Entire surface of exposed conduits.
- G. Install painted identification as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
 - 3. Apply one intermediate and one finish coat of silicone alkyd enamel.
 - 4. Apply primer and finish materials according to manufacturer's instructions.
- H. Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.
 - 1. Bands: Pre-tensioned, snap around, colored plastic sleeves; colored adhesive tape; or combination of both. Make each color band 2 in. (51 mm) wide, completely encircling conduit, and place adjacent bands of 2 color markings in contact, side by side.
 - 2. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) in congested areas.
 - 3. Colors: As follows:

- a. Fire Alarm System: Red.
- b. Fire Suppression Supervisory and Control System: Red and yellow.
- c. Combined Fire Alarm and Security System: Red and blue.
- d. Security System: Blue and yellow.
- e. Mechanical and Electrical Supervisory System: Green and blue.
- f. Telecommunications System: Green and yellow.
- I. Install Caution Signs for Enclosures Over 600 V: Use pressure sensitive, self-adhesive label indicating system voltage in black, preprinted on orange field. Install on exterior of door or cover.
- J. Install Circuit Identification Labels on Boxes: Label externally as follows:
 - 1. Exposed Boxes: Pressure sensitive, self adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card stock tags.
 - 3. Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.
- K. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 in. (150 to 200 mm) below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 in. (400 mm), use single line marker.
 - 1. Install line marker for underground wiring, both direct buried and in raceway.
- L. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.
 - 1. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than No. 10 AWG.
 - a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 in.

(150 mm) from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 in. (25 mm) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 in. (76 mm) from terminal and spaced 3 in. (76 mm) apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

System Voltage		ΑΒ	3	CNeutral
120/240 Volt 1Ph/3w	Black	Red		White
120/208 Volt 3Ph/4w	Black	RedE	3lue	White
120/240 Volt 3Ph/4w	Black	OrangeE	3lue	White
277/480 Volt 3Ph/4w	Brown	Purple	Yellow	Grey
Motor Control		1	Black	
			2	Red
		:	3	.Blue

- Ground
- M. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

Green

- 1. Legend: 1/4 in. (6.4 mm) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
- 2. Fasten tags with nylon cable ties; fasten bands using integral ears.
- N. Apply identification to conductors as follows:
 - 1. Conductors to Be Extended in Future: Indicate source and circuit numbers.
 - 2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
 - 3. Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.
- O. Apply warning, caution, and instruction signs and stencils as follows:
 - 1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 - 2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 in. (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.
- P. Install identification as follows:

- 1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, control and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2 in. (13 mm) high lettering on 1 1/2 in. (38 mm) high label; where 2 lines of text are required, use lettering 2 in. (51 mm) high. For small control panels a smaller text may be used but shall be clearly readable. Use black lettering on white field. Use red lettering on white field where shown on plans or as requested by Engineer or Owner. Apply labels with stainless screws for each unit of following categories of equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Electrical substations.
 - e. Motor control centers and control panels.
 - f. Motor starters.
 - g. Push button stations.
 - h. Power transfer equipment.
 - i. Contactors.
 - j. Remote controlled switches.
 - k. Dimmers.
 - I. Control devices.
 - m. Transformers.
 - n. Inverters.
 - o. Rectifiers.
 - p. Frequency converters.
 - q. Battery racks.
 - r. Power generating units.
 - s. Telephone equipment.

- 2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
- 3. For control panels, the nameplate designation shall be according to the control, alarm or status function indicated on the control diagrams, one-line diagrams, details as required in other applicable specifications for this project.
- 4. Provide nameplate designations list and nameplate and text size for Engineer's and/or Owner's approval as required by 1.02 of this specification.

END OF SECTION

This Page is Intentionally Left BLANK

SECTION 16401

ELECTRIC SERVICE

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Electric Utility Charges:
 - 1. Electric Utility charges for extension of distribution system to point of service termination and meters will be paid by Owner, except where bid allowance is indicated or, except where noted otherwise on plans or in other specifications.
- 1.02 DEFINITIONS
 - A. Electric Utility: Local Electric Power Company.
- 1.03 QUALITY ASSURANCE
 - A. Regulatory Requirements:
 - 1. National Fire Protection Association (NFPA):
 - a. NFPA No. 70-93 National Electrical Code (NEC).

PART 2 PRODUCTS

2.01 ELECTRIC SERVICE

A. Electric Service Characteristics:

1. As indicated on Drawings and provided by Electric Utility.

PART 3 EXECUTION

3.01 PREPARATION

- A. Confirmation of Electric Service:
 - 1. Consult with Electric Utility to verify service information specified and shown on Drawings.
 - 2. Include deviations required by Electric Utility from contract documents to comply with Electric Utility standards and requirements.
 - 3. Relocate service pole or structure up to (10) ten feet to maintain clearance required by Electric Utility Company or to maintain other clearances.

16401-1

В.	Metering:		
	1.	Consult with Electric Utility regarding service entrance requirements and metering equipment.	
	2.	Install metering equipment and empty conduit for metering conductors to meet standards and requirements of Electric Utility.	
C.	Application for Electric Service.		
	1.	Obtain required forms from Electric Utility.	
	2.	Assist Owner in completion of forms and deliver completed forms to Electric Utility.	
	3.	Coordinate schedule for installation of electric service with Electric Utility.	
	4.	Notify utility company, within 30 days of project start date that permanent service will be required for this project. Specify date required and location of project.	
		END OF SECTION 16401-2	

SECTION 16452

GROUNDING

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 SUMMARY

- A. Section includes:
 - 1. Solid grounding of electrical systems and equipment.
 - 2. Basic requirements for grounding for protection of life, equipment, circuits, and systems.
 - 3. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. B3-90 Standard Specification for Soft or Annealed Copper Wire.
 - 2. B8-90 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 3. B33-91 Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
 - 4. E699 E1-79 Standard Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E-6.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 78-89 Lightning Protection Code.
- C. Underwriter's Laboratories (UL)
 - 1. 467 84 UL Standard for Safety Grounding and Bonding Equipment.
- 1.03 SUBMITTALS

- A. Submit all products covered under this specification for Engineer=s approval.
- B. Test Results:
 - 1. Report of field tests and observations certified by Contractor.
- C. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.04 QUALITY ASSURANCE
 - A. Items provided under this section shall be listed OR labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
 - B. Regulatory Requirements:
 - 1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

- 2.01 GROUNDING AND BONDING PRODUCTS
 - A. Products: Of types indicated and of sizes and ratings to comply with current NEC. Where types, sizes, ratings, and quantities indicated are in excess of current NEC requirements, more stringent requirements and greater size, rating, and quantity indications govern.
 - B. Conductor Materials: Copper.
- 2.02 WIRE AND CABLE CONDUCTORS
 - A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
 - B. Equipment Grounding Conductor: Green insulated.
 - C. Grounding Electrode Conductor: Stranded cable.
 - D. Bare Copper Conductors:

- 1. Solid Conductors: ASTM B3.
- 2. Assembly of Stranded Conductors: ASTM B8.
- 3. Tinned Conductors: ASTM B33.

2.03 MISCELLANEOUS CONDUCTORS

- A. Ground Bus: Bare annealed copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.
- C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 in. thick and 2 in. wide, except as indicated.
- 2.04 CONNECTOR PRODUCTS
 - A. General: Listed and labeled as grounding connectors for materials used.
 - B. Pressure Connectors: High-conductivity-plated units.
 - C. Bolted Clamps: Heavy-duty units listed for application.
 - D. Exothermic Welded Connections: Provide in kit form and select for specific types, sizes, and combinations of conductors and other items to be connected.
- 2.05 GROUNDING ELECTRODES
 - A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
 - 1. Size: 3/4 inch by 10 feet unless otherwise indicated.
 - B. Plate Electrodes: Copper plates, minimum 0.10 in. thick, size as indicated.

PART 3 EXECUTION

3.01 APPLICATION

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
 - 1. Install separate insulated equipment grounding conductors with circuit conductors.
 - a. Raceway may be used as equipment ground conductor where feasible in nonhazardous areas and permitted by current NEC for lighting circuits and receptacle circuits.

- b. Install insulated equipment ground conductor in nonmetallic raceways unless designated for telephone or data cables.
- B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicted.
- C. Signal and Communications: For telephone, alarm, instrumentation and communication systems, provide #4 AWG minimum green insulated copper conductor in raceway from grounding electrode system to each terminal cabinet or central equipment location.
- D. Ground separately derived systems required by NEC to be grounded in accordance with NEC paragraph 250-26.
- E. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to grounding electrode as indicated in addition to separate equipment grounding conductor run with supply branch circuit.
- F. Connections to Lightning Protection System: Bond grounding conductors or grounding conductors or grounding protection down conductors or grounding conductors in compliance with NFPA 78.
- G. Common Ground Bonding With Lightning Protection System:
 - 1. Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode.
 - 2. Use bonding conductor sized same as system ground conductor and installed in conduit.

3.02 INSTALLATION

- A. General: Ground electrical systems and equipment in accordance with current NEC requirements except where Drawings or Specifications exceed NEC requirements.
- B. Ground Rods:
 - 1. Locate minimum of one-rod length from each other and at least same distance from any other grounding electrode.
 - 2. Interconnect ground rods with bare conductors buried at least 24 in. below grade.
 - 3. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated.
 - 4. Make connections without damaging copper coating or exposing steel.
 - 5. Use 3/4-inch by 10-ft. ground rods except as otherwise indicated.
 - 6. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.
- C. Metallic Water Service Pipe:

- 1. Provide insulated copper ground conductors, sized as indicated, in conduit from building main service equipment, or ground bus, to main metallic water service entrances to building.
- 2. Connect ground conductors to street side of main metallic water service pipes by means of ground clamps.
- 3. Bond ground conductor conduit to conductor at each end.
- D. Braided-Type Bonding Jumpers:
 - 1. Use elsewhere for flexible bonding and grounding connections.
- E. Route grounding conductors along shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
- F. Test Wells: Locate as indicated, and fabricate in accordance with details indicated.
- G. UFER Ground:
 - 1. Fabricate with 20 feet of conductor laid lengthwise in excavation for foundation or footings.
 - 2. Install so conductor is within 2 in. of bottom of concrete.
 - 3. Where base of foundation is less than 20 feet in length, coil excess conductor at base of foundation.
 - 4. Bond conductor to reinforcing steel at four locations, minimum.
 - 5. Extend conductor below grade and connect to building grounding grid or grounding electrode.

3.03 CONNECTIONS

- A. General: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 - 2. Make connections with clean bare metal at points of contact.
 - 3. Aluminum to steel connections: stainless steel separators and mechanical clamps.
 - 4. Aluminum to galvanized steel connections: tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

- B. Exothermic Welded Connections:
 - 1. Use for connections to structural steel and for underground connections except those at test wells.
 - 2. Install at connections to ground rods and plate electrodes.
 - 3. Comply with manufacturer's written recommendations.
 - 4. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Terminations:
 - 1. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs.
 - 2. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to housing, terminate each conduit with grounding bushing.
 - 3. Connect grounding bushings with bare grounding conductor to ground bus in housing.
 - 4. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make boltedand clamped-type connections between conductors and ground rods.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on ground conductor.
- G. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.
- 3.04 OVERHEAD LINE GROUNDING
 - A. General: Comply with ANSI C2, "National Electrical Safety Code" for "Single-Grounded Systems," using two electrodes in parallel if single electrode resistance to ground exceeds 25 ohms.

- B. Ground Rod Connections: Use exothermic welds for underground connections and connections to rods.
- C. Lightning Arresters: Separate arrester grounds from other ground conductors.
- D. Secondary Neutral and Tank of Transformer: Interconnect and connect to ground.
- E. Grounding Conductor Protection: Protect grounding conductors running on surface of wood poles with molding of a type manufactured for this purpose. Extend from grade level up to and through communications and transformer spaces.
- 3.05 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING
 - A. Manholes and Handholes:
 - 1. Install 3/4-inch by 10-ft. driven ground rod close to wall and set rod depth such that 4 inches will extend above finished floor.
 - 2. Where necessary, install ground rod before manhole is placed and provide No. 1/0 bare tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall.
 - 3. Protect ground rods passing through concrete floor with double wrapping of pressuresensitive tape or heat-shrunk insulating sleeve from 2 in. above to 6 in. below concrete.
 - 4. Seal floor opening with waterproof non-shrink grout.
 - B. Connections at Manholes:
 - 1. Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole to ground rod or ground conductor.
 - 2. Make connections with minimum No. 4 AWG stranded hard-drawn copper wire.
 - 3. Train conductors plumb or level around corners and fasten to manhole walls.
 - 4. Connect to cable armor and cable shields by means of tinned terminals soldered to armor or shield, or as recommended by manufacturer of splicing and termination kits.
 - C. Grounding System: Ground non-current-carrying metallic items associated with manholes, substations, and pad-mounted equipment by connecting them to bare underground cable and grounding electrodes arranged as indicated.
- 3.06 FIELD QUALITY CONTROL
 - A. Test:
 - 1. Subject completed grounding system to megger test at each location where maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells.

- Measure ground resistance without soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
- Perform tests by 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."
- B. Ground/resistance maximum values shall be as follows:
 - 1. Equipment rated 500 kVA and less: 10 Ohms.
 - 2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms.
 - 3. Equipment rated over 1000 kVA: 3 Ohms.
 - 4. Unfenced substations and pad-mounted equipment: 5 Ohms.
 - 5. Manhole grounds: 10 Ohms.
- C. Deficiencies: Where ground resistances exceed specified values, notify Engineer, and if directed by Engineer, modify grounding system to reduce resistance values. Where measures are directed that exceed those indicated, provisions of Contract covering changes will apply.
- D. Report: Prepare test reports, certified by testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.07 RESTORATION

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated.
- B. Where sod has been removed, replace it as soon as possible after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition.
- D. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.
- E. Restore disturbed paving as indicated.

END OF SECTION

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 SUMMARY

- A. Section Includes:
 - 1. Overcurrent protective devices (OCPD's) rated 600 V and below and switching devices commonly used with them.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA).
 - 1. NEMA KS-1-83 Enclosed Switches.
 - 2. NEMA 250-85 Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 3. NEMA FU1-86 Low Voltage Cartridge Fuses.
 - 4. NEMA AB1-86 Molded Case Circuit Breakers and Molded Case Switches.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70-90 National Electrical Code (NEC).
- C. Underwriters Laboratory (UL):
 - 1. UL 98-87 Enclosed and Dead Front Switches.
 - 2. UL 198C-86 High-Interrupting Capacity Fuses, Current-Limiting Types. Fifth Edition.
 - 3. UL 198E-88 Class R Fuses. Fourth Edition.
 - 4. UL 486A-80 Wire Connectors and Soldering Lugs for Use with Copper Conductors. Seventh Edition.
 - 5. UL 489-86 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures. Seventh Edition.
 - 6. UL 943-85 Ground-Fault Circuit Interrupters. Second Edition.
 - 7. UL 977-84 Fused Power-Circuit Devices. Third Edition.

8. UL 198L-88 - UL Standard for Safety D-C Fuses for Industrial Use.

1.03 DEFINITIONS

- A. Overcurrent Protective Device (OCPD): Device operative on excessive current that causes and maintains interruption of power in circuit it protects.
- B. Ampere-Squared-Seconds: Expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, ampere-squared-seconds during fault current interruption represents energy allowed to flow before fuse or breaker interrupts fault current within its current limiting range.
- 1.04 SUBMITTALS
 - A. Submit all products covered under this specification for Engineer=s approval.
 - B. Shop Drawings:
 - 1. Spare fuse cabinet showing dimensions and features including storage provision for fused cartons, where shown on plans.
 - C. Product Data:
 - 1. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for protective devices and let-through current curves for those with current limiting characteristics.
 - 2. Include coordination charts and tables and related data. D. Test Results:
 - 1. Certified reports of field tests and observations.
- E. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.05 QUALITY ASSURANCE
 - A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
 - B. Regulatory Requirements:
 - 1. Components and Installation:

- a. NFPA 70 "National Electrical Code (NEC)."
- b. Local codes and ordinances.
- C. Single-Source Responsibility: Obtain similar OCPD's from single manufacturer.
- D. Coordinate OCPD sizes with characteristics of motors supplied for this project. Pay special attention to high efficiency motors.
- 1.06 MAINTENANCE
 - A. Extra Materials:
 - 1. Maintenance Stock, Fuses: For types, voltage, and ampere ratings required, furnish 10% spare fuses, but not less than 1 set of 3 of each kind.

PART 2 PRODUCTS

- 2.01 OVERCURRENT PROTECTIVE DEVICES (OCPD's), GENERAL
 - A. General: Provide OCPD's in indicated types, as integral components of panelboards, switchboards, and motor control centers; and also as individually enclosed and mounted single units.
 - B. Enclosures: NEMA 250.
- 2.02 GENERAL FUSES
 - A. General: Provide fuses of types, classes, and current ratings as indicated. Voltage ratings shall be consistent with circuits on which used.
 - B. Fuses for Direct Current Circuits: UL 198L and marked for such use by manufacturer on fuse label.
 - C. Cartridge Fuse:
 - 1. Manufacturers:
 - a. Bussmann Div., Cooper Industries, Inc.
 - b. Gould Shawmut.
 - c. Littelfuse Inc.
 - 2. NEMA Standard FU1, unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with circuits on which used.
 - 3. Class CC Fuses: UL 198C.

- 4. Class J Fuses: UL 198C.
- 5. Class L Fuses: UL 198C.

a. Current limiting threshold of 10 times current rating or less and time delay of 4 sec at 5 times rating.

- 6. Class RK1 and RK5 Dual Element Time-Delay Fuses: UL 198E.
- 7. Class RK1 Fast-Acting Fuses: UL 198E.

2.03 FUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Square D Co.
 - 2. General Electric
 - 3. Eaton Corp.
 - 4. Or pre-approved equal.
- B. UL 98 and NEMA KS 1 quick-make, quick-break heavy-duty units.
- C. Rating: Load-breaking capacity in excess of normal horsepower rating for switch.
- D. Withstand Capability: In excess of let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.
- E. Operation: By means of external handle.
- F. Interlock: Prevents access to switch interior except when in "off" position.
- G. Fuse Clips: Rejection type.
- H. Padlocking Provisions: For 2 padlocks, whether open or closed.
- I. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting where indicated.
- J. Enclosure for Switchboard Mounting: Provide individual mounting where indicated.
- K. Enclosure for Independent Mounting: NEMA Type 0 as indicated or required to suit environment where located.
- 2.04 FUSED POWER CIRCUIT DEVICES

_

Α.	Manufacturers:					
	1. F	Pringle Electric Mfg. Co.				
	2. 5	Square D Co.				
	3. C	Dr pre-approved equal.				
В.	UL 977, with either bolted-pressure-type or high-pressure contact-type switch.					
C.	Operation: As indicated.					
D.	Ground Fault Protection: Integral, self-powered type with mechanical ground fault indicator, test function, adjustable pick-up current and delay time with inverse and constant time characteristics, internal memory arranged to integrate intermittent arcing ground faults, and ground fault current sensor located as indicated.					
E.	Open Fuse Trip Device: Arranged to trip switch open if phase fuse opens.					
F.	Enclosure for Switchboard Mounting: Suitable for individual mounting.					
G.	Enclosure for Independent Mounting: NEMA Type 1 enclosure, as indicated or as required to suit environment where located.					
H.	Minimum Fault Current Rating: As indicated.					
2.05	MOLDED-CASE CIRCUIT BREAKERS					
A.	Manufacturers Except as Indicated:					
	1. S	Square D Co.				
	2. 0	General Electric				
	3. E	Eaton Corp.				
	4. C	Dr pre-approved equal.				
В. С.	UL 489 and NEMA AB 1. Construction: Bolt-in type, except breakers in load-center-type panelboards and breakers 225-ampere frame size and larger may be plug-in type if held in place by positive locking device requiring mechanical release for removal.					
D.	Characteristics: Indicated frame size, trip rating, number of poles, and short-circuit interrupting capacity rating of 10,000 amperes symmetrical, unless greater rating is indicated on Drawings.					
E.	Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole.					
F.	Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.					

- G. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting in switchboard or panelboards where indicated.
- H. Enclosure for Switchboard or Motor Control Center Mounting: Provide individual mounting where indicated.
- I. Enclosure for Independent Mounting: NEMA Type 1 enclosure, as indicated or required to suit environment where located.
- J. Combination Circuit Breakers and Ground-Fault Circuit Interrupters: UL 943 arranged for sensing and tripping for ground-fault current in addition to overcurrent and short-circuit current.
 - 1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
 - 2. Trip Setting for Ground Fault: 4 to 6 milliamperes, listed and labeled as Class A, Type 1 device.
 - 3. Trip Setting for Ground Fault: 30 milliamperes.
- K. Current-Limiting Circuit Breakers: Arranged to limit let-through ampere-squared-seconds during fault conditions to value less than ampere-squared-seconds of one-half-cycle wave of prospective symmetrical fault current. Circuit breaker shall use no fusible devices in its operation. Currentlimiting characteristic shall be in addition to normal time-delay and instantaneous-trip characteristics and other features as indicated.
- L. Circuit Breakers With Solid-State Trip Devices: Provide indicated circuit breakers with solidstate trip devices having following features:
 - 1. Ambient Compensation: Trip device insensitive to temperature changes between minus 20°C and plus 55°C.
 - 2. Adjustability: Breaker ratings and trip settings shall be changeable by operation of controls on front panel of breaker, by change of plug-in element without removing breaker from mounting, or by combination of 2 methods.
 - 3. Ground-Fault Tripping: Adjustable for pick-up and time-delay values. Provide for indicated units.
 - 4. Provide clear plastic shield limiting access to rating plug and adjustments on solid state trip circuit breaker. Seal by attaching sealing wire through hole in posts provided. With wire seal installed, circuit breaker rating plug and adjustments shall not be "readily accessible."

2.06 INSULATED-CASE CIRCUIT BREAKERS

- A. Manufacturers:
 - 1. Square D Co.
 - 2. General Electric

- 3. Or pre-approved equal.
- B. UL 489 and NEMA AB 1.
- C. Ratings: Continuous-current, interrupting, and short-time-current ratings, and voltage and frequency ratings as indicated.
- D. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with following features:
 - 1. Moving Contacts Closing Speed: Independent of both control and operator.
- E. Circuit-Breaker Trip Devices: Solid-state overcurrent trip device system that includes 1 integrally mounted current transformer or sensor per phase, release mechanism, and following features:
 - 1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, which are independent of each other in both action and adjustment.
 - 2. Temperature compensation to assure accuracy and calibration stability from minus 20°C to plus 55°C.
 - 3. Field-adjustable, time-current characteristics.
 - 4. Current Adjustability: Effected by operating controls on front panel or by changing plug-in elements or current transformers or sensors.
 - 5. Three bands for long-time- and short-time-delay functions marked "minimum," "intermediate," and "maximum."
 - 6. Five pickup points, minimum, for long-time- and short-time-trip functions.
 - 7. Six pickup points, minimum, for instantaneous-trip functions.
 - 8. Ground fault protection with at least 3 short-time-delay settings and 37 trip-time-delay bands. Adjustable current pickup.
 - 9. Trip Indication: Labeled lights or mechanical indicators on trip device shall indicate type of fault causing breaker trip. If lights are used, integral power source shall maintain indication for 60 hrs, minimum.
- F. Auxiliary Contacts for Remote Indication: Where remote indication of breaker position is indicated, provide spare auxiliary switch in addition to other auxiliary switches required for normal breaker operation. Spare auxiliary switch shall consist of 2 Type "a" and 2 Type "b" stages (contacts), wired to terminal block in breaker housing.
- G. Draw out Features: Circuit-breaker mounting assembly equipped with racking mechanism that properly positions power circuit breaker and holds it rigidly in connected, test, and fully disconnected positions and includes following features:

- 1. Interlock arrangement, preventing movement of circuit breaker to or from connected position when it is in closed position and closure of circuit breaker unless it is in connected, test, or disconnected position.
- 2. Construction, permitting racking open circuit breaker to or from connected, test, and disconnected positions with associated compartment door closed or equivalent dead-front barrier protection, and manual withdrawal to position for removal from structure with door open.
- 3. Primary disconnecting devices disengaged and secondary disconnecting devices engaged when breaker is in test position.
- 4. Primary and secondary devices disengaged when circuit breaker is in disconnected position.
- 5. Ground contact engaged when circuit-breaker element is in connected and test positions.
- H. Circuit-Breaker Features and Accessories: Include following:
 - 1. Padlocking Provisions: For installing at least 2 padlocks on each breaker to secure its enclosure and prevent movement of draw out mechanism.
 - 2. Operating Handle: Provide 1 for each manually operated breaker. No handle ties are permitted.
 - 3. Electric Close Button: Provide 1 for each electrically operated breaker.
 - 4. Indicating Lights: Contacts for "Breaker Open" and "Breaker Closed," for main and bus tie circuit breakers, and for other indicated breakers.

2.07 OCPD ACCESSORIES

- A. Key Interlocks: Arrange interlocking so keys are held captive at devices indicated. Where future key interlocking provisions are indicated, provide necessary mountings and hardware as required for future installation.
- B. Instantaneous Undervoltage Trip Device: For indicated OCPD's.
- C. Adjustable-Time-Delay Undervoltage Trip Devices: For indicated OCPD's.
- D. Shunt-Trip Devices for Circuit Breakers: Where indicated, arrange to trip breaker from external source of power through control switch or relay contacts.

2.08 SPARE FUSE CABINET (WHERE INDICATED)

A. Cabinet: Wall-mounted, 18 gauge minimum steel unit with full-length, recessed piano-hinged door with key coded cam lock and pull.

- B. Size: Provide for orderly storage of all spare fuses of this project plus 15 percent spare capacity, minimum.
- C. Finish: Gray baked enamel.
- D. Cabinet Door: Bear legend in stenciled 1-1/2-inch high letters, "Spare Fuses."

PART 3 EXECUTION

- 3.01 INSTALLATION
 - A. Fuses:
 - 1. Install fuses in fusible devices indicated.
 - B. Independently Mounted OCPD's:
 - 1. Locate as indicated and install in accordance with manufacturer's written installation instructions.
 - C. Factory install OCPD's furnished in distribution equipment.
 - D. Coordinate size overcurrent protective devices with each motor and equipment manufacturer to assure correct size devices and provide accordingly.
- 3.02 APPLICATION OF FUSES
 - A. Control Circuits: Class CC, time delay.
 - B. General Purpose Fusible Switches: Apply following class and types:
 - 1. 30-600 Amperes: Class J or RK1, time delay.
 - 2. 601-6,000 Amperes: Class L, time delay.
 - a. Size at 125% of motor FLA not to exceed 150%.
 - b. For transformers, size 12 times FLA for .1 second and 25 times for 0.1 second.
 - c. Size at 100% of load for mains and feeders with non-inductive loads.
 - C. Combination Starters: Class J or RK1, time delay.
 - D. Bolted Pressure Switches: Class L, time delay.
- 3.03 IDENTIFICATION
 - A. Identify with components as specified in Section 16195.
3.04 CONTROL WIRING INSTALLATION

A. Install wiring between OCPD's and control/indication devices as specified in Section 16120 for hard wired connections.

3.05 CONNECTIONS

- A. Check connectors, terminals, bus joints, and mountings for tightness.
- B. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.06 GROUNDING

- A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.
- B. Ground in accordance with Section 16452.

3.07 COORDINATION STUDY

- A. Provide coordination study to determine settings for overcurrent protective devices. Where coordination study recommends changes in types, classes, features or ratings of equipment or devices those indicated, make written request for instructions.
- Obtain instructions from Engineer before ordering equipment or devices recommended to be changed. Make all settings and adjustments according to coordination study results. Provide hard copy records of study for Engineer's review.
- 3.08 FIELD QUALITY CONTROL
- A. Manufacturer's Field Services:
 - 1. Supplier's or manufacturer's technician for equipment specified herein shall be present at job site or classroom designated by Owner for minimum of 1/2 workday, travel time excluded, for assistance during plant construction, plant startup, equipment adjustment, and training of Owner=s personnel for plant operation. Include minimum of:
 - a. 1/2 manday for Instructional Services.
 - 2. Supplier or manufacturer shall direct services to specific system and equipment operation, maintenance, and troubleshooting.
- B. Testing:

- 1. Reports: Prepare certified written reports on tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include complete records of repairs and adjustments made.
- 2. Labeling: Upon satisfactory completion of tests and related effort, apply label to tested components indicating test results, date, and responsible person.
- 3. Schedule visual and mechanical inspections and electrical tests with at least 1 week's advance notification.
- 4. Pre-testing: Upon completing installation of system, perform following preparations for tests:
 - a. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
 - b. Make continuity tests of circuits.
 - c. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
 - d. Comply with manufacturer's instructions for installation and testing of OCPD's.
- 5. Visual and mechanical inspection: Include following inspections and related work.
 - a. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make final system adjustments.
 - b. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
 - c. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - d. Check tightness of electrical connections of OCPD's with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - e. Clean OCPD's using manufacturer's approved methods and materials.
 - f. Verify installation of proper fuse types and ratings in fusible OCPD's.

6. Electrical Tests: Include following items performed in accordance with manufacturer's instructions:

a. Insulation resistance test of OCPD conducting parts. Insulation resistance less than 100 megohms is not acceptable.

- b. Verify trip unit reset characteristics for insulated-case circuit breakers.
- c. Make adjustments for final settings of adjustable-trip devices.
- d. Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.
- e. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.
- f. Check operation of electrically operated OCPD's in accordance with manufacturer's instructions.
- g. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on lockedclosed devices including moveable barriers and shutters.
- 7. Retest: Correct deficiencies identified by tests and observations and retest. Verify by system tests that specified requirements are met.

3.09 CLEANING

A. Upon completion of installation, inspect OCPD's. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

This Page is Intentionally Left BLANK

SECTION 16476

DISCONNECTS AND CIRCUIT BREAKERS

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Section Includes:
 - 1. Service disconnects.
 - 2. Feeder and equipment disconnects.
 - 3. Enclosed circuit breakers.

1.02 SUBMITTALS

- A. Submit the following for Engineer=s approval.
- B. Product Data:
 - 1. Submit for switches, circuit breakers, and accessories.
 - 2. Descriptive data and time-current curves for protective devices and let-through current curves for those devices with current-limiting characteristics. Include coordination charts and tables, and related data.
- C. Shop Drawings:
 - 1. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.
- D. Test Results:
 - 1. Field test reports indicating and interpreting test results.
- E. Operating and Maintenance Data:
 - 1. Maintenance data for tripping devices.

- F. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.03 QUALITY ASSURANCE
 - A. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
 - B. Regulatory Requirements:
 - 1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.
 - C. Single-Source Responsibility: Enclosed switches and circuit breakers shall be product of single manufacturer.

PART 2 PRODUCTS

- 2.01 MANUFACTURERS
 - A. Fusible Switches:
 - 1. Square D Co.

2. Cutler-Hammer Products/Westinghouse Electric Co. B. Fused Power Circuit Devices:

- 1. Square D Co.
- 2. Boltswitch.
- C. Molded-Case Circuit Breakers:
 - 1. Square D Co.
 - 2. Cutler-Hammer Products/Westinghouse Electric Co.
- D. Combination Circuit Breaker and Ground Fault Trip:
 - 1. Square D Co.

- 2. Cutler-Hammer Products/Westinghouse Electric Co.
- E. Molded-Case Current-Limiting Circuit Breakers:
 - 1. Square D Co.
 - 2. Cutler-Hammer Products/Westinghouse Electric Co.
- 2.02 ENCLOSED SWITCHES
 - A. Enclosed Non-fusible Switch: NEMA KS 1, Type HD handle lockable with 2 padlocks.
 - B. Enclosed Fusible Switch, 800 Amperes and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
 - C. Enclosed Fusible Switch Larger Than 800 Amperes: Bolted-pressure or high-pressure contact switch, bus drilled to accommodate specified fuses, enclosure consistent with environment where located.
 - 1. Minimum Fault Current Rating: 100,000 symmetrical rms amperes.
- 2.03 ENCLOSED CIRCUIT BREAKERS
 - A. Enclosed Molded-Case Circuit Breaker: NEMA AB 1, handle lockable with 2 padlocks.B. Characteristics:
 - 1. Frame size, trip rating, number of poles, and auxiliary devices as indicated
 - 2. Interrupting capacity rating to meet available fault current, 10,000 symmetrical rms amperes minimum.
 - 3. Appropriate application listing when used for switching fluorescent lighting loads or heating, air conditioning, and refrigeration equipment.

PART 3 EXECUTION

- 3.01 INSTALLATION
 - A. Install enclosed switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
 - B. Install enclosed switches and circuit breakers level and plumb.
 - C. Install wiring between enclosed switches and circuit breakers and control/indication devices.

D. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer=s Field Services:
 - 1. Supplier=s or manufacturer=s representative for equipment specified herein shall be present at job site or for assistance during plant construction, plant startup, and training of Owner=s personnel for plant operation.
- B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.5 for enclosed switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
- C. Training:
 - 1. Train Owner=s maintenance personnel on procedures and schedules for startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 2. Review operating and maintenance data.

3.03 ADJUSTING

- A. Set field-adjustable enclosed switches and circuit breaker trip ranges as indicated.
- 3.04 CLEANING
 - A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

SECTION 16481

MOTOR CONTROLLERS

PART 1 GENERAL

- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Section Includes:
 - 1. AC motor control devices rated 600 v and below.
 - B. Overcurrent protective devices and disconnect switches used with motor controllers are specified in Section 16475.
- 1.02 DEFINITIONS
 - A. Motor Controller: Device that controls, protects, and energizes electric motor, and where required, controls its speed or torque or power delivered by it.
- 1.03 SUBMITTALS
- A. Submit all products covered under this section for Engineer=s approval.
 - 1. Product Data:
 - a. Include dimensions, ratings, and data on features and components.
 - 2. Test Results:
 - a. Certified reports of field tests and observations.
 - 3. Miscellaneous:
 - a. Load Current and Overload Relay Heater List: Compiled by Contractor after motors have been installed. Arrange list to demonstrate selection of heaters to suit actual motor nameplate full load currents.
 - 4. Operation and Maintenance (O&M) Data:

- a. Manufacturer's data on maintenance and operation of equipment.
- B. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.04 QUALITY ASSURANCE
 - A. Single-Source Responsibility: Obtain similar motor-control devices from single manufacturer.
 - B. Manufacturer Qualifications:
 - 1. Provide controllers from manufacturers regularly engaged in manufacture of equipment of types and capacities indicated, with such products in satisfactory use in similar service for not less than 5 yrs.
 - C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
 - 1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
 - 2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.
 - D. Regulatory Requirements:
 - 1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) No. 70.

1.05 COORDINATION

- A. Coordinate features of controllers and control devices with pilot devices and control circuits provided under other sections of Specifications covering control systems.
- B. Coordinate motor controls, starters and overcurrent devices with motor manufacturer=s data. Provide motor manufacturer=s data sheets to motor control manufacturer at time of order.
- 1.06 MAINTENANCE
 - A. Extra Materials:
 - 1. Spare Fuses and Incandescent Indicating Lamps: Furnish one spare for every 5 installed units, but not less than one set of 3 of each kind.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manual and Magnetic Motor Controllers:
 - 1. Square D Company.
 - 2. Westinghouse Electric Corporation.
 - 3. Eaton Corporation.
 - 4. Furnas Electric Controls.
 - 5. Or, pre-approved equal.
- 2.02 MOTOR CONTROLLERS, GENERAL
 - A. Coordinate features of each motor controller with ratings and characteristics of supply circuit, motor, required control sequence, duty cycle of motor, drive, and load, and pilot device, and control circuit affecting controller functions. Provide controllers horsepower rated to suit motor controlled.
 - B. NEMA Size 1 minimum.
 - C. Contacts shall open each ungrounded connection to motor.
 - D. Overload Relays:
 - 1. Ambient-compensated type with inverse-time-current characteristic.
 - 2. Provide with heaters or sensors in each phase matched to nameplate full load current of specific motor to which connected with appropriate adjustment for duty cycle. Overload devices to require manual reset after tripping occurs.
 - 3. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.
 - E. Enclosures:
 - 1. For individually mounted motor controllers and control devices, comply with NEMA 250.
 - 2. Provide enclosures suitable for environmental conditions at controller location.
 - 3. Provide NEMA Type enclosures as indicated or required to suit environment where located.
 - 4. All enclosures for motor starters 100 hp and greater shall have forced cooling.
- 2.03 MANUAL MOTOR CONTROLLERS
 - A. Quick-make, quick-break toggle action.
 - B. Doublebreak silver alloy contacts.

C. Pilot light.

- D. Padlocking provision.
- 2.04 MAGNETIC MOTOR CONTROLLERS
 - A. Full voltage, non-reversing, across-the-line, magnetic controller, except where another type indicated.
 - B. Control Circuit: 120 v. Control power transformer integral with controller where no other supply of 120 v control power to controller indicated. Control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.
 - C. Combination Controller: Switch type; fused or non-fused as indicated; quick-make, quick-break switch; factory assembled with controller and arranged to disconnect it. For fused switches, provide rejection type fuse clips and fuses rated as indicated.
 - D. Combination Controller: Motor circuit protector; molded case circuit breaker type with magnetic only trip element calibrated to coordinate with actual locked rotor current of connected motor and controller overload relays. Provide breakers factory-assembled with controller, interlocked with unit cover or door, and arranged to disconnect controller. Provide motor circuit protectors with fieldadjustable trip elements.
 - E. Overvoltage/Undervoltage/Phase-Failure Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
 - 1. Provide in starter enclosure for Size 2 and larger starters.
 - 2. Delay initial motor start.
 - 3. Delay motor restart due to starter dropout caused by undervoltage or starter coil circuit interruption for maintained control circuits.
 - 4. Adjustable on delay from 0.15 to 30.0 sec set at 10.0 sec.
 - 5. Connect control relay in motor starter coil circuit.
 - 6. Coordinate control relay selection with motor starter to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

2.05 AUXILIARY CONTROL DEVICES

- A. General: Furnish auxiliary control device as shown on 1-line diagrams, Drawings, or as specified. Factory-install in controller enclosure except as otherwise indicated.
- B. Pushbutton Stations, Pilot Lights, and Selector Switches: Heavy duty type.
- C. Stop Pushbutton Station: Momentary break pushbutton station with factory-applied hasp arranged so padlock can be used to lock pushbutton in depressed position with control circuit open.

- D. Lockout Pushbutton Station: Maintained contact red mushroom pushbutton station with factoryapplied hasp arranged so padlock can be used to lock pushbutton in depressed position with control circuit open.
- E. Control Relays: Auxiliary and adjustable time-delay relays.
- F. Elapsed Time Meters: Heavy duty with digital readout in hrs.
- G. Ammeters, Voltmeters, and Frequency Meters: Panel type, 2 2-in. minimum size with 90 or 120 degree scale, and □2% accuracy. Where indicated, provide transfer device with off position.
- H. Current Sensors: Rated to suit application.
- I. Current-Sensing Phase-Failure Relays: Solid-state sensing circuit with isolated contacts for hardwired connection. Arranged to operate on phase failure, phase reversal, current unbalance of from 5% to 30%, or loss of supply voltage. Provide adjustable response delay.
- J. Over temperature sensors are to be installed on transformers in reduced voltage autotransformer starters. Sensor stall interrupt and lockout starter control circuit. Provide reset switch and alarm light.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install motor controllers and auxiliary motor control devices in accordance with manufacturer's written instructions and approved submittals.
- B. Mounting:
 - 1. For control equipment at walls, bolt single units to wall. Mount multiple units on lightweight structural steel channels bolted to wall.
 - 2. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels. Use feet consisting of 3/8 in. thick steel plates, 6 in. square, bolted to floor. Use feet for welded attachment of 1-1/2-in. by 1-1/2-in. by 1/4 in. vertical angle posts not over 3 ft oc. Connect posts with horizontal lightweight slotted steel channels and bolt control equipment to channels.
 - 3. Unless shown otherwise on plans.
- C. Motor Controller Fuses and Circuit Breakers: Conform to requirements of Section 16475.
- 3.02 IDENTIFICATION
 - A. Comply with Section 16195.
- 3.03 CONTROL WIRING INSTALLATION

- A. Install wiring as specified in Section 16120.
- B. Install wiring in enclosures bundled, trained, and supported.

3.04 CONNECTIONS

A. Tighten connectors, terminals, and mountings. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements not indicated, comply with tightening torques specified in UL 486A and 486B.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services:
 - 1. Supplier's or manufacturer's technician for equipment specified herein shall be present at job site or classroom designated by Owner for minimum mandays indicated, travel time excluded, for equipment adjustment, and training of Owner=s personnel for plant operation. Include minimum of:
 - a. 2 manday for Instructional Services.

B. Testing:

- 1. Reports: Notify Engineer in writing indicating defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.
- 2. On completing installation of system, perform following tests.
 - a. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by manufacturer.
 - b. Make continuity tests of circuits.
 - c. Review updating of final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
 - d. Review manufacturer's written instructions for installation and testing of motor control devices.
- 3. Visual and Mechanical Inspection: Include following inspections and related work.
 - Motor Control Device Ratings and Settings: Verify ratings and settings as installed are appropriate for final loads and final system arrangement and parameters.
 Recommend final protective device ratings and settings where differences found. Use accepted revised ratings or settings to make final system adjustments.

- b. Inspect for defects and physical damage and nameplate compliance with Drawings.
- c. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's written instructions.
- d. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
- e. Clean devices using manufacturer's approved methods and materials.
- f. Verify proper fuse types and ratings in fusible devices.
- 4. Electrical Tests: Perform following in accordance with manufacturer's written instructions.
 - a. Insulation resistance test of motor control devices conducting parts to extent permitted by manufacturer's written instructions. Insulation resistance less than 100 megohms not acceptable.
 - b. Use primary current injection to check performance characteristics of motor circuit protectors and for overload relays of controllers for motors 15 hp and larger. Trip characteristics not within manufacturer's published time-current tolerances not acceptable.
 - c. Make adjustments for final settings of adjustable trip devices.
 - d. Test auxiliary protective features such as loss of phase, phase unbalance, and undervoltage to verify operation.
 - e. Check for improper voltages at terminals in controllers having external control wiring when controller disconnect opened. Voltage over 30 v unacceptable.
- 5. Correct deficiencies and retest motor control devices. Verify by system tests that specified requirements are met.

3.06 ADJUSTING

- A. Overvoltage/Undervoltage/Phase Failure Control Relay:
 - 1. Adjust control relay to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

3.07 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally using manufacturer's recommended methods and materials.

END OF SECTION

This Page is Intentionally Left BLANK

SECTION 16496

AUTOMATIC TRANSFER SWITCH

- PART 1 GENERAL
- 1.00 CONDITIONS
- A. This copyright protected © specification is issued confidentially for this specific project only. Reproduction of this document for any other purpose is prohibited.
- 1.01 SUMMARY
 - A. Section Includes:
 - 1. Delayed transition automatic transfer switches to automatically transfer between normal and standby power sources.

1.02 REFERENCES

- A. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
- B. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA ICS 2-447- AC Automatic Transfer Switches
- C. Underwriters Laboratories (UL)
 - 1. UL 1008 Standard for Automatic Transfer Switches

1.03 SUBMITTALS

- A. Submit all products covered under this specification for Engineer's approval.
- B. Manufacturer shall submit shop drawings for review, which shall include the following, as a minimum:
 - 1. Descriptive literature
 - 2. Plan, elevation, side, and front view arrangement drawings, including overall dimension, weights and clearances, as well as mounting or anchoring requirements and conduit entrance locations.
 - 3. Schematic diagrams.
 - 4. Wiring diagrams.
 - 5. Accessory list.

C. With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification

applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Russelectric

Onan

Lexington

Pre-approved equal

2.02 CONSTRUCTION

General

- The delayed transition automatic transfer switch shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of poles shall be as shown. Switches shall be UL listed in accordance with UL-1008.
- On 3 phase, 4 wire systems, utilizing ground fault protection, a true 4 pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles and shall have quick-break contacts.
- The transfer switch shall be mounted in a NEMA 1 enclosure for indoors and NEMA 4X S.S. for outdoors, unless otherwise indicated. Enclosures shall be fabricated from 12 gauge steel. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008. Outdoor enclosures shall have no exposed controls. Where shown on plans in MCC, transfer switch enclosure shall match MCC enclosure.
- The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual.

The transfer switch shall be top and bottom accessible.

The main contacts shall be capable of being replaced without removing the main power cables.

- The main contacts shall be visible for inspection without any major disassembly of the transfer switch.
- All bolted bus connections shall have Belleville compression type washers.
- When a solid neutral is required, a fully rated bus bar with required AL-CU neutral lugs shall be provided.
- Control components and wiring shall be front accessible. All control wires shall be multi-conductor 18 gauge 600 volt SIS switchboard type point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
- The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical type lugs.
- The complete transfer switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.
- Transfer time shall be of sufficient duration to allow motor run controls to drop out or, Contractor shall provide additional time delay controls to accomplish this function.

Automatic Transfer Switch

- The transfer switch shall be double throw, actuated by two electric operators momentarily energized, and connected to the transfer mechanism by a simple over center type linkage.
- The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungston alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable unless specifically shown on plans.
- The transfer switch shall be equipped with a safe external manual operator, designed to prevent injury to operating personnel. The manual operator shall be front accessible and shall provide "quick make-quick break" operation, offering the same contact to contact transfer speed as the electrical operator to prevent switching the main contacts slowly. The external manual operator shall be UL listed for operation, under load, from the outside of the transfer switch while the door is closed.

Automatic Transfer Switch Controls

- The transfer switch shall be equipped with a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.
- The CPU shall be equipped with self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit
- The controller shall use industry standard open architecture communication protocol for high speed serial communications via multi-drop connection to other controllers and to a master terminal with up to 4000 ft of cable, or further, with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
- The serial communication port shall allow interface to either the manufacturers or the owner's furnished remote supervisory control.
- The controller shall have password protection required to limit access to qualified and authorized personnel.
- The controller shall include a 20 character, LCD display, with a keypad, which allows access to the system.
- The controller shall include three phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
- The controller shall be capable of storing the following records in memory for access either locally or remotely:
 - Number of hours transfer switch is in the emergency position.

Number of hours emergency power is available.

Total transfer in either direction.

Date, time, and description of the last four source failures.

Date of the last exercise period.

Date of record reset (where applicable).

Sequence of Operation

When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-300 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.

- The transfer switch shall transfer to emergency when the generating plant has reached specified voltage and frequency on all phases.
- After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-3600 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.
- After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-3600 seconds, factory set at 300 seconds.

Automatic Transfer Switch Accessories

- Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
- Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-300 seconds. Factory set at 3 seconds, if not otherwise specified.
- Time delay to control contact transition time on transfer to either source. Programmable 0-120 seconds, factory set at 10 seconds.
- Time delay on retransfer to normal, programmable 0-3600 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 03600 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
- Time delay on transfer to emergency, programmable 0-300 seconds, factory set at 1 seconds.
- A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.
- A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.
- A time delay bypass on retransfer to normal shall be included. Keypad initiated.

- Contact, rated 10 Amps 30 volts DC, to close on failure of normal source to initiate engine starting.
- Contact, rated 10 Amps 30 volts DC, to open on failure of normal source for customer functions.
- Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.
- A plant exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise generating plant programmable in one minute increments. Also include selection of either "no load" (switch will <u>not</u> transfer) or "load" (switch will transfer) exercise period. Keypad initiated.
- Provision to select either "no commit" or "commit" to transfer operation in the event of a normal power failure shall be included. In the "no commit position," the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90% of its rated values (switch will remain in normal). In the "commit position" the load will transfer to the emergency position after any normal power failure. Keypad initiated.
- Two auxiliary contacts rated 10 Amp, 120 volts AC (for switches 100 to 800 amps) 15 amp, 120 volts AC (for switches 1000 to 4000 amps), shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections.
- A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages simultaneously, for both the normal and emergency source.
- A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.
- An LCD readout shall display normal source and emergency source availability.

Signal before transfer contacts:

Ratings

Delayed transition automatic transfer switches shall have the following 3 cycle short circuit closing and withstand as follows:

RMS Symmetrical Amperes 480 VAC

		Current Limiting
Amperes	Closing and Withstand	Fuse Rating
100-400	42,000	200,000
600	50,000	200,000
800	65,000	200,000
1000-1200	85,000	200,000
1600-4000	100,000	200,000

During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc.

When conducting temperature rise tests to UL-1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

The microprocessor controller shall meet the following requirements:

Storage conditions - 25 degrees C to 85 degrees C

Operation conditions - 20 degrees C to 70 degrees C ambient

Humidity 0 to 99% relative humidity, non-condensing

Capable of withstanding infinite power interruptions

Surge withstand per ANSI/IEEE C-37.90A-1978

5. Manufacturer shall provide copies of test reports upon request.

Manufacturer

The transfer switch manufacturer shall employ a nationwide factory-direct, field service organization, available on a 24-hour a day, 365 days a year, call basis.

The manufacture shall include an 800 telephone number, for field service contact, affixed to each enclosure.

The manufacturer shall maintain records of each transfer switch, by serial number, for a minimum 20 years.

Warranty

1. Provide 5 year standard manufacturer's warranty consisting of 2 years parts and labor, and an additional 3 years of replacement parts. Warranty shall be "on site" and warranty service shall be available by the factory service department on an emergency basis if required. Depot or non site warranties are not acceptable.

PART 3 EXECUTION

3.01 INSTALLATION

Automatic Transfer Switches shall be provided with adequate lifting means for ease of installation of wall or floor mounted enclosures.

Provide access and working space as indicated or as required.

3.02 ADJUSTMENTS

A. Tighten assembled bolted connections with appropriate tools to manufacturer's torque recommendations prior to first energization.

3.03 START-UP AND TESTING

 A. Provide the services of a factory representative to check-out, test, and start-up the automatic transfer switch in conjunction with the standby generator.
Fully function test the automatic transfer switch to verify proper operation.

3.04 TRAINING

A. Provide one (1) 4 hour training course conducted by Manufacturer's Representative at a time approved by Owner and Engineer.

Provide training outline to Engineer for approval of contents. Notify Engineer of training schedule. Engineer may be present. Training shall include operation and required owner service and preventative maintenance. Operation and Maintenance Manuals shall be used during training for reference.

END OF SECTION

Section 16510

LIGHTING FIXTURES

PART1 GENERAL

1.01 SECTION INCLUDES

A. Specification for:

Fluorescent lighting fixtures

High intensity discharge (HID) lighting fixtures

Emergency lighting fixtures

Exit fixtures

Incandescent lighting fixtures

Photo cells

1.02 REFERENCES

American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

1. No. 70 - National Electrical Code (NEC)

Article 410 - Lighting Fixtures, Lampholders, Lamps and Receptacles

Article 500 - Hazardous (classified) locations

Article 700 - Emergency Systems

2. No. 101 - Life Safety Code

American National Standards Institute (ANSI)

- C78.379 Electric Lamps Incandescent and High Intensity discharge Reflector Lamps Classification of Beam Patterns.
- C82.1 Ballasts for Fluorescent Lamps Specifications.
- C82.4 Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

American National Standards Institute/Illuminating Engineering Society (ANSI/IES): The IES Handbook shall be used as a basis for design and construction of lighting systems.

- American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc./Illuminating Engineering Society (ASHRAE/IES): ASHRAE/IES 90.1 - 1989 - Energy Efficient Design of new Buildings Except Low-Rise Residential Buildings.
- American National Standards Institute/Underwriters Laboratories (ANSI/UL).

UL1570 - Fluorescent Lighting Fixtures.

UL1571 - Incandescent Lighting Fixtures.

UL1572 - High Intensity Discharge Lighting Fixtures.

UL844 - Fixtures for Hazardous Areas.

- 1.03 SUBMITTALS
 - A. Submit the following under the provisions of Section 01330 Submittal Procedures:

Outline dimensions, support points and unit weight.

Operation and maintenance data.

Complete test report with photometric curves.

Storage, handling, and installation recommendation.

Connection diagrams.

Catalog data.

1.04 QUALITY ASSURANCE

- A. Tests. Run manufacturer's tests on lighting fixtures in accordance with applicable Underwriters Laboratories (U.L.) Standards 1570, 1571 and 1572.
- 1.05 DELIVERY, STORAGE AND HANDLING
 - A. Have lighting fixtures individually packed to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Benjamin Div., Thomas Industries

Crouse-Hinds, Div. of Cooper Industries

G.E. Lighting System

Guth Lighting

Holophane Company, Inc.

Hubbell Lighting, Inc.

Killark Electric Mfg. Company

LIGHTING FIXTURES

Lithonia Lighting

Pauluhn Electric

Wide-Lite Corporation

Dual-Lite Company

2.02 REQUIREMENTS

Provide lighting fixtures in accordance with the lighting plan Drawings, Lighting Fixture Schedules and this specification.

Fluorescent Lighting Fixtures

1. Fixtures

Select fixtures designed for operation on rapid start ballast circuit with medium bipin T8 bases.

Use ballasts with high power factor rapid start electromagnetic type in accordance with ANSI C82.1.

Use fixtures tested and approved under UL 1570 for damp locations as a minimum.

Provide heavy duty industrial type fixtures with baked white finish, spring loaded metal clad lamp holders and heavy duty apertured reflector, unless indicated otherwise on the Drawings.

2. Ballasts

Ballasts shall be UL listed with a Class P thermal rating, a Class A sound rating conforming to Part 18 of CRF 47 of the Federal Communications Commission Rules and Regulations.

Ballasts shall comply with ANSI C62.1-1984 (IEEE 587) for line transients and ANSI C78-1 for maximum starting voltage for each type of fluorescent lamp.

Ballasts shall be for minimum starting temperature of 0 degree F, unless otherwise specified and shall have a power factor greater than 0.90 and shall not contain PCB (Polychlorinated biphenyls).

Ballasts shall maintain constant light output for line voltage fluctuations of plus or minus 10 percent and be able to operate properly with plus or minus 15 percent voltage fluctuations.

Ballast factor: Ballasts shall comply with ANSI C82.1 and shall have a high ballast factor (.88 or greater) when firing the number of lamps wired to the ballast.

Crest factor: Ballasts shall have a lamp current crest factor, CCF, of 1.65 or less, and shall be furnished by the manufacturer.

Electronic ballasts shall have an output frequency of 20 Khz or higher with less than 2 percent lamp flicker. The average ballast life shall be rated at 60,000 hours or

greater based on 3 hour average burn cycles. Total Harmonic Distortion (THD) shall not exceed 10 percent and third Harmonic Distortion shall be less than 6 percent.

For lamp types for which none of the acceptable manufacturers produces an electronic ballast, the ballast shall be energy-saving magnetic type.

- Ballast and T8-lamp compatibility: Ballasts for use with T8 lamps shall be compatible with T8 lamps only. The ballast shall not adjust current if T12 lamps are inserted.
- Ballast and T12-lamp compatibility: Electronic ballasts for use with T12 lamps shall be T12 compatible only.
- Ballast for Compact Fluorescent Lamps: Ballasts shall be High Power Factor (HFP) type.
- Warranty: Ballast shall carry a manufacturer's warranty against failure due to defects in material or workmanship for 5 years.
- 3. Lamps
 - Fluorescent lamps shall meet the following specifications unless otherwise specified for a particular lamp.
 - Lamp Type: Lamps shall be T8 tri-phosphor type.
 - Lamp Correlated Color Temperature, CCT: Lamps shall have a manufacturer's Correlated Color Temperature, CCT, of 4100K.
 - Lamp Color Rendering Index, CRI: Lamps shall have a Color Rendering Index, CRI, of greater than 75.
 - 4-foot Fluorescent Lamp type: Lamps shall be 4-foot Phillips F32T8/TL741, or equal. Initial lumen output shall be 2850 lumens or greater with a design lumen output of 2600 lumens or greater at 40 percent of rated lamp life. Lamps shall have an average rated life at 20,000 hours or greater, based on 3-hour burn cycles.
 - 8-foot Fluorescent Lamp type: Lamps shall be 8-foot Phillips F96T8/TL741, or equal. Initial lumen output shall be 4500 lumens or greater with a design lumen output of 4050 lumens or greater at 40 percent of rated lamp life. Lamps shall have an average rated life at 15,000 hours or greater, based on 3-hour burn cycles.
 - U-lamp type: U-lamps shall be Phillips FB31T8/TL741, or equal. Initial lumen output shall be 2600 lumens or greater with a design lumen output of 2370 lumens or greater at 40 percent of rated lamp life. Lamps shall have an average rated life at 20,000 hours or greater, based on 3-hour burn cycles.
 - Compact Fluorescent Lamps Short: Lamps shall be Phillips PL-S 13W/41, or equal. Initial lumen output shall be 900 lumens or greater. Lamps shall have an average rated life at 10,000 hours or greater, based on 3-hour burn cycles.
 - Compact Fluorescent Lamps Long; Lamps shall be Phillips PL-L 40W/2G11/RS/41, or equal. Initial lumen output shall be 3150 lumens or greater with a design lumen output of 2835 lumens or greater at 40 percent of rated lamp life. Lamps shall have an average rated life at 20,000 hours or greater, based on 3hour burn cycles.
- C. High-Intensity Discharge (HID) Fixtures

Provide fixtures that are High Pressure Sodium (HPS) type.

Select fixtures which are enclosed and gasketed with mogul base porcelain lamp socket.

Use ballast high power factor type with taps for 120V, 208V and 277V input voltage, conforming to ANSI Standard C82.4.

Refer to Drawings or fixture schedules specific types, sizes and mounting hardware.

Emergency Fixtures / Exit Fixtures

- In working areas such as dry wells, or valve vaults with two or more levels, rooms which do not exit directly outside, or rooms with multiple means of egress, exit signs and lighting are required for safe evacuation of workers.
- Provide Dual Light AS-160-BCI wall-mounted, sealed beam, battery powered packs with dual heads where emergency illumination is required.
- In areas where exit signs and emergency lighting is needed, utilize Dual Light ESRWW-RGI packs to provide both.

Incandescent Lighting Fixtures

- Provide incandescent lighting fixtures with a maximum 150W design and vandal-proof construction.
- Fixtures shall be made for wall, ceiling or pendant mount in accordance with the Drawings or fixture schedules.
- Fixtures shall be designed for single incandescent lamp, medium base for maximum 150 watts with cast aluminum base and vandal-resistant polycarbonate lens or globe.
- For outdoor application the fixtures shall be of vaporproof NEMA 4X construction with globe, guard and stainless steel hardware.
- In hazardous areas the fixtures shall be approved under standard UL844 for Class 1, Division 1, Group D environment and shall be equipped with globe, guard and stainless steel hardware.

Photo Cells

- Provide a photo cell to control outdoor fixtures unless otherwise indicated on the lighting plans.
- Use a photo cell that is either the plug-in twist-locking type or the wire-in swivel-top type, both with similar features and operating characteristics.
- Provide a photo cell that is enclosed in a UV-resistant rain-tight polypropylene housing with the cell being a 0.75 square inch cadmium sulfide surface passivated and a single pole, single throw normally closed bi-metallic switch.

LIGHTING FIXTURES

3.01 PREPARATION

- Check the types and quantity of fixtures to be mounted in the area to be illuminated and verify that materials are on hand.
- Pick out the correct bulbs for the fixtures along with the necessary accessories and mounting hardware.

3.02 INSTALLATION

- Install fixtures in accordance with manufacturer's instructions, NEC Articles 410, 500 and 700 as applicable, and the Drawings.
- Wire up fixtures in accordance with the Drawings and ensure proper switching, circuiting and balanced loads.
- Make sure proper grounding and bonding are provided for fixtures and raceways.

Install specified lamps in each fixture.

When applicable, aim and adjust fixtures in accordance with directions as indicated on the Drawings.

Energize and test fixtures for proper operation.

Check the illumination level with a light meter and ensure that sufficient light is reaching areas where tasks are performed and that egress paths are properly illuminated during emergency situations.

END OF SECTION

This Page is Intentionally Left BLANK

SECTION 16622

SOUND ATTENUATING ENCLOSURE

- PART1 GENERAL
- 1.00 CONDITIONS
- A. This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 SECTION INCLUDES

This section specifies furnishing and installing a weatherproof sound attenuating enclosure around the standby emergency power generator.

1.02 REFERENCE STANDARDS

- Furnish and install a weatherproof sound attenuating enclosure designed to reduce the noise level of the standby emergency power generator set. The overall acoustical performance shall reduce the unsilenced noise levels 3 ft. from all sides and at 5 ft. elevation and at 3 ft. above the enclosure to 84 db or less.
- Wall construction and cooling baffle or silence construction shall be independently tested in conformance with ASTM procedures C423 for sound absorption, E90 for transmission loss, E413 for sound transmission class and E477 for silencer acoustical performance (Dynamic Insertion Loss).
- In addition to these minimum acoustical performance numbers, the enclosure shall meet the following fire related parameters per NFPA No. 255 or ASTM E84. Flame spread = 15, smoke developed = 0, and fuel contributed = 0.
- General enclosure design shall be able to withstand the following loadings: 100 mph winds, 42 lbs. /ft. Roof loads.
- 1.03 RELATED WORK
 - A. Division 16 Electrical Specifications that apply to the requirements of this project.
- 1.04 PRODUCT
 - Construction
 - General construction of the enclosure walls and roof shall consist of dual wall, prefabricated tongue-and-groove type acoustic panels with a 16 gauge, galvanized steel outer skin: a 22 gauge, perforated galvanized steel inner skin; roll formed internal channel stiffers and framing; and 3 lbs/cu. ft. density mineral glass fiber acoustical/ thermal insulation completely filling the void between the inner and outer skins. Also included shall be a 2 mil mylar protective liner installed between the perforated inner skin and the insulation material. An acoustical labyrinth shall be achieved at each panel joint or seam.
 - The enclosure=s super structure will consist of a structural rectangular tube frame work. The structure shall consist of two full length base members, six full width base members, four

full height corner columns, and two full width roof beams. This structure shall be completely seal welded at each connection point and all open tube ends will be capped with seal welded plates.

- Lifting eyes rated at a safe working load of 8,000 pounds each (for units that weigh more than 6,000 pounds) or 6,000 pounds each (for units that weigh less than 6,000 pounds) shall be installed at the top of each structural tube steel corner column. Anchor bolt clips shall be located and installed along the inside perimeter of the structural tube steel base frame.
- All doors will be factory mounted in a separate, self supporting, welded steel frame. All door hardware will be factory mounted. Door hardware to include 316 stainless steel Component Hardware Group brand refrigeration type slam locks with exit bar, two-point slam and take-up locks with inside release handle, Component Hardware Group, Inc. ball bearing heavy duty hinges, and positive type stainless steel door holders. Doors shall have neoprene or EPDM perimeter gasketing. Door shall seal completely along gasketed perimeter.
- Acoustical treatment of the cooling air intake and discharge opening shall be achieved with straight-through type, full height vertical baffles. Each baffle shall be of a one-piece construction. Construction of each baffle shall include a galvanized steel frame and stiffeners, perforated galvanized steel skin, roll-formed galvanized steel end caps, and acoustical insulation completely filling the void between the perforated skins. Each baffle must be easily removable to allow for completely open ends. Removal of the baffles shall not affect structural integrity of the enclosure. The baffles shall be located within the overall length of the enclosure=s walls and roof. Silencers mounted externally from the enclosure are not acceptable.
- In addition to the cooling air intake/discharge openings being acoustically treated, a set of 6" deep stationary weather louvers with bird screens shall be supplied. These louvers shall be mounted to the enclosure=s structural tube steel frame at each end of the enclosure. Louvers are to be removable and have lifting eyes to aid in removal.
- Forced air ventilation and interior lighting and GFI W.P. receptacle shall be provided and connected to a 12 circuit (minimum) NEMA 1 surface mounted lighting panel complete with 60AT/2P main breaker, (12) 20A plug-in circuit breakers and 10kVA encapsulated 480/120240 volt transformer, located in the enclosure. Contractor to provide feeder circuit from Motor Control Center.
- Provide approved concrete or steel stairs with landing where required for access from grade level. Provide shop drawings for Engineer=s approval.

Manufacturers

1. Acceptable manufacturers are:

SEMCO, Inc.

Acoustical Control Systems, Inc.

1.05 SUBMITTALS

Submit all products covered under this specification for Engineer=s approval.

Submit the following information to the Engineer for approval prior to placing any equipment on order:
<u>Dimensional Drawings.</u> Submit dimensional drawings of the sound attenuating enclosure and accessories.

Test Report. Furnish a certified copy of the factory test report on the actual enclosure provided.

- With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.
- 1.06 INSTALLATION
 - A. Install sound alternating enclosure according to plans.

END OF SECTION

This Page is Intentionally Left BLANK

Section 16670

LIGHTNING PROTECTION SYSTEM

PART1 GENERAL

1.01 SECTION INCLUDES

A. Specification for lightning protection system, including design, installation and materials.

1.02 REFERENCES

A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

NFPA No: 780 - Lightning Protection Code

NFPA No: 70 - National Electrical Code

Section 250-46 - Spacing from Lightning Rods

Section 250-86 - Use of Lightning Rods

B. American National Standards Institute/Underwriters Laboratories (ANSI/UL)

UL 96 - Lightning Protection Components

UL 96A - Safety Installation Requirements for Lightning Protection System

Lightning Protection Institute (LPI)

a. LPI 175 - Installation Standards

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 - Submittal Procedures:

Outline dimensions and weights

Installation and maintenance manual

Catalog data

Complete design and construction drawings

Underwriters Laboratories, Inc. Master Label Certification

Lightning protection institute certified system certification

1.04 QUALITY ASSURANCE

A. See Part 3.02 - INSTALLATION

1.05 PREPARATION FOR SHIPPING

A. Pack and crate materials to permit ease of handling and provide protection from damage during shipping, handling and storage.

PART2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Advanced Lightning Technology

East Coast Lightning Equipment

Harger Lightning Protection

Thompson Lightning Protection

2.02 DESIGN, CONSTRUCTION AND MATERIALS

- System Design: Provide a functional and unobtrusive lightning protection system. Departures from the Drawings or submittals shall be submitted to the Engineer for approval.
- Lightning Protection Equipment: Materials shall be copper and bronze and of the size, weight, and construction to suit the application and used in accordance with PLI, UL, and NFPA code requirements. Use bolt type connectors and splicers Class I and Class II structures. Pressure squeeze clamps are not acceptable. Use stainless steel mounting hardware to prevent corrosion.
- Aluminum Components: Aluminum materials may not be used except on roofs that utilize aluminum roofing components. On aluminum roofs or where aluminum parapet caps are used, the utilize aluminum components for roof lightning protection equipment to ensure compatibility. However, use copper down leads and grounding with the bimetal transition occurring at the through roof assembly with an approved bimetal through roof assembly.
- Use equipment which is UL listed and properly UL labeled. Equipment shall be new, and of a design and construction to suit the application in accordance with accepted industry standards and LPI, UL, NFPA, and NEC code requirements.

PART3 EXECUTION

3.01 PREPARATION

A. The Contractor is responsible for the following coordination with the building contractors:

The lightning protection installer shall install a correct, neat and unobtrusive installation in cooperation with other trades.

The roofing contractor shall seal and flash protection roof lightning penetrations conforming to the roof manufacturer's recommendations. However, the lightning

protection contractor shall designate locations of through roofs and submit details of through roof penetrations, as required.

- Should the roofing manufacturer require any special walk pads, membrane patches or pavers under the components of the lightning protection system, the lightning protection installer shall install such items with the roofing materials (patches, pads, pavers, adhesive) supplied by the roofing manufacturer at no additional cost to the lightning protection installer.
- The roofing contractor shall instruct the lightning protection installer of the proper installation procedures of the roof pads, patches and pavers, if required.

3.02 INSTALLATION

- Have the system installed by an experienced installation company that is UL listed, a member of the Lightning Protection Institute and an employer of Certified Master Installers of lightning protection systems.
- A certified Master Installer shall directly supervise the work. Install equipment in a neat, workmanlike manner. Provide and install a complete conductor network at the roof and include air terminals, connectors, splicers, bonds, copper down leads, and proper ground terminals.
- Use copper down lead conductors even when aluminum is required on the roof. Do not bring down lead conductors in conduit directly through the roof. Use through roof assemblies with solid brass or stainless steel rods for this purpose. Structural steel may be utilized in the installation as outlined by UL, NFPA, and LPI.
- Upon completion of the installation, the lightning protection installer shall secure and deliver to the Contractor for submittal to the Engineer, the Underwriters Laboratories, Inc., Master Label certification and the Lightning Protection Institute Certified System certification. The system will not be accepted without the UL Master Label plate and the LPI certification certificate.

END OF SECTION

DESIGN COORDINATION CONSIDERATIONS STANDARD SPECIFICATION

LIGHTNING PROTECTION SYSTEM

This Page is Intentionally Left BLANK

SECTION 16903

REMOTE TERMINAL UNIT

PART 1 GENERAL

1.00 CONDITIONS

This specification is issued for this specific project only. Reproduction of this document for any other purpose is prohibited.

1.01 WORK INCLUDED

This section covers work necessary for the installation, field testing and startup and final documentation for a SCADA or telemetry Remote Terminal Unit system hereafter referred to as the RTU and as described herein.

1.02 PRODUCTS

- Major components of this system shall include the specified materials, equipment and installation required to implement a complete and operational SCADA RTU system along with associated instrumentation.
- In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service to the greatest extent possible, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.
- Requirements for the electrical work associated with the installation of the RTU and instrumentation equipment are as specified in other sections.
- There is no intent to describe a single preferred RTU System manufacturer's equipment or software but, rather to describe system concepts and technical requirements. However, RTU will be required from a preferred manufacturer when it is a component of a SCADA System. RTU shall be Control Micro Systems SCADA PAC 32.
- RTU hardware manufacturer may not act as Contractor or Sub-Contractor for installation of the telemetry system.

1.03 RESPONSIBILITY FOR COMPLETE SYSTEM

- The Contractor shall be responsible for and shall provide for the supply, delivery, installation, certification, calibration, adjustment, testing and startup, of a complete, coordinated system which shall perform the specified functions indicated herein and as indicated on the plans.
- The Owner and the Engineer will review system technical information as submitted by the Contractor for hardware, peripheral devices, software operating system, database, control logic and alarming for complete compliance with these specifications.

Where radio communications is specified or shown on plans, the Contractor shall be responsible for the antenna tower selection and antenna selection that will minimize the degradation of the radio

signals between the sites. Selection shall be based on results of a TOPO/PATH study conducted by an experienced professional radio shop for this project. Study shall be coordinated with the West and East Plant SCADA systems. Antenna tower or mast shall be limited in height to 20 ft. and shall be set at minimum height allowed by wastewater treatment plant antenna height. Contractor shall be responsible for all license and frequency coordination. Radio frequency shall be the same used for the West Wastewater Treatment Plant. Radios shall be tha same models as the wastewater treatment plant radios.

All software shall be provided by Contractor and all programming for RTU's will be performed by the Contractor. Contractor shall provide for programming work at no separate payment.

1.04 CONTRACTOR QUALIFICATIONS

- RTU System Contractor (or subcontractor) may be required to submit a statement of qualifications to the Engineer before bid is awarded for RTU System work. Qualification Statement shall show proof of similar water plant installations for not less than four (4) recent projects in County of project location or, immediate vicinity there of.
- Provide name of project; name of Owner, address and telephone number of Owner's representative who can be contacted for references regarding successful completion and satisfactory performance of most recent projects. Contractor, or subcontractor, may not bid or construct the telemetry system.
- SCADA System RTU assembly may be performed by the following System Integrators:

Hyrdro-Con, 217 Nolana, #22, McAllen, TX 78504, Tel: 956-618-1525.

Systems, Inc., 14410 Luthe Rd., Houston, TX 77039, Tel: 281-442-8637.

Weimar Manufacturing, 505 South Eagle St., Weimar, TX 78962, Tel: 800-274-7054.

Prime Controls, 815 Office Park Circle, Lewisville, TX 75057, Tel: 972-221-4849.

Trac-N-Trol Inc., 713 South Rock Street, Georgetown, TX 78626, Tel: 512-869-2686.

MOV Controls, 9506 Clay Road, Houston, TX 77080, Tel: 281-969-2109.

BL Technology, 13171 Misty Willow Drive, Houston, TX 77070, Tel: 281-970-8191.

Or, as pre-approved by Engineer in writing

PREBID SUBMITTAL – (NOT APPLICABLE)

SUBMITTALS

Submit all products covered under this section for Engineer's approval.

- Hardware Submittals: Before any components are fabricated, and/or integrated into assemblies or shipped to the job site, furnish to the Engineer for his review six (6) copies of submittal documents. Submittals shall include full details, shop drawings, catalog cuts and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these specifications. Specifically, the Contractor shall submit the following materials:
 - Block diagram and operational description of the system showing all major components and their interconnections and interrelationships.
 - Label each diagram and specify all external power and communications interfaces. All diagrams shall be in an 11 by 17 format. Provide CD in AutoCad Release 14 format.
 - Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, console, etc., including internal and external arrangements and door mounted operator devices with nameplate designations.
 - Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified. Provide AutoCad CD.
 - Operational Description shall include the principal functions/capabilities of the RTU, as provided and configured/programmed. Included shall be a description of system communications.
 - Provide a detailed Bill of Materials along with descriptive literature identifying component name, manufacturer, model number, and quantity supplied.

Provide system hydraulic layout(s) where applicable.

- Software Submittals:
 - Provide user manuals for all supplier furnished software and firmware. For ancillary software such as spreadsheets being supplied under this contract, only a listing of the manuals which will be included with the O & M's is required.
 - Provide sample communication and control database programs for project in hardcopy form. As a minimum, hardcopy form shall be fully documented, including code, comments, addressing data and cross-references, etc. Every line or section of code shall be accompanied by a comment describing its function.
- Test Outlines and Procedures Submittals: Test descriptions shall be in sufficient detail to fully describe the specific tests to be conducted to demonstrate conformance with this specification.
- Spares and Expendables Recommendations: The Contractor shall provide a list of recommended spares and expendable items. The list shall be exclusive of any spares furnished under this Contract. A total purchase cost for the recommended list shall be provided in addition to the unit cost for each item.
 - One (1) each spare circuit board of each type used. Where number used is greater than six (6) provide two (2) spares.

One (1) spare UPS unit.

One (1) spare battery rectifier board and charger.

One (1) spare radio.

One (1) spare modem. Where six (6) or more are used, provide two (2) each.

Two (2) spare interconnecting cables of each type, with connectors.

Two (2) spare RTU and CCU power supplies.

One (1) each spare controller board for RTU and for CCU.

The list shall be exclusive of any spares furnished under this Contract. A total purchase cost for the recommended list shall be provided in addition to the unit cost for each item.

With each submittal, include a copy of the applicable specification(s) page(s) for the item submitted and mark "Complies" or "Non-Compliance" or "Exception" adjacent to the applicable paragraph. Identify applicable drawing sheet number and specification section on front of each submittal cover.

1.07 ON SITE SUPERVISION

- The Contractor shall provide experienced personnel to supervise, perform, and coordinate the installation, adjustment, testing, and startup of the RTU system. The personnel shall be present onsite as required to effect a complete and operating system.
- Furnish resume of experience for supervisor directly in charge of project and who will be directly supervising day-to-day on-site activities of contractor's employees or sub-contractors.

1.08 TESTING AND STARTUP

- A. All elements of the SCADA system shall be tested to demonstrate that the total system satisfies all of the requirements of this Specification. All special testing of materials and equipment shall be provided by the Contractor. The Contractor shall coordinate and schedule all of his testing and startup work with the Owner and Engineer.
- As a minimum, the testing shall include both a factory test and a field test. Testing requirements are as follows:
 - Factory Tests: The RTU and all other associated hardware shall be tested at the factory, prior to shipment, so as to demonstrate that each component is operational and meets the requirements of these specifications. Test results shall be certified, with written documentation provided to the Owner upon test completion. Factory testing may be witnessed by the Owner or Engineer.
 - Field Tests: All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis. Each test shall be witnessed and signed off by the Contractor and the Engineer upon satisfactory completion. The Contractor shall notify the Owner at least two (2) weeks prior to the commencement date of the field tests.

SCADA Programming: Testing will require a minimum of ten (10) working days after programs are downloaded to RTU's, CCU's, PLC's, and PC's. This shall be accounted for in project schedule.

1.09 TRAINING

- The training program shall educate operators, maintenance, engineering, and management personnel with the required levels of system familiarity to provide a common working knowledge concerning all significant aspects of the system being supplied and shall be conducted by a professional factory trained knowledgeable instructor. Training shall be conducted only by the SCADA System Manufacturer's Representative unless prequalified and accepted by Electrical Engineer in writing, in which case Contractor shall provide Training Instructor's resume or qualifications statement to Electrical Engineer for approval no later than twelve (12) weeks prior to start of training classes. The training program shall consist of the equivalent of five 8-hour days and conforming to Owner's schedule of operators. Both classroom-type and field site sessions shall be provided. At least two weeks prior to the requested start of the program, the proposed dates of training shall be submitted to the Owner and the Engineer for approval.
- The Instructor shall provide all instructional course material, equipment and manuals to conduct the training program. Owner shall provide facilities for the training.

The training program shall be conducted as follows:

Initial training shall familiarize the student with the fundamental operation of any microprocessors, operating systems, software programs and programming languages.

Operator training shall be conducted utilizing the actual system.

- Maintenance training shall address each item of equipment being supplied (operator interface equipment, computer equipment, instrumentation, RTU's, modems, etc.) down to the individual module, board or card level.
- Programmer or configuration training shall, as a minimum, address control logic creation and editing; graphic display creation and editing; software flowcharts or ladder diagrams; special housekeeping requirements; configuration and modification of all specified functions; report generation; and the addition of new equipment to the system.
- The training shall provide Owner personnel with basic proficiency in software functions pertaining to the specified system.
- A minimum of 75 percent of training time shall be dedicated to actual operation and use of the SCADA System as encountered in day-to-day operations.

Engineer's representative may be present during training.

Where Owner deems training is inadequate for Operators to fully understand and successfully operate SCADA System, additional training shall be provided at no additional cost to Owner.

The SCADA Instructor shall provide a professional published detailed training manual for Owner's use during training classes. Provide six (6) copies for Engineer's and Owner's approval four (4) weeks prior to training. Provide ten (10) copies for training after approval. Manual shall be professionally bound. (Ring type binders are unacceptable.)

1.10 OPERATION AND MAINTENANCE MANUALS

The Contractor shall provide (6) complete sets of hard-covered ring-bound loose-leaf O&M manuals. In addition to "as-built" system drawings, the manuals shall include internal wiring diagrams and operating and maintenance literature for all components provided under this section.

- The submitted literature shall be in sufficient detail to facilitate the operation, removal, installation, programming and configuration, adjustment, calibration, testing and maintenance of each component and/or instrument.
- The O&M manual shall be professionally composed and compiled and shall not be an assembly of "cut-sheets". Engineer shall have sole discretion of acceptance of O&M manual contents and composition.

The contents of the O&M manuals shall be generally organized as follows:

System Hardware/Installation

System Software

Operation (step-by-step procedures)

Maintenance and Troubleshooting

Where a SCADA System is to be installed under this contract or where existing and noted, the Contractor shall further provide a complete set of as-built plans, diagrams, parts and materials list, parts source, operational instructions, programming data, maintenance and trouble shooting instructions, service data, calibration data, testing data, required service and programming instruments and wiring diagrams sufficient for complete operation, service and programming and maintenance of the System by plant technicians and operators or by outside service technicians.

This information shall be provided on CD in AutoCAD 14, or later version, and in Word format and shall be arranged in final order for insertion into System files. Coordinate overall layout and contents with Engineer and with System Programmer.

Allow adequate manhours for adjustment of layout and contents during System testing and Owner review. All data submitted will be reviewed by Engineer for acceptance and where deemed insufficient by Engineer, data will be resubmitted at no additional cost to Owner.

1.11 DEFINITION OF ACCEPTANCE

A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:

All O&M documentation has been submitted, reviewed and approved.

The complete RTU system and instrumentation have successfully passed all acceptance testing requirements specified herein and have successfully been started up, tested and accepted by the Engineer.

All Owner's staff personnel training programs have been completed.

Owner/Engineer sign a document indicating system has formally been accepted.

PART 2 PRODUCTS

- 2.01 GENERAL
 - The functions and features specified hereunder are the minimum acceptable requirements for the system. The provided system shall equal or exceed each requirement. Consult with RTU Manufacturer's Representative, to verify exact component requirements before bidding. Failure to do so shall be at Contractor's risk and at no additional cost to Owner or Engineer.
 - In some cases, the specifications may allow the accomplishing of certain functions by means of more than one hardware/firmware/software approach. Any approach that is proposed shall equal or exceed all functional, operational, convenience and maintenance aspects of the one described.

Whether a proposed approach is equal to or exceeds specification requirements shall be in the sole desecration of the Engineer.

Major equipment, component and software items are specified; however the Contractor shall, at no additional cost, provide all appurtenant items, whether specifically referenced herein or not, but which may be required for system operation as hereinafter specified.

Where spread spectrum radio is used the SCADA Pac 32 radio version may be used.

2.02 FUNCTIONAL REQUIREMENTS

- A. General
 - The RTU system shall monitor and control the equipment functions stated herein and as indicated on the plans. Location shall be coordinated with Owner and approved by the Engineer.
 - Under this contract, the RTU System Contractor is to interconnect all listed systems, setup controls for all systems and, in general, provide a complete unified operating RTU System.
 - The related SCADA System operation shall be from CCU/RTU and shall not be dependent on PC system software to run program. The RTU supplied shall be compatible with this type operation. No exceptions.
 - SCADA system RTU's, CCU's, PLC's, and/or controllers shall have data I/O connections for RS 232 or RS 485 data signals from other controllers, Multilin Motor Protection Units, automatic transfer switches, generators, analyzers, automatic power factor correction units, electrical devices, recorders, and all

other Vendor furnished equipment. Interface with SCADA and provide all necessary graphics, programs, software, and hardware for a complete operating system.

2.03 COMPONENT SPECIFICATIONS

General

- Enclosures shall be corrosion resistant welded NEMA Type 4X stainless steel for outdoor locations, NEMA Type 12 for indoor locations. Enclosure shall be fabricated from 316 stainless steel. Units shall include a single gasketed front door. Full height hinges, locking hasp and door clamping hardware shall be included. All enclosures shall be UL listed.
- Controls shall operate from a source of 120 Vac, 1 phase, 60 Hz. All controls shall be protected from lightning or other transient voltages by power arresters and surge protectors on both power and telephone lines.
- Condensation protection shall be provided for panels not in climate-controlled environments. Enclosures shall have a heater which operates continuously to prevent condensation build-up. A freeze protective heater and thermostat shall also be provided at those outdoor locations containing hydraulics. Where ambient temperatures (assume 100 degrees F) exceed component manufacturers specified maximum operating temperature by a factor of .85, cooling shall be supplied with the enclosure.
- All DC power supplies required for operation of RTU System or instruments shall be provided. Units shall provide sufficient voltage regulation and ripple control to assure powered components can operate within their required tolerances.
- Included shall be a battery backed power source to run remote units for a period of twentyfour hours in the event of a failure of the normal AC source. The battery shall be of the gel cell type and sized to provide DC power for the specified power fail period. The battery shall be kept fully charged using a regulated float voltage charging system. "Switching" type battery supplies are not acceptable.
- RTU units shall have an operational temperature range of -40° C to 70° C (-40° F to 158° F), and a storage temperature range of -40° C to 800 C (-4° F to 176° F), under relative humidity conditions of 10% to 95% non-condensing.
- All wiring shall be in complete conformance with the National Electrical Code, state, local and NEMA electrical standards. All incoming and outgoing wires shall be connected to numbered terminal blocks and all wiring neatly tied and fastened to chassis as required.
- Local construction permits shall be sole responsibility of Contractor. Local inspection authorities' acceptance is required before final acceptance of system.

Outdoor RTU's shall not have devices mounted in outer doors.

Where radio communications is specified or shown on plans, the Contractor shall be responsible for the antenna tower selection and antenna selection that will minimize the degradation of the

radio signals between the sites. Selection shall be based on results of a TOPO/PATH study conducted for this project.

- Study shall be conducted prior to ordering equipment and where study indicates unacceptable signal levels, Contractor shall immediately notify Engineer in writing, in which case a telephone modem connection may be used at no additional cost to Owner.
- UL Labeling
 - Panels provided under this section shall meet the requirements of UL 508. All panels shall bear the UL508 serialized label. Panels shall be constructed only by a U.L. listed fabrication shop. No exceptions. No field certification is allowed. All field modifications shall be in conformance with UL508. When the Owner accepts the panels, the contractor certifies that the panels have retained their UL labeling.

Intelligent Remote Terminal Units (RTU's):

General: Intelligent Remote Terminal Units (RTU's) shall be SCADA PAC 32 as manufactured by Control Micro Systems and shall be provided for each remote location in the system and shall be installed as shown on the plan drawings or as otherwise directed by the Engineer. Units shall be specifically designed for telemetry applications and shall be

Control Microsystems "SCADA PAC 32" or pre-approved equal as manufactured by Autocon (U.S. Filter) or, pre-approved equal. The RTU's shall be equal in operation, construction and quality to Intelligent units by listed manufacturers listed in specifications or pre-approved equal. Listing of a Manufacturer does not relieve obligation of meeting all conditions on this specification. The use of generic programmable logic controllers

(PLC's) not designed for water and wastewater is specifically prohibited. All Intelligent RTU's shall be warranted by the manufacturer for a period of not less than three years from date of shipment.

- Hardware: The CCU shall, as a minimum, be a 32 bit microprocessor with 3 MB of total memory and support for three full duplex serial ports. Minimum required: 3 RS-232. Each serial port shall include a 9-pin RS232 connector. Supply modems as required as part of this contract. All integrated circuits shall utilize CMOS components to ensure low power consumption. Unit shall incorporate a watchdog timer circuit. The unit shall include a lithium battery to backup the on board RAM and real time calendar/clock chip for up to two years with power off. Basic input/output capabilities of the typical unit shall include:
 - A minimum of four 12- 24 Vdc digital inputs, three of which can also be used as high speed counter input capable of accepting up to 5 KHz), expandable to 260 digital inputs. Digital inputs shall be optically isolated and meet IEEE 2.5 kV surge suppression
 - A minimum or two digital outputs, expandable to 258 Digital (Relay) outputs. Digital outputs shall be form C relays (SPDT).
 - A minimum or five analog inputs, expandable to 133 analog inputs. Analog input shall support a 12 bit minimum bipolar analog to digital conversion.

Unit shall include two expansion bus connectors allowing support of up to 40 expansion modules.			
All inpu	All inputs/outputs shall have LED's to indicate status. LED's can be turned on/off in the program.		
The fol require	The following technical specifications for the CCU Controller are the minimum requirements.		
\$	128k RAM expandable to 1MB RAM, non-volatile.		
Ş	28K ROM expandable to 2MB ROM		
\$	0.5K EEPROM.		
\$	Clock/calendar accurate to +/- 1 Min. / Month		
\$	Diagnostic LED's		
\$	Internal temperature sensor.		
\$	Ladder Logic Memory; 12K words non-volatile program memory.		
\$	11,000 words, 16 bit register, non-volatile data memory		
\$	8,192 bits, one bit wide, non-volatile data memory.		
\$	Protocols: Modbus RTU and Modbus ASCII with store and forward repeater function and Master and Slave on all ports.		
\$	Optional protocols: Allen-Bradley DF! Full Duplex and DF1 Half Duplex.		
Ş	Environment: -40 Deg F to 158 Deg. F, 5% to 95% RH, non-condensing.		
\$	Process I/O Terminations: Removable terminal blocks with screw compression terminals.		
\$	Certifications and Standards:		
Ş	Surge withstand capability: ANSI/IEEE C37.90		
\$	RF emission compatibility: FCC Part 15, Subpart J, Class A.		
\$	Electrical safety classification: UL 508/CSA C22.2/142		
\$	Hazardous area classification: CSA Class 1, Division 2, Groups A, B, C, D		
\$	CE standards: EN55011, EN55022, EN60082-1, EN60082-2 and EMC directive 89/226/EEC.		
\$	Programmable in Relay Ladder Logic, IEC 61`131-3 and multitasking C languages.		
\$	OPC communications. (OLE for Process Control)		

The unit shall include a lithium battery to backup the on board RAM and real time calendar/clock chip for up to two years with power off. Expansion modules/cards shall be available (Minimum requirements) as:

4 channel isolated analog output module (0-20/4-20 madc)

8 channel isolated analog input module (0-5/1-5 Vdc)

8 channel discrete input module (12 B 240 Vac/dc)

16 channel discrete input module (12-240 Vac/dc)

8 channel discrete output module (Relay B 6Amp Contacts)

16 channel discrete output module (Relay B 6 Amp Contacts)

HART Protocol Module.

4 channel High Speed Counter/Accumulator input module.

All discrete input and output modules shall have status indicating LED's which can be enabled/disabled by the program in the base card. All input/output modules shall have removable terminal blocks.

- Diagnostics: All RTU's shall include integral diagnostic tests of the base card to determine current operating conditions, including ambient temperature and Lithium Battery conditions. On board LED's shall be utilized for indication of: power on, carrier detect, receive data, request-to-send and transmit data for each communication port, and each digital input and output.
- Communications: All communications ports shall be capable of communicating with the CCU utilizing leased-line or dial-up modem, radio transceiver, spreadspectrum radio, or communication link to another device. All ports shall be capable of utilizing custom protocols and as a minimum utilize either/or the ASCII or RTU version of the Modbus protocol with any combination of baud rate, parity, duplex and word length.

All ports shall support RTS/CTS handshaking for radio transmitter control and all ports shall be capable of Modbus master and/or slave operation, dynamic switching between master and slave on the same communication port, and allowing report by exception. All ports shall be capable of utilization for programming and diagnostics. All communications ports shall allow remote programming and configuration.

Power Requirements: All RTU's shall be capable of being powered by 10-28 Vdc or 16Vac. A sealed gel cell 12 volt battery and charger as previously specified shall be supplied to power the RTU and base station during emergency power outage conditions for a duration of 48 hours.

All RTU's shall be capable of being put in a Sleep-Mode by turning off the power supply under application software control and being reactivated by any combination of external interrupt input, a specific time and date, or expiration of a time delay. During the SleepMode the high-speed counter/accumulator inputs shall be functional. All I/O module LED's and diagnostic LED's which are powered by the RTU shall have the capability of being enabled or disabled under software control.

Application Software: All Intelligent RTU's shall be equipped for Relay Ladder Logic programs, PID feedback control, modem dialing and control and communications using the Modbus protocol. A "C" compiler shall be programmed for custom protocols and complex functions. All RTU's shall have multitasking capability where ladder and "C" programs execute concurrently.

Ladder Logic programming software shall be provided and shall be IEC-1131 compliant and shall include a simulator which does not require hardware to test a program.

Ladder Logic application programs shall be capable of being developed on Windows NT, Windows 95/98 or Windows 2000, as applicable. The RTU system shall be capable of full program support and diagnostics being performed remotely through the SCADA network.

System supplier shall provide the "Programmer" with all RTU programming packages, manuals, licenses, development keys, hardkeys, etc. at least 90 days prior to date programming is to be installed.

Operator Interface: Operator interface to the system CCU (where required) shall be provided by means of an Alphanumeric Keyboard and Display Terminal which is compatible with third-party Modbus or A-B DF1 MMI's. Operator Interface Unit shall be a product of the RTU manufacturer unless specifically approved otherwise by Engineer.

The Terminal shall display RTU analog and digital input/output signal status in appropriate engineering units. Terminal shall allow changes to set points, control parameters and outputs. All changes by operators shall be password protected. In addition to the RTU displays, the Terminal shall provide menu driven commands, communications status and statistics, alarm history and on-line help. Terminal shall communicate with the CCU via an RS232C interface at 9600 baud.

Non-Intelligent Remote Terminal Units.

- General: Non-Intelligent Remote Terminal Units (RTU's) shall be installed only where specifically shown on the plan drawings or as otherwise directed by the Engineer. Units shall be specifically designed for telemetry applications. The RTU's shall be equal in operation, construction and quality to Intelligent units by listed manufacturers listed for CCU (Par. C above) or pre-approved equal. Listing of a Manufacturer does not relieve obligation of meeting all conditions on this specification. The use of generic programmable logic controllers (PLC's) not designed for water and wastewater is specifically prohibited. All Non-Intelligent RTU's shall be warranted by the manufacturer for a period of not less than three years from date of shipment.
- Hardware: All Non-Intelligent RTU's consist of a Communications Controller and the required I/O Modules.

a. Communications Controller. (RS-232 Serial): The communications controller shall provide RS-232 serial communications interface for the Non-intelligent RTU to the SCADA system.
 The communications controller shall emulate the Modbus protocol and shall be capable of connecting up to forty I/O modules. (See Next sec for I/O Specifications).

The communications controller shall provide RS-232 interface support for both two-wire (half duplex) and four wire (half or full duplex communications).

The communication controller shall have the ability to enable and disable status LED's on all modules connected to its I/O bus. The following technical specifications are minimum Requirements:

- Processor M37702 16 bit CMOS micro-controller, 14 MHz, watchdog timer
- \$ Memory 64K bytes total, 32K CMOS RAM, 64K EPROM
- \$ Serial Port RS-232, DE-9 male, DTE
- \$ RS-232 Signals TxD, RxD, RTS. CTS, DCD, DTR
- \$ Baud Rate 300, 600, 1200, 2400, 4800, 9600, 19200, 38400
- \$ Parity None
- \$ Word Length 8 bits, 1 stop
- \$ Duplex Half or full, RTS/CTS hardware handshake
- Protocol TeleBUS7 (compatible with Modbus RTU and Modbus ASCII)
- Protocol Mode Slave or master
- Slave Addresses Switch configurable 1 to 255
- Physical I/O Capacity 64 digital inputs, 64 digital outputs, 64 analog inputs, 32 analog outputs.
- Visual Indicators: RS-232 signals: TxD, RxD, CTS, RTS, DCD LED Power (shows if I/O module LED's are enabled) STATUS (shows functional status) Pushbuttons LED Power toggle Status.
- Soutput: Opto coupler open collector transistor, 3-15V, 25mA, open on fault.
- \$ Power Requirements 5 volts, 60mA
- Dimensions 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep

- \$ Mounting 7.5 x 35 DIN rail
- \$ Packaging Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F
- Input / Output Expansion Modules, Power Supplies, Gateways, Modems, and Interface Modules utilized at CCU, Intelligent RTU and Non-intelligent RTU's.
- Un-interruptible Power Supply: Each location, Intelligent and Non-intelligent RTU's, shall be powered by an Interruptible power supply. The power supply shall provide all operating power for the controller.

Power supplies shall provide a battery charger, which maintains a charge on the gelled electrolyte backup battery. The battery backup shall maintain system operation during power outages including loop- powered instrumentation.

All power supplies shall utilize transformer isolated, switch-mode technology. All outputs shall be isolated from the input and from each other. Power supplies shall be cascaded to provide the necessary power capacity for the system. The following technical specifications are minimum requirements:

- \$ Primary Input: 14B40V or 16B24Vrms
- \$ DC/Battery Input: Turn on at 11.5V
 0.3V, Turn off at 10.5V
 0.5V
- \$ Maximum: 40V
- \$ Input Power: 35VA maximum at 24Vrms, 1.9A maximum at 13.5V
- \$ Outputs: 5V @ 1.0 ampere, 24V @ 0.5 ampere, 11 to 14V battery charger @ 200mA
- \$ Mode Isolated: switch-mode, 30 KHz switch frequency
- \$ Line Regulation: < 1% over operating range
- \$ Load Regulation: 5V 🛛 1% over operating range
- \$ **24V 🛛 17%**
- \$ Output Ripple 5V: < 10mV</p>
- \$ 24V: < 50mV
- \$ Visual Indicators: 5V and 24V green LED's
- \$ Battery Charger 13.5V @ 0.2 Ampere for gelled electrolyte lead/acid battery
- \$ Terminations: 10 pole, removable terminal block, 12-22 AWG, 15 amp contacts
- Dimensions 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep.

- \$ Mounting 7.5 x 35 DIN rail
- \$ Packaging Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F

Isolated Analog Input Modules: The Isolated Analog Input Module shall provide eight analog inputs to the system I/O. The Isolated Analog Input Module shall be capable of being configured for 20 madc loop or 5 Vote operation. Offset shall be controlled by DIP switches.

The Isolated Analog Input Module shall as a minimum utilize a 12 bit successive approximation analog to digital (A/D) converter. All inputs shall be transient protected and optically isolated from the main logic power. The inputs shall be single ended and share a common return. The following technical specifications are minimum requirements.

- \$ Number of Signals: 8
- \$ Input Offset DIP switch configurable for 20% offset
- \$ Type: Single ended
- Over-voltage: 60% over-scale sustained input signal without damage 115Vrms will only damage 20mA current resistor and transient suppressor.
- \$ Isolation: 500Vrms from the logic power
- \$ Resolution: 12 bits
- \$ Input Resistance: 100 KSL nominal for 5V inputs 250 SL for 20mA inputs.
- \$ Converter type: Successive approximation
- Accuracy: 0.1% @ 25°C (77°F) 0.2% over temperature range
- \$ Transient Protection: Transient suppresser on each input
- \$ Response Time: 20mS typical for 10% to 90% signal change
- \$ Addressing: DIP switch configurable
- Power Requirements: 5V @ 20mA 11 to 28V @ 10mA (loop power extra @ 20mA maximum per loop)
- \$ Terminations: 12 pole, removable terminal block, 12-22 AWG, 15 A contacts
- Dimensions: 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep.
- \$ Mounting: 7.5 x 35 DIN rail
- \$ Packaging: Corrosion resistant zinc plated steel with black enamel paint.

- \$ Environment: 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F
- Analog Output Module: The analog output module shall provide four analog outputs to the system I/O. The analog output module shall generate either 4 to 20 ma outputs or 0 to 20 ma outputs,

switch selectable. The output resolution shall be a minimum of 12 bits. Outputs shall be isolated from the logic circuits. The following technical specifications are minimum requirements.

- \$ Number of Analog Outputs: 4
- \$ Output Signal Range: 0-20mA or 4-20mA, switch configurable
- S Maximum Load Resistance: 1000 ohms with 24V loop power
- \$ 400 ohms with 12V loop power
- \$ 250 ohms with 9V loop power
- \$ Output Type: Single ended regulation on positive side with common negative return
- \$ Isolation: 1500Vrms field to logic
- \$ D/A Resolution: 12 bits
- S Absolute Accuracy: □ 0.05 % @ 25°C with 250 ohm load □ 0.2 % over temperature range, 0-1000 ohm load
- \$ Noise and Ripple: 0.04% maximum
- \$ Transient Protection: 600 watt
- \$ Response Time: 250mS typical for 10% to 90% signal change
- \$ Addressing: DIP switch configurable
- Power Requirements: 5V @ 45mA 9 to 28V @ 95mA (with all outputs at 20mA, 15mA quiescent)
- \$ Field Terminations: 10 pole, removable terminal block, 12-22 AWG, 15 A contacts
- Dimensions: 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep.
- \$ Mounting: 7.5 x 35 DIN rail
- Packaging: Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment: 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F.

Combination Digital Input/Output Module: The combination digital input/output module shall provide eight digital inputs/outputs (any combination) to the system I/O. The I/O modules shall utilize sockets to facilitate field replacement and point configuration.

Each I/O point shall be individually isolated, and have two poles on the field wiring terminal block. A light emitting diode (LED) shall be provided for each I/O point indicating the status of the I/O point. The following technical specifications are minimum requirements.

- \$ Number of Inputs or Outputs: 8/16
- \$ Voltage Range: Output relay 12-280Vac, Input Relay 90-140 Vac
- \$ Load Current: 3 Amps
- \$ Transient Protection: Integral to the solid-state relay
- \$ Isolation: 1500Vrms
- \$ Addressing: DIP switch configurable. Addressed as 8 inputs and 8 outputs
- \$ Input/Output Assignment DIP switch selection for each I/O point
- \$ Power Requirements: 5V @ 90mA 24V @ 0mA (not required)
- \$ Visual Indicators: 8 red LED's, permanently enabled
- Field Terminations: Two 8 pole, removable terminal block 12 to 22 AWG 15 amp contacts
- Dimensions: 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep
- \$ Mounting: 7.5 x 35 DIN rail
- Packaging: Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment: 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F
- High Level Digital Input Module: The High Level Digital Input module shall provide sixteen digital inputs to the system I/O. The Digital inputs shall be capable of utilizing a signal range of 12 V ac/dc to 240 V ac/dc. Each I/O point shall be individually isolated, and have two poles on the field wiring terminal block. A light emitting diode (LED) shall be provided for each I/O point indicating the status of the I/O point. The following technical specifications are minimum requirements.
 - \$ Number of Signals: 8 or 16
 - Input Logic: HI Level Off to on transition threshold is typically 50% of full scale signal range
 - \$ Over-voltage: Tolerance 150% sustained over-voltage without damage
 - \$ Input Current: 5mA typical
 - \$ Response Time: OFF to ON: 7ms, ON to OFF: 24mS typical
 - \$ Isolation: 1500Vrms in groups of 4 inputs
 - \$ Addressing: DIP switch configurable

- Power Requirements: 5V @ 80mA all LED's on, 5V @ 25mA with LED's disabled, 24V
 @ 0mA (not required)
- \$ Visual Indicators: 16 red LED's, controlled by CPU for power reduction
- Field Terminations: One, 10 pole, removable terminal blocks, 12-22 AWG, 15 amp contacts
- Dimensions: 5.65 inch (144 mm) wide by 4.625 inch (118 mm) high by 1.75 inch (44 mm) deep
- \$ Mounting: 7.5 x 35 DIN rail
- Packaging: Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment: 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F
- Dry Contact Relay Output Module, 8 and 16 Point: The Dry contact Digital Output Module shall provide sixteen, sealed, dry contact, Form A (N.O.) mechanical relay outputs to the system I/O. Each I/O point shall be individually isolated, and have two poles on the field wiring terminal block. A light emitting diode (LED) shall be provided for each I/O point indicating the status of the I/O point. The following technical specifications are minimum requirements:
 - \$ Number of Relay Outputs: 8/16
 - Sealed mechanical relay, Form A (Normally open) resistive loads to Form B (Normally closed contacts).
 - Contact Ratings: 6 amperes @ 250Vrms resistive loads 6 amperes @ 30V resistive loads 3.5 amperes @ 30V/250Vrms inductive load (pf=0.4. L/R=7 ms) 1/4 HP 125Vrms.
 - S Operating Frequency: 18,000 operations/hour mechanically, 1,800 electrically at rated load
 - Service Life: 1,500,000 operations at 0-250mA loads, 600,000 operations at 1A resistive load, 100,000 operations at 6A resistive load, 300,000 operations at 1A inductive loads (pf=0.4), 100,000 operations at 3.5A inductive loads (pf=0.4).
 - \$ Operate Time: 10mS maximum, 5mS typical
 - \$ Release Time: 10mS maximum, 2mS typical
 - Sounce Time: 3mS typical
 - \$ Contact Isolation: 1000Vrms
 - \$ Logic Isolation: 1500Vrms
 - \$ Addressing: DIP switch configurable
 - \$ Power Requirements: 5V @ 600mA with all LED's and all relays energized
 - \$ 5V @ 540mA with LED's disabled and all relays energized 24V @ 0mA (not required)

- \$ Visual Indicators: 16 red LED's, controllable by CPU for power reduction
- Field Terminations Four 8 pole, removable terminal blocks, 12 to 22 AWG 15 amp contacts.
- Dimensions: 8.37 inch (215 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep.
- \$ Mounting: 7.5x 35 DIN rail
- \$ Packaging: Corrosion resistant zinc plated steel with black enamel paint
- \$ Environment: 5% RH to 95% RH, non-condensing -40°C to 60°C/140°F.
- Bell 202 Radio or Leased Line Modem: The Bell 202 Radio or Leased Line Modem shall convert RS-232 signal levels to audio tones for transmission over radios, two wire networks, four wire multipoint networks, and four wire point-to-point networks. Each signal shall be capable of being wired for active high or active low signals. Each modem shall have configurable carrier detect and loss delays, and RTS/CTS delays. The Bell 202 Radio or Leased Line Modem shall be protected against inadvertent sustained transmission through a user selected anti-streaming timer. Configuration switches shall be provided that permit adjustment of carrier detection and loss delays, anti-streaming time, soft-carrier turn-off tones, RTS/CTS handshake timing, and full/half duplex selection. The following technical specifications are minimum requirements.
 - S Modulation: Bell 202 FSK, mark = 1200 Hz, space = 2200 Hz, soft carrier turnoff = 900 Hz
 - S Data Rate: DC to 1200 baud
 - \$ Transmit Level -35 dBm to 0 dBm, potentiometer adjustable, factory set at 0 dBm
 - \$ Input/Output Impedance: 600 ohm balanced, transformer isolated
 - \$ Duplex Full or half. Half requires DTE to implement hardware RTS/CTS handshake
 - \$ Wires: Two or four
 - Receive Sensitivity: -30 dBm to +3 dBm, potentiometer adjustable to -40 dBm
 - \$ Receive Dynamic Range: 45 dB

RTS/CTS Delay Wire: 25mS, 50mS, 125mS, 250mS Radio: 67mS, 133mS, 266mS, 1000mS

- \$ CTS Hold Time: 1mS, 8mS
- \$ Transmit-Receive Turnaround Delay: 3-10mS
- \$ Soft Carrier Tone Transmit Time: None, 13mS, 25mS, 38mS
- \$ Soft Carrier Turnoff Detect Time: 4-10mS
- \$ Radio Transmit Key Output: Optical coupler open collector transistor, 5-15V, 25mA

Ş		Radio Carrier Detect Input: Optical coupler LED input, 5V @ 1mA, 12V @ 3mA, 24V @ 7mA	
\$		Radio Carrier Detect Input Mode: Use or ignore	
\$		Carrier Detect Delay: Wire; 19mS, 30mS, 51mS, 92mS, Radio; 33mS, 67mS, 133mS, 265mS	
\$		Carrier Loss Delay: 6mS, 10mS, 23mS, 39mS	
\$		Anti-Streaming: None, 10 Sec, 30 Sec, 60 Sec	
\$		Visual Indicators: TD (transmitted data), RD (received data), CS (clear-to-send), RS (request-to-send) CD (carrier detect), KEY (radio transmit key)	
Ş		Test Modes: Half duplex test pattern transmission Full duplex loopback Self-diagnostic test	
\$		Dimensions: 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep	
\$		Terminations: 8 pole, removable terminal block, 12-22 AWG, 15 amp contacts RJ-45	
\$		Power Requirements: 5V @ 60 mA	
\$		Mounting: 7.5 x 35 DIN rail	
\$		Packaging: Corrosion resistant zinc plated steel with black enamel paint	
\$		Environment 5% RH to 95% RH, non-condensing -40°C/F to 60°C/140°F	
Ethernet Gateway: The Ethernet Gateway shall support RS-232 using RTS/CTS handshaking. Capabilities shall be provided for multi-drop communications over RS-485, or half-duplex modems and radios allowing up to 255 Modbus slave devices to be connected to each gateway. The following technical specifications are minimum requirements.			
\$		LAN Compatibility Ethernet: Version 2.0/IEEE 802.3	
\$		Network Protocols: IP, ARP, TCP, SNMP, TFTP, DHCP	
\$		SCADA Protocols: Modbus RTU or ASCII	
\$		RS-232/485 Data Rate: 300 to 38,400	
D	ouplex:	Full or half. Half requires the DTE to implement hardware RTS/CTS handshake	
\$		RTS/CTS Delay: Settable during configuration	
\$		RTS Hold Time: Settable during configuration	

\$ Configuration: Telnet over Ethernet or locally connected terminal emulator. Firmware may be updated over the network using TFTP client.

- Visual Indicators: Ethernet Link Status, Tx (transmit serial data), Rx (received serial data), Error & Status.
- Dimensions: 4.25 inch (108 mm) wide x 4.625 inch (118 mm) high x 1.75 inch (44 mm) deep
- \$ Ethernet Termination: RJ-45, 10Base-T (twisted pair), 10M bits/second.
- \$ RS-232 Termination: DE9P connector
- \$ RS-485 Termination: Removable terminal strip
- \$ Power Requirements: 250mA @ 5V
- \$ Mounting: 7.5 X 35 DIN rail
- \$ Packaging: Corrosion resistant zinc plated steel with powder coating
- \$ Environment 5% RH to 95% RH, non-condensing 0°C/32°F to 50°C/122°F.
- Communications Capabilities: SCADA system shall be capable of supporting the following communication types: dedicated telephone, dial-up, fiber optics, cable TV, VHF, UHF, 800 MHZ trunking, or near-microwave radio, and RS-232/RS-485. Different communications types shall be capable of concurrent operation. Modification of communications type shall require only a modem change and minor communications database configuration changes only.

Communications for this project shall be via 900-1000 MHz preferred or, where not available, may be via VHF/UHF. Spread Spectrum radio may be used where Contractor provides acceptable radio path study for operation under all weather conditions and where path study is acceptable to Engineer.

Spare Parts: As part of this contract, the Contractor shall furnish a minimum of one (1) each of the following spare parts: CCU board, RTU board, I/O boards (one each type), modem, power supply, and radio transceiver. Parts shall be provided in a single package with each component power supply tagged. All cables or wiring assemblies such as ribbon cables, that are specific to this project and can not be purchased as complete assemblies shall be considered a required spare part.

I/O Listing

- 1. Digital Inputs
 - a. See plans for digital input requirements.
- 2. Digital Outputs
 - a. See plans for digital output requirements.
- 3. Analog Inputs

a. See plans for analog input requirements. 4. Analog Outputs

- a. See plans for analog output requirements.
- Allow for a minimum of five (5) each spare discrete inputs, five (5) each spare discrete outputs, five (5) each spare analog inputs and five (5) each spare analog outputs with complete circuits and devices (not including transmitters and analyzers) to be installed at no additional cost to Owner or, a minimum of 10% spares of each, whichever is greater.

See plans and specifications for additional I/O's.

2.04 SYSTEM SOFTWARE

- A. Provide Ladder Logic programming software specific applicable to RTU provided.
- 2.05 ENGINEERS DIAGNOSTIC AND PERFORMANCE EVALUATION
 - RTU system contractor shall provide means for Engineer to observe system setup, verify functional operation, view process and observe settings and data during warranty period of system and to evaluate the overall RTU system performance to assure compliance with the Plans and Specifications.
 - As a minimum requirements, the contractor shall provide the following to Engineer prior to the time system graphics are developed:

Networking software as required to access system via modem.

- Additional software required for complete analysis of RTU system operation, control, programming and set point adjustment.
- The means to access the RTU System via a standard dial-up type modem using the Engineers Computer.

2.06 PROGRAMMING PERIOD

- A. Contractor shall install all RTU's, CCU's, PLC's, PC's, and peripheral devices in a timely manner so as to allow the following time periods for program installations:
- RTU's, CCU's, and PLC's allow a minimum of ten (10) working days for downloading and testing.
- PC's and Screen Graphics: Allow a minimum of fifteen (15) working days for downloading programs and testing.
- Overall SCADA: Allow a minimum of ten (10) working days for overall SCADA systems testing after the above noted programming and testing has been completed.
- Failure to meet these schedules will be at expense of Contractor and at no additional cost to Owner. Project completion delays caused by Contractor's failure to meet these scheduled periods are at Contractor risk and expense and at no additional cost to Owner.

2.07 SPARE PARTS

A. Provide Owner with complete set of spare parts as recommended by the Manufacturer's Representative, J & E Instruments, (800) 779-5798.

PART 3 EXECUTION

- 3.01 GENERAL
 - Coordinate all work with the engineer/owner to avoid conflicts, errors, delays and unnecessary interference with operation of the existing system during installation, testing, cut-over and startup.
 - Install all new equipment in accordance with the manufacturer's instructions and approved submittals.
 - Where required, telephone lines shall be ordered as regular standard voice grade line without dial up for SCADA "Links". Advise Engineer in writing of exact type of telephone lines ordered, after consulting with Telephone Service Representative.
 - Field bridged lines may not be utilized by Telephone Company, where multiple SCADA RTU's are involved. Do not order special data telephone lines unless authorized by Engineer in writing.
 - Coordinate with Engineer before ordering any SCADA related lines. A Telephone Service Provider will be used under certain circumstances, depending on data line requirements, in which case Engineer will provide name for Contractor to coordinate with when ordering lines.
 - Provide adequate man-hour allowance for coordination with, Owner, and SCADA RTU Manufacturer.
 - All delays in programming due to SCAA component installation problems or malfunctioning devices or failure to deliver software promptly or failure to have SCADA components installed in a timely manner will be at the Contractor's risk and at no additional cost to Owner.

PART 4 WARRANTY

4.01 GENERAL

The SCADA system supplier shall warrant all hardware and telemetry software provided under this contract against all defects in material and workmanship for a period of three (3) years from "date of written acceptance" as described in specifications. The system supplier shall warrant the telemetry software to be free of defects for as long as it is in operation by the owner. The system supplier shall also provide free updates to this software for the_life of the system. The function modules utilized in the remote terminal units shall carry an additional 2-year return-to-factory warranty. The 2-year return-to-factory warranty shall cover damage due to lightning.

The SCADA System Supplier shall provide all necessary operation, use and development keys and licensing required for unlimited system operation, development, programming and maintenance.

1.00 PART 1 - GENERAL

- 1.0 THE GENERAL CONDITIONS, SPECIAL PROVISIONS and applicable requirements of DIVISION 1 GENERAL REQUIREMENTS are hereby made a part of this section.
- 1.1 SCOPE: This section covers excavation and supporting systems for trenches necessary to protect the safety of workers. This specification shall govern for construction of all types of trenches except where the requirements of this section are explicitly revised or superseded by another section. Additional requirements as set forth by federal, state, and local government regulations will be applicable and must be followed. The contractor shall be responsible for the design, placement, and inspection of all trench safety systems in conformance with the Occupational Safety and Health Administration (OSHA) standards as contained in Subpart P, Part 1926, Title 29 of the Code of Federal Regulations (29 CFR 1926). Other OSHA construction standards shall also apply.
- 1.2 Section 01420 contains a geotechnical engineering study with boring logs for your information. It is the Contractor's responsibility to determine and evaluate soil conditions at the site and design adequate trench safety systems. The Contractor will be responsible for detecting varying soil conditions which may be hazardous and take appropriate action. The contractor, at his expense, shall be responsible for obtaining any geological data required for his design of the trench safety system.
- 1.4 APPLICABILITY: These specifications apply to any trench excavation which is over five (5) feet in depth from the ground surface, or trench excavations that are less than five (5) feet in depth located in areas where unstable soil conditions are present (Ref. OSHA Safety and Health Regulations, Part 1926, Subpart P, Paragraph 29 CFR 1926.652, Subparagraph (a)).
- 1.5 LIABILITY: It is the Contractor's responsibility that all excavation work and site conditions are within the regulations as established by OSHA. Any property damage or bodily injury (including death) that arises from use of the trench safety systems, from the Contractor's negligence in performance of the contract work, shall remain the sole responsibility and liability of the Contractor.
- 1.6 EXISTING UNDERGROUND INSTALLATIONS: Underground installations are shown in approximate locations on the Drawings. It is the Contractors responsibility to verify the size, locations and elevations of all existing utilities in the construction area prior to commencement of excavation operations.
- 1.7 SURCHARGE LOADS: The Contractor's trench safety system shall be designed to take into account all surcharge loads including, but not limited to adjacent structures, contractor's equipment and heavily loaded truck traffic which will be routed near the work site.
- 2.00 PART 2 MATERIALS Not applicable.
- 3.00 PART 3 INSTALLATION Not applicable.

4.00 PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT/ PAYMENT: Trench Excavation Protection shall be measured by the lump sum for the trenching and excavations shown or implied in the plans.

SECTION 19000-TRENCH PROTECTION

- A. Payment shall include all components for design and construction of the Trench Protection System which can include, but not be limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage. Payment shall also include the additional excavation and backfill required, any jacking, jack removal, and removal of the trench supports after completion.
- B. Payment of all work prescribed under this item shall be full compensation for all additional excavation and backfill; for furnishing, placing and removing all shoring, sheeting, or bracing; for dewatering or diversion of water; for all jacking and jack removal; and for all other labor, materials, tools, equipment and incidentals necessary to complete the work.

END OF SECTION

19000 - Page 2 of 2