CONTRACT DOCUMENTS AND SPECIFICATIONS

FOR CONSTRUCTION OF

Lift Station Rehabilitation Project No. 1

Vol. II

Issued for Bid

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FREESE AND NICHOLS

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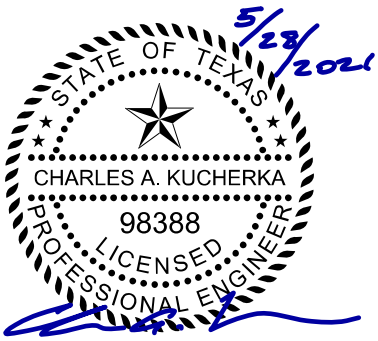
00 01 07 DESIGN PROFESSIONAL SEALS

	Specification Sections Sealed
	**DIVISION 02, 08, 09, 22, 31, 32, 33, 44** **SPECIFICATIONS** 40 05 53 “Identification for Process Piping and Equipment” 40 05 61 “Gate Valves” 40 05 65.23 “Swing Check Valves” 40 05 78 “Air Release and Air and Vacuum Valves”
FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	

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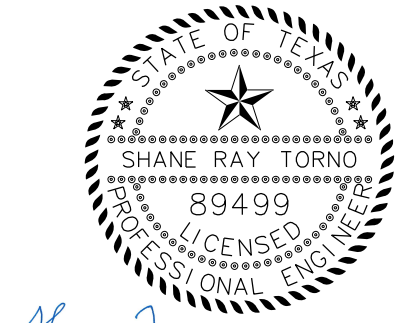 May 28, 2021	**DIVISION 03, 05** **SPECIFICATIONS** 31 05 23.13 Soil Cement 31 23 10 Structural Excavation and Backfill 31 64 00 Caisson Lift Stations 31 68 19 Foundation Drilling and Grouting
FREESE AND NICHOLS, INC. TEXAS REGISTERED ENGINEERING FIRM F-2144	

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 SQUARE E ENGINEERING, LLC TEXAS REGISTERED ENGINEERING FIRM F-12247	**DIVISION 26** **SPECIFICATIONS** 40 61 13 “Process Control System General Provisions” 40 61 13.01 “Control Systems PCS Software” 40 61 16 “Control Panels” 40 63 00 “Programable Logic Controls (PLCs)” 40 94 00B “Instrumentation (Lift Station No. 4)” 40 94 33 “Local Operator Interface (LOI)”

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DIVISION 02

EXISTING CONDITIONS

02 11 00 HANDLING ASBESTOS CEMENT PIPE

1.00 GENERAL

1.01 SUMMARY

A. This item shall govern for the removal, handling, disturbance, and disposal of asbestos cement (AC) pipe and other asbestos containing materials (ACM) related to the AC pipe work. AC pipe is also known as transite pipe. Since buried AC pipe typically contains approximately 15% to 20% chrysotile and crocidolite asbestos, it is considered to be an asbestos-containing material. The material is classified as non-friable, unless broken at which time its classification changes to friable ACM. The removal and/or disturbance of this material is governed by the National Emissions Standards for Hazardous Air Pollutants (NESHAP) and the Occupational Safety and Health Administration (OSHA).

B. This item shall consist of the handling, disturbance, removal and disposal of AC water pipe, joints, wrappings and other ACM. In order to comply with NESHAP and OSHA regulations, this project will require workers with specialized training using wet work procedures to cut and remove AC pipe, AC pipe joints, valves (any type) containing ACM and surrounding soils containing ACM. A Texas Department of Health (TDH) licensed Asbestos Consultant shall develop the asbestos work practices and monitoring in the Contractor's Health & Safety Plan to be reviewed by the Engineer. It is the contractor's responsibility to obtain the services of a licensed Asbestos Consultant authorized in the State of Texas and this work shall be considered subsidiary to this item.

C. To meet and/or exceed NESHAP and OSHA guidelines, the contractor will subcontract the AC water pipe handling to an Environmental Protection Agency (EPA) accredited and TDH licensed Asbestos Abatement Contractor and TDH Licensed Asbestos Consultants.

D. An alternative method would entail the disturbance, handling, repair, and disposal of the AC pipe by an authorized TDH licensed worker with the required course of an asbestos worker awareness class or a TDH required asbestos training course preparing workers to handle disturbed ACM. Review of the asbestos work practices and monitoring in the Contractor's Health & Safety Plan will still need to be performed by a licensed TDH Asbestos Consultant.

1.02 STANDARDS

All work under these specifications shall be done in strict accordance with all applicable Federal, State, and local Regulations, standards, and codes governing asbestos abatement and any other trade work done in conjunction with the asbestos abatement. The most recent edition of any relevant regulation, standard, or code shall be in effect. Where conflict exists between the regulations, standards, codes, or these specifications, the most stringent requirements shall be utilized. The Contractor shall comply with, at minimum, the following specific regulations:

A. Occupational Safety and Health Administration (OSHA)

Title 29 Code of Federal Regulations Section 1910.1001 – General Industry Standard for Asbestos
Title 29 Code of Federal Regulations Section 1910.134 – General Industry Standard for Respiratory Protection
Title 29 Code of Federal Regulations Section 1926 – Construction Industry
Title 29 Code of Federal Regulations Section 1910.2 - Access to Employee Exposure and Medical Records
Title 29 Code of Federal Regulations Section 1910.1200 – Hazard Communication

B. Environmental Protection Agency (EPA):

Title 40 Code of Federal Regulations Part 61 Subpart M – National Emission Standard for Asbestos.

C. Texas Department of Health:

Texas Department of Health - Texas Administrative Code, Title 25, Chapter 295, Subchapter C - Texas Asbestos Health Protection.
Texas Department of Health - Texas Administrative Code, Title 25, Chapter 325 - Texas Solid Waste Regulations.
Texas Department of Health - Texas Civil Statutes, Article 4477-A, Section 12, General Provisions 295.31 to 295.73.

D. American National Standards Institute (ANSI)

E. American Society for Testing and Materials (ASTM)

F. Department of Transportation - HM 181

1.03 SUBMITTALS

A. A Texas Department of Health (TDH) licensed Asbestos Consultant shall develop the asbestos work practices and monitoring in the Contractor's Health & Safety Plan to be submitted as Record Data and reviewed by the Engineer.

B. Prior to beginning work Contractor shall submit training records, certifications, medical records, and laboratory qualifications for employees and subcontractors working on the project as Record Data. Submit documentation satisfactory to the Engineer that the Contractor's employees, including foremen, supervisors and any other company personnel or agents who may be exposed to airborne asbestos fibers or who may be responsible for any aspects of asbestos disturbance activities, have received adequate training in compliance with applicable rules and regulations.

C. Asbestos abatement work plan in accordance with NESHAP, OSHA, and other applicable regulations developed by a Texas Department of Health (TDH) licensed Asbestos Consultant. Provide detailed asbestos specific safety and work plans for ensuring worker and community protection as Record Data.

D. Submit documentation satisfactory to the Engineer that an Initial and/or Negative Exposure Assessment in accordance with OSHA Standard 29 CFR 1911 has or will be performed (as applicable) as Record Data.

E. Submit documentation to the Engineer of a respiratory protection program for affected employees as per OSHA Standard 29 CFR 1910.134.

F. Name of OSHA monitoring Consultant/Lab. The Contractor will be responsible for air monitoring as required to meet OSHA Requirements.

G. Submit proof satisfactory to the Engineer that required permits, site location and arrangements for transport and disposal of asbestos containing waste materials have been made.

H. Air monitoring abatement report.

I. Submit copies to the Engineer of all transport manifests, trip tickets, and disposal receipts for all asbestos waste materials removed from the work area during the project. The Contractor will sign manifests as the CITY'S representative (generator) for the AC pipe and provide copies to Engineer for final payment.

J. Upon completion of the AC pipe project an abatement report shall be required by the contractor's asbestos consultant. Copies of the final abatement report shall be prepared and submitted to the Engineer by the contractor's consultant.

1.04 DEFINITIONS

A. Air Monitoring - The process of measuring the fiber concentration of a known volume of air collected during a specific period of time. The analysis procedure utilized for asbestos is the NIOSH Standard Analytical Method for Asbestos in Air, Method 7400. Transmission electron microscopy (TEM) may be utilized for lower detection limits and/or specific fiber identification.

B. Air Monitoring Technician - The person licensed by the Texas Department of Health to conduct air monitoring for an asbestos abatement project or related activity. The Air Monitoring Technician may only obtain air samples, and may only perform analysis of air samples with an upgraded Air Monitoring Technician License, which includes completion of the NIOSH-582 equivalent course. The air monitoring technician shall be an employee of a licensed asbestos laboratory or a licensed Asbestos Consultant agency.

C. Amended Water - Water to which a surfactant has been added.

D. Asbestos - The asbestiform varieties of serpentines and amphiboles. Specifically, chrysotile, crocidolite, grunerite, amosite, anthophyllite, actinolite, and tremolite.

E. Asbestos Containing Material (ACM) - Material or products that contain more than 1.0% of any kind of asbestos.

F. Asbestos Containing Waste Material - asbestos containing material or asbestos contaminated objects requiring disposal

G. Authorized Personnel - Any person authorized by the Contractor and required by work duties to be present in the work area or other regulated areas.

H. Authorized Visitor – Engineer's representatives, and any representative of a regulatory or other agency having jurisdiction over the project.

I. Asbestos Consultant - That person licensed by the Texas Department of Health to perform the following asbestos related functions:

1. Project design;

2. Asbestos surveys and condition assessment of ACM;

3. Asbestos Management Planning;

4. The collection of bulk material samples, airborne substance samples and the planning of sampling strategies;

5. Owner-representative services for asbestos abatement projects or O&M programs, including air monitoring and project management;

6. Consultation regarding regulatory compliance and all aspects of technical specifications and contract documents;

7. The selection, fit testing, and appropriate use of personal protection equipment and the development of asbestos related engineering controls.

J. Abatement Contractor - The company, agency, or entity licensed by the Texas Department of Health that has been retained by the Contractor to perform asbestos abatement and other associated functions.

K. Class II Asbestos Work (OSHA Standard) – Activities involving the removal of ACM, which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.

L. Competent Person – One who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them.

M. Encapsulant - A specific adhesive designed to lock down and minimize the fiber release of asbestos containing materials and asbestos contaminated materials.

N. Friable Asbestos - Asbestos-containing material, which can be crumbled to dust, when dry, under hand pressure, and includes previously non-friable material after such previously non-

friable material becomes damaged to the extent that, when dry, it may be crumbled, pulverized, or reduced to powder by hand pressure.

O. HEPA Filter - A high efficiency particulate air filter capable of removing particles > 0.3 microns in diameter with 99.97% efficiency.

P. NESHAP - The National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61).

Q. NIOSH - The National Institute for Occupational Safety and Health.

R. OSHA - The Occupational Safety and Health Administration.

S. Regulated Area – An area established by the Contractor to demarcate areas where asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos, exceed or there is a reasonable possibility they may exceed the permissible exposure limit.

T. Regulated Asbestos-containing Material (RACM) – (1) Friable asbestos material; (2) Category I non-friable ACM that has become friable; (3) Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading; or, (4) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by forces expected to act on the material in the course of the demolition or renovation operations regulated by 40 CFR Part 61, Subpart M.

U. Staging area – A pre-selected area where containerized asbestos containing waste material will be placed prior to removal from the project site.

V. Surfactant - A chemical wetting agent added to water to improve penetration.

2.00 PRODUCTS [NOT USED]

3.00 EXECUTION

A. The Work includes all Work specified herein, to include mobilization and demobilization, labor, materials, overhead, profit, taxes, transportation, disposal fees, administrative fees incidental cost, etc. Estimating areas, quantities, weight, etc., are the sole responsibility of the Contractor.

B. The Contractor shall remove, seal, transport and dispose of all impacted asbestos-containing materials in compliance with all current Federal, State and local regulations, laws, ordinances, rules, standards and regulatory agency recommended requirements. Asbestos disturbance and/or removal activities shall be conducted by properly trained, accredited, and licensed personnel using proper personal protective equipment.

C. The Contractor shall notify the Engineer, if applicable, at least 72 hours in advance prior to beginning removal and/or disturbance of the AC pipe. AC pipe disturbance shall be

conducted during regular business hours, Monday-Friday. No weekend work of AC pipe disturbance is allowed, unless special circumstances require the contractor to do so.

D. Time is of the essence in removing the asbestos-containing materials from the project area. All work must be completed within the time period specified. The Owner will be responsible for coordinating this work in high-density areas, such as schools, church facilities, and residential areas.

E. All required notifications required to state regulatory agencies will be made by the Contractor with copies provided to Owner, including but not limited to the TDH Demolition/Renovation Notification Form.

F. The Contractor shall have an on-site supervisor, who is an OSHA Competent Person, present on the job site at all times that the work is in progress. This supervisor shall be thoroughly familiar with and experienced at asbestos disturbance and other related work and shall be familiar with and shall enforce the use of all safety procedures and equipment. He shall be knowledgeable of all applicable EPA, OSHA, NIOSH and TDH requirements and guidelines.

G. Prior to commencing any preparation of the work areas for asbestos disturbance, the Contractor shall post all required documents, warning signs and, as necessary, erect physical barriers in order that the work area may be secured.

H. The Contractor has sole and primary responsibility for the “means and/or methods” of the work and obligation to the Owner to make inspections of the work at all stages and has sole responsibility to supervise the performance of the work.

I. The Contractor shall be responsible for site safety and for taking all necessary precautions to protect the Contractor’s personnel, the Engineer and Owner’s personnel and the public from asbestos exposure and/or injury. The Contractor shall be responsible for maintaining the integrity of the work area.

J. The Contractor shall confine operations at the site to the area requiring disturbance of AC pipe and the general site area associated with the proximity of the project. Portions of the site beyond areas on which the indicated work is required are not to be disturbed. The Contractor will not unreasonably encumber the site with materials or equipment. If asbestos containing waste materials are required to be stored overnight, it will be properly labeled, secured, and containerized to preclude unauthorized disturbance of the waste materials.

K. The Contractor shall be responsible for the transport and disposal of asbestos containing waste materials to a duly licensed landfill facility permitted to accept asbestos waste. The Contractor shall be responsible for obtaining and coordinating waste disposal authorization from a TCEQ licensed landfill. Waste manifests shall be used to transport the AC pipe from the project site to the final landfill disposal site. The Contractor will sign manifests as the Owner’s representative (generator) for the AC pipe and provide copies to the Engineer for final payment.

3.01 SITE SECURITY

A. The Contractor shall demarcate the area of AC pipe disturbance ("regulated area") with barrier tape and warning signs, as per OSHA regulation 29 CFR 1926.1101. Access to the regulated area will be limited to only authorized personnel. Authorized personnel will have to have asbestos awareness training, respiratory training, etc. including the Engineer and the Owner's personnel.

B. Entry into the work area by unauthorized individuals shall be reported immediately to Engineer by the Contractor.

C. A logbook shall be maintained immediately outside of the regulated area. Anyone who enters the regulated area must record name, affiliation, time in, and time out for each entry

3.02 PERSONAL PROTECTIVE EQUIPMENT

A. All work which will or may disturb asbestos-containing materials as specified shall be accomplished utilizing, as a minimum disposal suits with protective head cover, gloves, boots, eye protection, proper respiratory protection, decontamination by HEPA vacuuming and/or wet methods and wet wiping all equipment. The Contractor shall provide hard hats and/or other protection as required for job conditions or by applicable safety regulations. Disposal suits consisting of material impenetrable by asbestos fibers shall be provided to all workers and authorized visitors in sizes adequate to accommodate movement without tearing. Workers will be provided protective clothing from the time of first disturbance of asbestos-containing or contaminated materials until final cleanup is completed.

B. Respiratory Protection: The Contractor shall use removal techniques, methods and equipment which will not permit the fiber count to exceed the OSHA Permissible Exposure Level (PEL) of 0.1 fibers per cubic centimeter (f/cc) of air as detected by personal air sampling methods. Any remedial measures taken by the Contractor to meet this requirement will be at the Contractor's expense.

3.03 AIR MONITORING

A. Area air monitoring shall be conducted in accordance with applicable Federal, State, and local requirements. The cost of area air monitoring due to failure to use adequate wet work procedures will be borne by the Contractor. Copies of all results will be provided to the Engineer.

B. Personal Air Monitoring: The Contractor shall provide personal air sampling as required by OSHA regulations. Personal air samples shall be obtained by a TDH licensed Asbestos Air Monitoring Technician and analyzed by an accredited, independent TDH licensed Phase Contrast Microscopy (PCM) laboratory. OSHA monitoring results shall be posted at the project site and made available to all affected Contractor personnel on a daily basis.

C. The Contractor shall provide, as a minimum, personal air monitoring on each worker who is cutting, (wet) sawing, breaking, or repairing the AC pipe.

D. Area Air Monitoring: At any time that visible airborne fibers are generated or that wet work procedures are not used, all work will immediately cease until air monitoring by a TDH-

licensed Asbestos Consultant Agency has started. The Contractor's on-site Competent Person shall be responsible for making this determination. Once initiated, the sampling and frequency of the area air monitoring will be dependent upon on the specific work practices being used by the workers at that time. However, the area air monitoring shall include, as a minimum, samples collected inside the regulated area, and upwind and downwind of the regulated area. The TDH licensed Asbestos Consultant Agency hired by the Contractor shall determine the need for additional samples and shall amend the Health & Safety Plan (with a copy to the Engineer) to include sampling protocols.

3.04 EMPLOYEE TRAINING

A. Training shall be provided by the Contractor to all employees or agents who may be required to disturb asbestos containing or asbestos contaminated materials for AC pipe handling and auxiliary purposes and to all supervisory personnel who may be involved in planning, execution or inspection of such projects. The training shall be in accordance with OSHA Standard 29 CFR 1926.1101 for "Class II asbestos work".

B. At a minimum, Contractor employees who will be potentially exposed to asbestos shall have completed within the last 12 months, an 8-hour Asbestos Awareness training course taught by a TDH licensed Asbestos Training Provider. The training course shall cover topics including, but not be limited to: the health effects of asbestos and work practices related to the handling of AC pipe.

C. The Contractor's Competent Person shall have completed within the last 12 months, a 40-hour Asbestos Contractor Supervisor training course taught by a TDH licensed Asbestos Training Provider. The training course shall cover topics including, but not be limited to: the health effects of asbestos, employee personal protective equipment, medical monitoring requirements for workers, air monitoring procedures and requirements for workers, work practices for asbestos abatement, personal hygiene procedures, special safety hazards that may be encountered, and other topics as required.

3.05 AC PIPE HANDLING

A. The Contractor shall properly remove, handle, transport and dispose of all AC pipe specified in the bid documents/plans for this project. All work involving AC pipe and other ACM products must be addressed in Health and Safety Program documents. The Contractor shall take special care to prevent damage to the adjacent structures, materials and finished materials not required for demolition to access ACM. The Contractor shall limit his use of the premises to the work area indicated. Access to the work area shall be controlled by the Contractor. All electrical equipment, etc., shall have ground fault circuit interrupter (GFCI) protection. The Contractor shall properly demarcate, barricade and contain the work and/or regulated areas. The work consists of providing GFCI protection, the use of approved equipment with engineering controls, sufficiently wetting the asbestos containing materials using a surfactant or lock-down encapsulant, removing the asbestos-containing materials, HEPA vacuuming the work area, wet wiping the work area, double-bagging/double-wrapping the waste and removing carefully as indicated herein and in accordance with the Contractor-provided Health & Safety Plan.

B. Equipment used to cut, break, or otherwise disturb AC pipe and associated asbestos-containing materials may include, but are not limited to: wet-cutting saws, saws equipped with point of cut ventilator (saw equipped with a water mister) or enclosures with HEPA filtered exhaust air, snap cutters, manual field lathes, pressure and non-pressure tapping devices. Equipment used to either control visible emissions of fibers, contain the work area, or facilitate the clean-up of debris may include, but are not limited to: airless spray equipment, pump-up sprayers, surfactant, lockdown encapsulant, HEPA vacuums, brushes, brooms, shovels, disposable rags, polyethylene sheeting of 6-mil thickness, moisture resistant duct tape, asbestos warning signs, notices and barrier tape.

C. Disposal bags for RACM shall be of true 6-mil polyethylene, pre-printed with labels as required by EPA regulation 40 CFR 61.152 (b)(i)(iv) or OSHA requirement 29 CFR 1926.1101(k)(8).

D. Stick-on labels identifying the Generator's name (City of Alamo Heights) and address and the project site location shall be applied to any asbestos waste bags that contain RACM, as per EPA or OSHA and Department of Transportation HM 181 requirements.

E. Work Area Preparation: Post warning signs and barrier tape meeting the specification of OSHA 29 CFR 1910.1001 and 40 CFR 61 at any location and approaches to a location where airborne concentrations of asbestos may exceed the PEL. Signs shall be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure. Maintain constant security against unauthorized entry past warning signs and barrier tape. Signs will be in both English and Spanish.

F. Abandonment of AC water mains/pipes: The Contractor is responsible for isolating the existing mains to remain in service by capping, plugging and blocking as necessary. The opening of an abandoned ac water main and all other openings or holes shall be blocked off by manually forcing cement grout or concrete into and around the openings in sufficient quantity to provide a permanent watertight seal. Abandonment of old, existing AC water mains will be considered subsidiary to the work required, and no direct payment will be made unless a specific bid item has been identified in the bid proposal.

G. Abandonment of Valves that contain ACM: Valves to be abandoned in the execution of the work shall have the valve box and extension packed with sand to within eight (8") inches of the street surface. The remaining eight (8") shall be filled with 2,500 psi concrete or an equivalent sand cement mix and finished flush with the adjacent pavement or ground surface. The valves covers shall be salvaged and return to the Owner. The abandonment of valves containing ACM will be considered subsidiary to the work required, and no direct payment will be made.

H. Verification of Removal & Clean-up Procedures: The Contractor's onsite Competent Person shall inspect the work area and ensure that all surfaces are free of AC pipe dust and debris.

I. Disposal Procedures

1. If a dumpster/trailer is used for temporary storage it will be secured and closed at all times except when loading. It will be properly marked and critical barrier tape will be in place.

2. AC pipe debris and asbestos-contaminated items shall be properly double bagged, labeled and loaded in a fully enclosed, lined, locked and placard transport container and transported and disposed of in compliance with all regulatory requirements as RACM.

3. After being removed from the regulated area, Category II nonfriable AC pipe shall be transferred to a polyethylene-lined container. Remove all containers as soon as practical, but no later than the end of the work shift.

4. When the dumpsters/trailers are full, they will be hauled away to the closest EPA approved landfill for proper disposal. The Contractor may dispose of the Category II non-friable AC pipe waste material as non-regulated waste in a municipal solid waste landfill as defined in the NESHAP and TCEQ Rule (Type I Landfill). Written approval to transport and accept the Category II non-friable material shall be obtained from a pre-approved transporter and landfill and submitted to the Engineer prior to disposal.

5. Submit copies to Engineer of all transport manifests, trip tickets, and disposal receipts for all asbestos waste materials removed from the work area during the project. The Contractor will sign manifests as the Owner's representative (generator) for the AC pipe and provide copies to the Engineer for final payment.

END OF SECTION

02 41 00 DEMOLITION

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary for every type of required demolition.

B. Furnish equipment of every type required to demolish and transport construction debris away from the Site.

C. Coordinate all demolition work with Section 01 35 00 “Special Procedures” if required.

D. Items scheduled for demolition / removal have been indicated in the drawings.

1.02 STANDARDS

A. Work shall be performed in accordance with the codes and ordinances of the agency having authority over the Place of Record.

B. Occupational Safety and Health Association (OSHA), 29 CFR Parts 1010 and 1926, “Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite”, 40 CPR Part 61 - “National Emission Standard for Hazardous Air Pollutants”

1.03 DELIVERY AND STORAGE

Stockpile construction debris at the Site only as long as necessary to haul to a disposal site. Stack materials neatly and handle in an orderly manner until removed from the Site.

1.04 JOB CONDITIONS

A. Contractor shall visit the Site and determine the extent of demolition required and the Site conditions that might affect its proposal. Include costs of covering all aspects of the demolition as part of the proposal.

B. The Drawings shall be carefully reviewed to determine the extent of necessary demolition and to identify elements of the existing construction which are to remain in place. Report any discrepancies to Owner and Engineer before disturbing existing conditions. Property lines and limits of demolition shall be accurately located prior to beginning site demolition. Start of demolition activities shall represent confirmation by Contractor that existing conditions are as presented in the Contract Documents. Demolition outside the limits indicated on the Drawings, or outside the property lines shall not be performed.

1. For electrical demolition, verify field measurements and circuiting arrangements are as shown on the Drawings. Verify that existing wiring and equipment designated to be abandoned or demolished serve only abandoned facilities.

2. For process piping demolition confirm with the Owner that current operations will not be impacted and provide temporary equipment with Owner to keep systems functional during demolition process if required.

C. Material removed during demolition, and any equipment not otherwise designated to remain the property of the Owner, shall become the property of the Contractor, and shall be promptly removed from the Site.

D. Equipment and material designated as remaining the property of the Owner shall be removed from the structure and transported to a designated location on the Site and stored for the Owner's use. Store on wood runners raised above the surrounding grade and cover with weather resistant covering that is tied securely in place.

E. Take necessary precautions in removing Owner designated property to prevent damage during the demolition process. Equipment shall be removed in one piece. Loose components may be removed separately. Controls and electrical equipment may be removed from the equipment and handled separately. Large units, such as motor driven pumps, may be dismantled and motors handled separately. Do not use a cutting torch to separate the Owner's equipment or material. Salvaged piping shall be taken apart at flanges or fittings and removed in sections.

F. Coordinate with the Owner on items to be salvaged prior to demolition. Protect and deliver items to be salvaged to the Owner.

1.05 SUBMITTALS

A. Record Data for all required permits relating to demolition of existing structures.

B. Record Data for documented disposal of all demolished materials.

2.00 PRODUCTS

2.01 MATERIALS

New materials and equipment for patching and extending work shall meet the requirements of the individual Sections in these Contract Documents. For materials not addressed in these documents, materials used shall meet or exceed the dimensions and quality of the existing work.

3.00 EXECUTION

3.01 DEMOLITION

A. Lift Station, Force Mains, and Gravity Mains: All concrete, steel, wood and other debris from the demolition must be placed into approved containers, labeled, secured and removed from the work site and legally disposed of at Contractor's expense. Special care must be used to control sparks from torches. Fire watch is the Contractor's responsibility. Any damage to the surrounding area as a result of demolition activities must be repaired at Contractor's expense.

B. Foundations and Concrete Structures. Contractor must remove the structures to the depth indicated on the plans. Excavation created must be backfilled as indicated on the plans and compacted to 95% standard proctor density and covered with 6-inches of top soil.

3.02 HAZARDOUS MATERIALS

A. If hazardous waste is generated by the demolition activities, Contractor must follow Texas Commission on Environmental Quality (TCEQ) procedure and a Generator ID number must be obtained by the Contractor from EPA. If hazardous materials are encountered during demolition operations, comply with all applicable regulations, laws, and ordinances concerning removal, handling and protective against exposure of environmental pollutions.

B. There is a potential for asbestos piping in the area and the Contractor must provide services for abatement per Section 02 11 00 “Handling Asbestos Cement Pipe.”

C. Contractor must provide for asbestos abatement services of asbestos containing materials. The Contractor must include time for this asbestos abatement in the project schedule.

D. Contractor is to educate his workmen concerning the nature of asbestos and the requirement to leave encapsulated ACM in place, undisturbed. At any time that work is being performed in or around ACM, the Contractor must provide and install warning signs at identified ACM material to caution workmen of the presence of ACM.

3.03 SITE CLEARING

A. Perform site clearing to the limits indicated on the Drawings. Scrape the Site, removing brush, trees, weeds and trash. Haul debris away from the Site to an approved site as it accumulates.

B. Grub out tree and brush roots within the limits of buildings, parking lots, driveways and other structures. Remove rock out-croppings and boulders from any area within the limits of grading or structures. Remove roots and backfill any excavation resulting from tree removal with suitable soil for final grading plan.

C. Trees not located within the construction limits, or otherwise indicated for removal, shall remain in place. Visit the Site with the Engineer or Owner and identify those trees that are to remain. Mark all other trees with yellow paint to indicate removal. Protect remaining trees during construction. Wrap the tree trunks with 2 x 4 timbers if construction equipment must operate in close proximity to them.

D. Only designated trees shall be removed. In the event that trees other than those designated are erroneously removed or damaged to the point of distress, install replacement trees of equal size and number to compensate for those destroyed, at no additional cost to the Owner.

3.04 ELECTRICAL DEMOLITION

A. Prepare for demolition of electrical facilities as follows:

1. Coordinate utility service outages with the appropriate utility company.
2. Meet with Owner and identify any material to be salvaged.
3. Disconnect electrical systems scheduled for removal.
4. Provide temporary wiring and connections to maintain existing systems in service during demolition.

5. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

6. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Make temporary connections to maintain services in areas adjacent to work area. Minimize outage duration.

7. Existing Telephone System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner and telephone utility company at least 72 hours before partially or completely disabling system. Make temporary connections to maintain service in areas adjacent to work area. Minimize outage duration.

B. Remove all electrical components scheduled for demolition, including light fixtures, duplex receptacles, switches, and panelboards, complete with related feeders, conduit and wiring. Remove disconnect switches, motor starters, panelboards and related feeders. Cut conduit flush with walls and floors, and patch surfaces. Where electrical components are removed from an electrical circuit scheduled to remain in use, re-connect wiring and conduit as required to make the remaining circuit electrically continuous. Provide blank cover for abandoned outlets which are not removed.

C. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

D. Where conduit, piping, or other utilities are presently installed under concrete slabs and the underground portion of the component is to be abandoned in place, remove conduit or piping to a point 2 inches below level of concrete slab surface and cap off. Abandon under floor conduit and piping. Patch concrete as required to match surrounding area.

3.05 REMOVAL OF PIPE

Meet with Owner and identify any material to be salvaged. Remove pipe designated for salvage by carefully excavating surrounding backfill material. Remove pipe using protective measures which prevent damage. Piping shall be disconnected at joints, allowing removal in one piece. Salvaged pipe determined unsatisfactory for re-use by the Engineer may be removed in any manner. Suspended or supported pipe shall be disassembled at joints. Remove in sections without cutting. Welded pipe sections may be cut with a torch, but cuts shall be along a welded joint.

3.06 UNDERGROUND PIPING

A. Contractor shall be responsible for obtaining location of underground utilities at the Site. Arrange for all applicable utility companies to accurately locate underground piping and set color-coded flags along the pipe route. Investigate utility company's records to ascertain depths and sizes of piping and other ancillary features.

B. In the event that exact location of piping cannot be obtained, dig test holes as necessary to establish location of piping. Contractor shall not use mechanical digging machines within 6 feet of any active buried piping. For a distance of 4 feet on either side of buried piping, all digging shall be by hand excavation. If the piping is not active, or is to be abandoned or

removed, any form of excavation may be used. Any existing active piping that is damaged during demolition will be repaired to new condition by the Contractor at no additional cost to the Owner.

3.07 BACKFILLING

Backfill cavities resulting from demolition. Fill cavities occurring within the limits of buildings, structures, or pavements in accordance with the requirements of other Sections of the Specifications. Backfill and compact cavities outside the construction limits to the same density as the surrounding earth. No testing is required for backfill outside the limits of new construction.

END OF SECTION

02 96 00 TEMPORARY BYPASS PUMPING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to implement a temporary bypass pumping system for the purpose of diverting existing sewer flows around the work area regardless of number of locations, set-ups, length and duration, and shall be for the duration of the Project.

B. Contractor is responsible for providing a by-pass pumping system that meets local noise ordinances.

1.02 QUALITY ASSURANCE

A. Contractor shall demonstrate that the temporary bypass pumping system is in good working order and is sufficiently sized to successfully handle all sanitary sewer flows by performing a test run for a period of 24 hours prior to beginning Work.

B. Contractor shall be required to have all materials, equipment and labor necessary to complete the repair and/or replacement on the Site prior to isolating the sewer manhole or line segment and beginning flow diversion or pumping operations.

C. Contractor shall provide both a strobe light type, high level alarm, as well as alarm notification to their cell phones, as well as other appointed personnel to be identified by the Owner and ensure adequate alarm notification is attained prior to actual startup of the test period.

D. Contractor shall coordinate all activities through Engineer and Owner.

E. Bypass pumping is anticipated to be required at all lift station sites. Additional by-pass pumping locations may be required, such as at manhole tie-ins, etc. Contractor must field verify and provide by-pass pumping as required to complete the project per the Contractor's means and methods and as approved by the Engineer.

F. Lift station by-pass pumping plans:

1. Lift Station No. 4

   Bypass pumping shall begin at the nearest upstream manhole and discharge to the existing 10" PVC force main from Lift Station No. 4 that runs approximately 13,645 linear feet and discharges at a manhole upstream of Lift Station No. 11.

2. Lift Station No. 15

   Bypass pumping shall begin at the nearest upstream manhole and discharge to the existing 6" asbestos concrete force main from Lift Station No. 15 that runs approximately 1,025 linear feet and discharges at a manhole upstream of Lift Station No. 16.

3. Lift Station No. 17

   Bypass pumping shall begin at the nearest upstream manhole and discharge to the existing 6" asbestos concrete force main from Lift Station No. 17 that runs

approximately 980 linear feet and discharges at a manhole upstream of Lift Station No. 16.

4. Lift Station No. 35

   Bypass pumping shall begin at the nearest upstream manhole and discharge to the existing 6" PVC force main from Lift Station No. 35 that runs approximately 600 linear feet and discharges to a manhole upstream of Lift Station No. 11.

G. Hickman Road by-pass pumping plan:

1. Bypass pumping shall begin at the nearest upstream manhole and discharge to the proposed manhole installed downstream of the gravity main replacement as indicated on the plans.

1.03 SUBMITTALS

A. Make submittals required by this Section under the provisions of Section 01 33 00 "Document Management."

B. Manufacturer's product data, instructions, recommendations, Shop Drawings, and necessary certifications in order for the proposed Temporary Bypass Pumping Plan to be reviewed. The plan shall include, but not be limited to, the following:

1. Staging areas for pumps.
2. Sewer plugging method and types of plugs.
3. Number, size, material, location and method of installation of suction piping.
4. Number, size, material, location and method of installation of discharge piping.
5. Bypass pump sizes, capacity, number of each size to be on site, including spare pump, and power requirements.
6. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted based on bypass pumping schedule at the end of this Section).
7. Standby power generator size and location.
8. Downstream discharge plan.
9. Calculations for selection of bypass pumping pump size.
10. Method of noise control for each pump and/or generator if required.
11. Method of protecting discharge manholes or structures from erosion and damage.
12. Schedule for installation and maintenance of bypass pumping lines.

2.00 PRODUCTS

2.01 MATERIALS

A. Contractor shall provide all necessary pumping equipment, piping and all other necessary appurtenances in order to maintain adequate and reliable sanitary sewer flow in the sewer system (excluding manholes) at all times during construction. All materials, equipment, etc.,

must be in good condition and should not have visible damage such as cracks, holes, foreign material, blisters, etc.

B. Pipe material shall be High-Density Polyethylene (HDPE) for all bypass piping. HDPE must be used when bypass discharge piping will be going through streams, storm water culverts, and/or environmentally sensitive areas.

1. HDPE pipe must be assembled and joined using couplings, flanges or fusion welding in order to avoid joint leakage.

2. HDPE fusion welding must be performed by personnel certified as fusion technician(s) by the manufacturer of HDPE pipe and/or fusing equipment.

3. The bypass pumping plan shall indicate the proposed DR of the pipe to be used.

C. Pipe material other than HDPE shall be submitted to the Engineer for approval. Neither "irrigation type" pipe nor glued PVC pipe will be permitted.

D. Plugs must be selected and installed according to the size of the line to be plugged. An additional plug must be on-site and ready to be installed in the event a plug fails or becomes dislodged. Plug(s) will be reviewed by the inspector and/or Engineer for defects that might lead to failure prior to being installed. It is also imperative that the Contractor notify the inspector at the completion of the Work in order to verify that all plugs have been removed from the system.

2.02 EQUIPMENT

A. Pumps must be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps to prime the system. Pumps may be electric or diesel powered. The primary pump must be a grinder or chopper pump, in order to reduce the potential for debris to complicate the safe operation of the pumps.

B. Contractor shall have one backup pump, equal in capacity to the largest pump in the system, connected to the temporary bypass pumping system and ready for operation in case any of the primary pumps fail. The backup pump shall not be used in Contractor's calculations for determining the pumping capacity requirements for the stated flow conditions.

C. Provide sound-attenuated pump enclosure for bypass operations.

1. Sound levels shall be no greater than 60 decibels measured from the nearest property line.

2. Owner may require Contractor to construct additional measures to limit noise including but not limited to plywood walls with insulating foam around pumps, generators, etc. All measures to control sound shall be at no additional cost to Owner.

D. Vibration controls are required for all pumps.

3.00 EXECUTION

3.01 PREPARATION

A. Obtain the Engineer's approval of location of bypass pipelines, staging areas and pump locations prior to installation.

B. Obtain approvals for placement within public or private property.

3.02 CONSTRUCTION, INSTALLATION, AND REMOVAL

A. During construction, it will be the Contractor's responsibility to maintain a safe and secure environment at all times. All provisions and/or requirements of the temporary bypass pumping plan must be followed throughout the course of any bypass flow operations. Contractor must notify the Owner 72 hours prior to commencing the bypass pumping operations.

B. Contractor shall provide continuous supply on-site fuel storage sufficient for 24-hour operation of the bypass pumping installation.

C. Contractor shall protect all components of the bypass operations from vandalism and vehicular damage by making the site secure.

D. Contractor shall minimize sewer odors by using lids, shroud covers, or any method approved by the Inspector or Engineer.

E. Contractor shall be solely responsible for any and all damages to private and/or public property caused by or during the installation, operation, and/or removal of the bypass pumping system.

F. All piping, joints and accessories shall be designed to withstand at least twice the maximum system pressure, or a minimum of 50 psi, whichever is greater.

G. During flow diversion and/or pumping, no sewage shall be leaked, dumped, or spilled in or onto, any area outside of the existing sanitary sewer system.

H. When flow diversion and/or pumping operations are complete, all pumping shall be drained into the sanitary sewer prior to disassembly and all flow management components shall be removed.

3.03 BYPASS PUMPING SCHEDULE

A. By-pass pumping flows have been indicated in the plans and are based on modeled flows.

B. Refer to Section 01 35 00 "Special Procedures" for bypass sequencing.

END OF SECTION

DIVISION 03

CONCRETE

03 21 00 REINFORCING STEEL

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor and reinforcing materials required to cut, bend, tie, splice, place and support the reinforcement in the material grades, sizes, quantities and locations specified.

1.02 QUALITY ASSURANCE

A. Tolerances:

1. Reinforcement shall be placed where specified, with the following maximum tolerances, plus or minus:

a. Concrete Cover: 1/4 inch.

b. Rebar Spacing: 1/4 inch in 12 inches.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings:

a. Reinforcing bar layout drawing with bar lists clearly marked and referenced to the Drawings. Include:

1). Material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement.

2). Additional reinforcement required for openings through concrete structures.

2. Record Data: Manufacturers’ literature for specified products.

3. Certified Test Reports:

a. Certification of steel quality, size, grade and manufacturer’s origin.

1.04 STANDARDS

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

1. ASTM International (ASTM) Standards:

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

2. American Concrete Institute (ACI) Publications:

ACI 301	Specification for Structural Concrete
ACI SP-66	ACI Detailing Manual

ACI 318	Building Code Requirements for Structural Concrete

3. Concrete Reinforcing Steel Institute (CRSI) Publications:

CRSI	Manual of Standard Practice

1.05 DELIVERY AND STORAGE

A. Store steel reinforcement above the surface of the ground upon platform skids or other supports. Protect from mechanical and chemical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the Work, steel reinforcement shall be free from dirt, scale, dust, paint, oil and other foreign material. Tag and store steel reinforcement for ease of correlation with Shop Drawings.

1.06 JOB CONDITIONS

A. Proposed deviations from reinforcing indicated on the Drawings or Specifications shall be approved in writing by the Engineer prior to fabrication.

B. Lap lengths shall be of the length shown on the Drawings or noted in lap and embedment table, and shall be in compliance with ACI 318.

C. Specified cover for reinforcing shall be maintained throughout construction. Bars shall be cut to lengths necessary to allow for proper clearances. Cover of concrete shall be measured from face of forms to outside face of reinforcement.

D. Stirrups shall be hooked.

2.00 PRODUCTS

2.01 MATERIALS

A. Steel Reinforcing Bars: Billet-Steel bars for concrete reinforcement conforming to ASTM A615; Grade 60, deformed, with minimum yield strength of 60,000 psi. Steel reinforcing bars shall be produced in the United States of America.

B. Welded Wire Reinforcement: Not in project.

C. Weldable Reinforcing Bars: ASTM A706/A706M, Grade 60, deformed.

D. Joint Dowel Bars: Plain-steel bars, ASTM A615/A615M, Grade 60. Cut bars true to length with ends square and free of burrs.

E. Epoxy-Coated Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60, plain-steel bars.

F. Supports (Chairs): Bar supports shall be of the proper type for the intended use.

1. Exposed Surface: CRSI Class 1 **–** Maximum Protection – uniform high density polyethylene (plastic) or fiberglass reinforced plastic (FRP). Plastic protected wire bar supports are not allowed.

2. Unexposed Surface: CRSI Class 3 – No Protection.

G. Spacers: Precast mortar blocks with a 28-day compressive strength that is greater than the specified concrete strength in which the blocks are being placed.

H. Mechanical Bar Splices: Cadweld splices as manufactured by Erico Products, Inc., or approved equal, installed in strict accordance with the manufacturer's instructions and recommendations. The mechanical devices shall develop at least 125 percent of the specified yield of the spliced bars.

I. Mechanical Threaded Splices: Mechanical threaded connections shall utilize a metal coupling sleeve with internal threads which engage threaded ends of the bars to be spliced and shall develop in tension or compression 125 percent of the specified yield strength of the bar.

J. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

2.02 FABRICATIONS

A. Bending: Reinforcement shall be bent cold by machine to shapes indicated on the Drawings; true to shapes indicated; irregularities in bending shall be cause for rejection. Unless otherwise noted, all hook and bend details and tolerances shall conform to the requirements of ACI SP-66 and ACI 318.

3.00 EXECUTION

3.01 PREPARATION

A. Before any concrete is placed, all mortar blocks to be used for holding steel in position adjacent to formed surfaces shall be cast in individual molds, after which time the blocks shall be immersed in water for the remainder of at least a 4-day curing period. The blocks shall be cast with the sides beveled and in such a manner that the size of the block increases away from the surface to be placed against the forms. Blocks shall be in the form of a frustum of a cone or pyramid. Suitable tie wires shall be provided in each block for anchoring the block to the reinforcing steel, and to avoid displacement when placing the concrete. The size of the surface to be placed adjacent to the forms shall not exceed 2-1/2 inches square or the equivalent thereof when circular or rectangular areas are provided. Blocks shall be accurately cast to the thickness required, and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Shop- or field-weld reinforcement according to AWS D1.4, only where indicated and only weldable reinforcement.

3.02 INSTALLATION

A. General: Place the reinforcement carefully and accurately in the concrete structures. Rigidly tie and support the reinforcement. Welding of any type of reinforcement shall not be permitted.

B. Splices:

1. Splicing of bars, except where indicated on the Drawings, shall not be permitted unless approved by the Engineer prior to fabrication. Splices shall be kept to a minimum. Splices shall preferably occur at points of minimum stress. Lap splices which are permitted shall have a lap in accordance with ACI 318. Rigidly clamp or wire the bars at all splices, in accordance with ACI. Overlap sheets of wire fabric sufficiently to maintain a uniform strength and securely fasten.

2. Welding of reinforcing steel splices shall not be permitted.

3. Make mechanical splices where shown on the Drawings using Cadweld splices or approved equal, installed in accordance with the manufacturer's instructions and recommendations. The mechanical device shall develop at least 125 percent of the specified yield strength of the bar.

C. Placement:

1. Place steel reinforcement, as indicated on the Drawings with the specified tolerances. Hold securely in place during the placing of the concrete. The minimum clear distance between bars shall be per ACI 318 unless noted otherwise. Always pass vertical stirrups around the main tension members and securely attach thereto. Wire reinforcing together at a sufficient number of intersections to produce a sound, sturdy mat or cage of reinforcement that will maintain the reinforcement in correct positions when the concrete is placed.

2. Hold the reinforcing steel in concrete slabs firmly in place with wire supports or "chairs." Sizing and spacing of the chairs shall be sufficient to properly support the steel, and shall be in accordance with CRSI Publications "Manual of Standard Practice in."

3. Space the reinforcing steel in concrete walls the proper distance from the face of the forms, as indicated on the Drawings:

   a. For wall surfaces exposed to view, use chairs.

   b. For wall surfaces not exposed to view, use chairs or precast mortar blocks.

4. Where reinforcing conflicts with location of anchor bolts, inserts, etc., submit prompt notifications so that revisions can be made before concrete is placed. No cutting of reinforcing shall be permitted without the prior approval of the Engineer.

5. Welded wire shall be fabricated flat sheets, in longest practical lengths. Lap joints one mesh. Do not locate end laps over beams of continuous structures or midway between supporting beams. Offset end laps of adjacent widths to prevent continuous lap. Fasten ends and sides of welded wire fabric at 48 inches O.C. with tie wire.

6. Reinforcing shall extend through construction joints.

7. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.03 FIELD QUALITY CONTROL

A. Concrete shall not be placed until the Engineer has observed the final placing of the reinforcing steel, and has given permission to place concrete.

END OF SECTION

03 30 00 CAST-IN-PLACE CONCRETE

1.00 GENERAL

1.01 SUMMARY

A. Furnish labor, materials, mixing and transporting equipment and incidentals necessary to proportion, mix, transport, place, consolidate, finish, and cure concrete in the structure.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, slag cement, silica fume, and metakaolin; subject to compliance with requirements.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawings for:

a. Mix design: For each concrete mix, complete the form “Concrete Mix Design” and one of the following forms: “Documentation of Required Average Strength – Field Strength Test Record” or “Documentation of Average Strength – Trial Mixtures.”

b. Submit a schedule to the Owner’s representative which shows the sequence of concrete placements.

2. Certified Test Reports for:

a. Materials used in the trial mix design.

b. Water: Verification that all potable mix water and curing water sources do not exceed the non-potable water limits listed in ASTM C1602 Table 2.

c. Aggregate, conforming to ASTM C33, including the test reports for soundness and abrasion resistance.

d. Aggregate:

1). Verification that aggregate is not “potentially reactive” per ASTM C1260.

2). Or a cement chemical analysis indicating that the total alkali content is acceptable per Paragraph **[2.02.A]**.

e. 7-day and 28-day compressive strength tests results.

1). When more than 15, 28-day compressive tests results are available from the current Project for a given class of concrete, include the 15-test running average compressive strength versus the required average compressive strength (based on the previous 15 tests) in graphical form.

3. Record Data for:

a. Manufacturer’s literature on specified materials.

b. Documentation indicating conformance with ASTM C94 requirements.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications:

1. A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.

2. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code—Steel Reinforcing Bars."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver cement in bulk or bags which are plainly marked with the brand and manufacturer's name. Immediately upon receipt, store cement in a dry, weather-tight, and properly ventilated structure which excludes moisture. Storage facilities shall permit easy access for inspection and identification. Cement not stored in accordance with the requirements shall not be used.

B. Sufficient cement shall be in storage to complete placement of concrete started. In order that cement may not become unduly aged after delivery, maintain records of delivery dates. Use cement which has been stored at the Site for 60 days or more before using cement of lesser age. No cement shall be used which is lumped, caked, stored more than 90 days, or whose temperature exceeds 170 F.

1.06 STANDARDS

A. Mixing, sampling, placing, curing and testing of concrete, and the materials used shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents. The Contractor shall maintain one copy of each of the applicable standards at the construction field office.

1. ASTM International (ASTM) Standards:

ASTM Standards	
ASTM C31	Standard Practice for of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM Standards	
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C87	Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94	Standard Specification of Ready Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C156	Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C579	Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C806	Standard Test Method for Restrained Expansion of Expansive Cement Mortar

ASTM Standards	
ASTM C827	Standard Test Method for Change in Height at Early Stages of Cylindrical Specimens of Cementitious Mixtures
ASTM C845	Standard Specification for Expansive Hydraulic Cement
ASTM C878	Standard Test Method for Restrained Expansion of Shrinkage Compensating Concrete
ASTM C881	Standard Specification for Epoxy Resin Base Bonding Systems for Concrete
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	Standard Specification for Silica Fume used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2240	Standard Test Method for Rubber Property Durometer Hardness
ASTM D6690-07	Standard Specification for Joint and Crack Sealant, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

2. American Concrete Institute (ACI) Standards:

ACI Standards	
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavy-weight, and Mass Concrete
ACI 301	Specification for Structural Concrete
ACI 304	Guide for Measuring, Mixing, Transporting & Placing Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 318	Building Code Requirements for Structural Concrete

3. Federal Specification:
    a. TT S 00227E - Type II, Class A or B, Expansion Joint Sealant.
4. Concrete Plant Manufacturers Bureau (CPMB) Standards:
    a. Concrete Plant Standards.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
    1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
    2. Products: Subject to compliance with requirements, provide one of the products specified.
    3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
    4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONCRETE MATERIALS

A. Cementitious Material; General: If the fine and/or coarse aggregates test "Potentially Reactive", in accordance with ASTM C1260, then a low alkali cementitious material shall be used. A low alkali cementitious material shall be such that, the Sodium Oxide Equivalent ($N_{a2}O_{eq}$) shall not exceed 0.6 percent of the total cementitious material content.

B. Cement; Type:
    1. Type II or I/II Portland cement, conforming to ASTM C150; used for all concrete, unless noted otherwise.
    2. Type "II" Portland cement, modified so that C3A is not more than 5 percent; shall be used for all concrete in the following structures:
        a. caissons.

C. Supplementary Cementitious Materials (SCM):
    1. Fly Ash/Pozzolans: Conforming to ASTM C618, Class F fly ash; used in all classes of concrete.
    2. Slag Cement: Conforming to ASTM C989, Grade 100 or 120.
    3. Silica Fume: Conforming to ASTM C1240:
        a. Manufacturers, Products:
            1). MasterLife SF 100; BASF Corporation.
            2). Force 10000 D; GCP Applied Technologies.

3). Approved equal.

D. Coarse Aggregate:

1. Crushed stone or gravel conforming to ASTM C33, in the gradation size specified.
   a. Class: Negligible weathering region, but not less than 1N.
   b. Aggregate shall have a coefficient of thermal expansion (CoTE) of 4.5 microstrain per degree Fahrenheit.
2. For gradation size number 57, the maximum aggregate size of 1 inch is:

Sieve Size	Percent Retained	Percent Passing
1-1/2”	0	100
1”	0-5	95-100
1/2”	40-75	25-60
No. 4	90-100	0-10
No. 8	95-100	0-5

3. For gradation size number 67, the maximum aggregate size of 3/4 inch is:

Sieve Size	Percent Retained	Percent Passing
1”	0	100
3/4”	0-10	90-100
3/8”	45-80	20-55
No. 4	90-100	10-10
No. 8	90-100	0-5

E. Fine Aggregate:

1. Washed and screened natural sands or sands manufactured by crushing stones; conforming to ASTM C33. The gradation in ASTM C33 for air entrained concrete is:

Sieve Size	Percent Retained	Percent Passing
3/8”	0	100
#4	0-5	95-100
#8	0-20	80-100
#16	15-50	50-85
#30	40-75	25-60
#50	70-90	10-30

2. Fine aggregate shall have not more than 45 percent retained between any two consecutive sieves. Its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

F. Normal-Weight Aggregate for Slab-on-Grade: ASTM C33, combined gradations as follows:

1. 8 to 22 percent for 3/4-inch or 1-inch stone.
2. 8 to 15 percent for #30 and #50 sieve.
3. 0 to 4 percent on top size sieve.
4. 1-1/2 to 5 percent on the #100 sieve.

G. Water: Potable and complying with ASTM C1602 and ASTM C1602 Table 2.

2.03 ADMIXTURES

A. Measure and dose admixtures in accordance with manufacturer's recommendations.

B. Air Entraining Admixture: Conforming to ASTM C260.

C. Water Reducing Admixtures: Conforming to ASTM C494; Types A or D.

D. Set Retarding Admixtures: Conforming to ASTM C494; Types B and D.

E. Water Reducing Admixtures, High Range (HRWR): High Range Water Reducer shall comply with ASTM C494, Type F or G. HRWR shall be added to the concrete mix at the concrete batch plant. HRWR may not be added at placement site except to redose a batch and only after approval of the HRWR manufacturer. The high range water reducing admixture shall be able to maintain the plasticity range without significant loss of slump or rise in concrete temperature for 2 hours. Other admixtures may only be used with the HRWR if approved by the HRWR manufacturer. A representative of the HRWR manufacturer shall be present during any large placement, placement of slabs, or during times of unusual circumstance which may require changes to the product formulation.

1. Manufacturers:
    a. BASF Corporation.
    b. GCP Applied Technologies.
    c. Sika Corporation.

F. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products:
    a. MasterLife CI 222; BASF Corporation.
    b. DCI or DCI S, GCP Applied Technologies, Inc.
    c. FerroGard-901; Sika Corporation.
    d. Approved equal.

2.04 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Unless indicated otherwise, provide the following configurations.

1. Construction Joints:
    a. Profile: Ribbed without center bulb.
    b. Width: 6 inches.
    c. Minimum thickness: 3/8 inch.
2. Expansion Joint:
    a. Profile: Ribbed with center bulb.
    b. Width: 9 inches.
    c. Minimum thickness: 3/8 inch.
3. Manufacturers:
    a. Sika Greenstreak and Sika Westec Barrier Technologies.
    b. W.R. Meadows, Inc.
    c. Paul Murphy Plastics Co.
    d. Progress Unlimited Inc.
    e. DCA Construction Products, LLC: Durajoint Waterstop.
    f. Vinylex Corporation.

B. Self-Expanding Strip Waterstops (Hydrophilic): Self-expanding strip waterstops shall be used only where specifically indicated. Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophilic material for adhesive bonding to concrete.
1. Products:
    a. De Neff Swellseal Joint; GCP Applied Technologies.
    b. Adeka Ultra Seal; Mitsubishi International Corporation.
    c. Sika Hydrotite; Sika Corporation – U.S.

2.05 RELATED MATERIALS

A. Joint Materials for Water-Retaining Structures:
1. Pre-molded, resilient, non-bituminous expansion joint filler conforming to ASTM D1752, Type “II”, in the thickness specified.
2. Joint sealer conforming to ASTM D6690.
3. Expansion joint sealant for non-potable water shall be a two-component, non-sag, polysulfide-base, elastomeric sealing compound. The material shall conform to Federal Specification TT S 00227E, Type “II”, Class B; installed according to the manufacturer’s recommendations. Backing material for sealant shall be a rod of a diameter and composition recommended by the sealant manufacturer.
4. Expansion joint sealant for potable water shall be a two-component, non-sag, polysulfide sealant containing no lead or mercury; conforming to Fed. Spec. TT S 00227E, Type “II”, Class A; applied according to the manufacturer’s specifications.

Backing material for sealant shall be a rod of a diameter and composition recommended by the sealant manufacturer.

5. Where surface is to receive a swept in grout topping, a 3-inch wide, 1-mil polyethylene strip shall be placed above the joint sealant and held in place with 1-inch wide polyethylene tape spaced at 12-inch centers (maximum).

B. Joint Materials for Non-Water-Retaining Structures:

1. Bituminous-type, preformed, expansion joint filler; conforming to ASTM D994.

2. Pre-molded, resilient, non-bituminous expansion joint filler conforming to ASTM D1752, Type "II", in the thickness specified.

C. Bonding Agents: Install according to the manufacturer's recommendations and written instructions.

1. Bonding agent shall be Sika Armatec 110 EpoCem by Sika Corporation.

D. Non-Shrink Grout:

1. General: Non-shrink grout for grouting of pump, motor, and equipment baseplates or bedplates, column baseplates, other miscellaneous baseplates, piping block outs and other uses of grout. Grout shall meet the following requirements, as verified by independent laboratory tests:

a. No shrinkage from the time of placement, or expansion after set, under ASTM C827 and CRD C621 83 (Corps of Engineers). When non-shrink grouts are tested under CRD C621 83, the grout shall be tested in a fluid state. A fluid state shall be defined as flowing through a flow cone at a rate of 20 seconds, plus or minus 5 seconds.

b. An initial set time of not less than 45 minutes under ASTM C191.

2. Non-Shrink Epoxy Structural Grouts: Furnished in two components from the factory and mixed on the Site; conforming to ASTM C579, ASTM C580, and ASTM C827; chemical resistant, water resistant and a minimum 7-day compressive strength of 12,000 psi.

a. Use for vibrating equipment.

b. Products:

1). Sikadur 42, Grout-Pak by Sika Corporation.

2). Five Star HP Epoxy Grout by Five Star Products, Inc.

3). MasterFlow 648 by BASF Corporation.

E. Foundation Waterproofing: Foundation coating shall be used only on the exterior of concrete walls not exposed to view where indicated on the Drawings.

1. MasterSeal 581 (Thoroseal) as manufactured by BASF Corporation.

2. TREMproof 250GC as manufactured by Tremco Commercial Sealants and Waterproofing.

3. Approved equal.

F. Zinc Rich Primer: Aluminum surfaces which contact or are embedded in concrete shall be coated with zinc rich primer. Primer shall be:

1. Tneme-Zinc; Tnemec Company, Inc.
2. MasterProtect P 8100AP; BASF Corporation.

G. Reglets: Fabricate reglets of not less than 0.0217-inch thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

H. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.06 REPAIR MATERIALS

A. Structural Concrete Repair Material: Low-shrink, non-slump, non-metallic, quick setting patching mortar; as approved by the manufacturer for each application and applied accordance with the manufacturer's recommendations.

1. Products:

a. Five Star Structural Concrete by Five Star Products, Inc.

b. Sikatop 123 by Sika Corporation.

c. Sikatop 122 by Sika Corporation.

d. Approved equal.

B. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C109/C109M.

2.07 CONCRETE MIXTURES

A. Design Criteria:

1. Provide a mix design for each concrete application indicated. This may necessitate multiple mix designs for each class of concrete depending on HRWR, entrained air, and other requirements.
2. All Concrete shall be normal weight concrete composed of Portland cement, fine aggregate, coarse aggregate, admixtures, and water, as specified.
3. ACI 211.1 shall be the basis for selecting the proportions for concrete made with aggregates of normal and high density and of workability suitable for usual cast in place structures.

4. The workability of any mix shall be as required for the specific placing conditions and the method of placement. The concrete shall have the ability to be worked readily into corners and around reinforcing steel without the segregation of materials or the collection of free water on the surface. Compliance with specified slump limitations shall not necessarily designate a satisfactory mix.
5. In no case shall the amount of coarse material produce harshness in placing or honeycombing in the structure, when forms are removed.
6. The maximum amount of coarse aggregate (dry loose volume) per cubic foot of finished concrete shall not exceed 0.82 cubic feet.
7. In calculating water-cement ratio: The water content shall include the amount of water batched or to be added later, plus the free water in the aggregate, and minus the water content at SSD conditions.
8. No allowance shall be made for the evaporation of water after batching. If additional water is required to obtain the desired slump, a compensating amount of cement shall also be added. In no case shall the maximum water cement ratio exceed the specified maximum or that of the approved mix design.
9. Air Entrainment: Provide the percent air entrainment in each concrete mix design as recommended by ACI 318 and ACI 350 for "Moderate Exposure" (Class F1), unless otherwise specified/restricted:
    a. Do not provide air-entrainment in drilled shafts unless placed underwater.
    b. Do not provide air-entrainment and entrapped air shall not exceed 3 percent for the following applications:
        1). Interior slabs.
        2). Slabs on composite metal decks.
10. When job conditions dictate, water-reducing and set-controlling admixtures may be used. Only specified admixtures shall be used. Admixtures shall be batched at the batch plant.
11. High Range Water Reducer (HRWR): Provide HRWR in mix designs as indicated for specified applications. Slump of concrete with the addition of HRWR may be increased to 8 inches (+/- 1 inch).
    a. Drilled shafts, footings, walls, columns, and beams.
    b. Interior of building curbs which are not cast monolithically with slabs.
    c. Precast concrete.
    d. Do not provide HRWR in slabs and pavement (a water reducer is permitted provided performance requirements are met).
12. If fly ash is to be used in place of cement, no more than 25 percent of the cement may be replaced.
13. Use silica fume where indicated. The trial mix shall be in accordance with this Section and the silica fume manufacturer.
    a. List locations of use, provide a specific concrete class

b. Single source throughout the Project.

c. Added to the mix at a rate of 10 percent of cement content. No reduction in cement content shall be allowed, but it may be included when determining the water-cement ratio.

d. Mix shall contain high range water reducer and air-entraining admixtures.

14. Concrete shall be capable of developing two-thirds of the required 28-day compressive strength in 7 days.

15. Maximum water-soluble chloride ion content in concrete, by percent weight of concrete, shall not exceed ACI 318 and ACI 350 limits for Exposure Class C1.

B. Concrete Classifications:

Class	Min. 28-Day Compressive Strength (psi)	Max. Size Aggregate (inches)	Max. Water: Cementitious Materials Ratio	Slump +/- 1 (inches)	Min. Sacks of Cement Per Cubic Yard **
A	4000	1.0 Size No. 57	0.45	3 (8*)	5.75
B	3000	1.0 Size No. 57	0.47	3	5.75
C	4000	1.0 Size No. 57	0.45	4 (8*)	5.75
D	5000	0.75 Size No. 67	0.47	4	6.00
E	1500	1.5 Size No. 467	0.70	4	4.00
F	4000	0.375 Size No. 8	0.47	3	6.50
* Slump shown is with HRWR ** Provide one additional sack of cement per cubic yard if concrete must be deposited in standing water.					

C. Concrete Usage:

Class	Usage
Class A Use	Footings and slabs, and other unless noted otherwise
Class B Use	Pavement, gutters, and sidewalks
Class C Use	Walls, columns, beams, drilled shafts
Class D Use	Precast concrete and precast panels
Class E Use	Cradling, Blocking, mud slab, lean concrete backfill
Class F Use	Stair Pans and Landings, interior building curbs.

D. Required Average Compressive Strength:

1. All concrete is required to have an average compressive strength greater than the specified strength. The required average compressive strength shall be established according to the requirements of ACI 301.

2. Standard Deviation: If the production facility has records of field tests performed within the past 12 months and spanning a period of not less than 60 calendar days for a class of concrete within 1000 psi of that specified for the Work, calculate a standard deviation and establish the required average strength fcr' in accordance with ACI 301. If field test records are not available, select the required average strength from ACI 301.

E. Documentation of Required Average Compressive Strength:

1. Documentation indicating the proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength, shall consist of field strength records or trial mixture.

2. Field Strength Records: Document field strength records according to ACI 301 and including the following:

a. Field test data shall not be older than 1 year.

b. If field test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 60 days, verify that the average of the field test results equals or exceeds fcr'. Submit for acceptance the mixture proportions along with the field test data.

c. If the field test data represent two groups of compressive strength tests for two mixtures, plot the average strength of each group versus the water-cementitious materials ratio of the corresponding mixture proportions and interpolate between them to establish the required mixture proportions for fcr'.

3. Trial Mixtures:

a. Establish trial mixture proportions according to ACI 301 and including the following.

1). Make at least three trial mixtures complying with performance and design requirements. Each trial mixture shall have a different cementitious material content. Select water-cementitious materials ratios that will produce a range of compressive strengths encompassing the required average compressive strength fcr'.

2). Submit a plot of a curve showing the relationship between water-cementitious materials ratio and compressive strength.

3). Establish mixture proportions so that the maximum water-cementitious materials ratio is not exceeded when the slump is at the maximum specified.

b. Laboratory Samples shall be taken in accordance with the trial mix designs for laboratory testing purposes.

c. The fresh concrete shall be tested for Slump (ASTM C143) and Air Content (ASTM C173 and ASTM C231). Strength test specimens shall be made, cured, and tested for

7-day and 28-day strength in accordance with ASTM C192, ASTM C39, and ASTM C78.

d. Suitable facilities shall be provided for readily obtaining representative Samples of aggregate from each of the weigh batchers for test purposes and for obtaining representative Samples of concrete for uniformity tests. The necessary platforms, tools, and equipment for obtaining Samples shall be furnished. Aggregates shall be tested in accordance with ASTM C1260.

e. The cement contents specified are minimum values. If additional quantities are required to obtain the specified strengths, supply the cement at no additional cost to the Owner.

f. A trial mix shall be designed by an independent testing laboratory, retained and paid by the Contractor and approved by the Owner. The testing laboratory shall submit verification that the materials and proportions of the trial concrete mix design meet the requirements of the Specifications.

g. From these trial mix tests, the ratios between 7-day and 28-day strengths shall be established. The 7-day strength which corresponds to the required 28-day strength shall be determined.

h. The final results of the trial mix design shall be submitted to the Engineer at least 10 days prior to the scheduled beginning of concrete placement and shall be approved by the Engineer prior to the placement of any concrete.

4. Revisions to concrete mixtures:

   a. When less than 15 compressive strength tests results for a given class of concrete are available from the current Project:

      1). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

         a). A 7-day compressive strength test result multiplied by 1.5 falls below the required 28-day compressive strength.

         b). A 28-day compressive strength test result is deemed not satisfactory.

   b. When at least 15 compressive strength test results for a given class of concrete become available from the current Project:

      1). Calculate the actual average compressive strength, standard deviation and required average compressive strength using the previous 15 consecutive strength tests. Submit results in graphical form with each 28-day test result for that class of concrete.

      2). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.

         a). A 7-day compressive strength test result multiplied by the average job-to-date ratio of 7-day to 28-day compressive strength falls below the required 28-day compressive strength.

         b). A 28-day compressive strength test result is deemed not satisfactory.

c). The average compressive strength falls below the required average compressive strength.

c. When revisions to the mix design are required, notify the Engineer in writing of the corrective actions taken.

2.08 OFF-SITE BATCH PLANT

A. Batch plants shall be an established concrete batching facility meeting the requirements of the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

2.09 CONCRETE MIXING

A. Mixers may be stationary, truck, or paving mixers of approved design. They shall be capable of combining the materials into a uniform mixture and of discharging without mixture segregation. Stationary and paving mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixers or mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer on the name plate.

B. The mixing time for stationary mixers shall be based upon the mixer's ability to produce uniform concrete throughout the batch and from batch to batch. For guidance purposes, the manufacturer's recommendations, or 1 minute for 1 cubic yard plus 1/4 minute for each additional cubic yard may be used. Final mixing time shall be based on mixer performance. Mixers shall not be charged in excess of the capacity specified by the manufacturer.

C. When a stationary mixer is used for partial mixing of the concrete (shrink mixed), the stationary mixing time may be reduced to the minimum necessary to intermingle the ingredients (about 30 seconds).

D. When a truck mixer is used, either for complete mixing (transit-mixed) or to finish the partial mixing in a stationary mixer and in the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum, at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If the batch is at least 1/2 cubic yard less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to no less than 50. Additional mixing shall be performed at the speed designated by the manufacturer of the equipment as agitating speed. When necessary for proper control of the concrete, mixing of transit-mixed concrete shall not be permitted until the truck mixer is at the Site of the concrete placement. Truck mixers shall be equipped with accurate revolution counters.

E. Paving mixers may be either single compartment drum or multiple compartment drum type. A sled or box of suitable size shall be attached to the mixer under the bucket to catch any concrete spillage that may occur when the mixer is discharging concrete into the bucket. Multiple compartment drum paving mixers shall be properly synchronized. The mixing time shall be determined by time required to transfer the concrete between compartments of the drum.

F. Vehicles used in transporting materials from the batching plant to the paving mixers shall have bodies or compartments of adequate capacity to carry the materials and to deliver each batch, separated and intact, to the mixer. Cement shall be transported from the

batching plant to the mixers in separate compartments which are equipped with windproof and rain proof covers.

3.00 EXECUTION

3.01 PREPARATION

A. Notify the Owner's representative upon completion of various portions of the work required for placing concrete, so that inspection may be made as early as possible. Keep the Owner's representative informed of the anticipated concrete placing schedules.

B. All items, including lines and grades, forms, waterstops, reinforcing, inserts, piping, electrical, plumbing and the Contractor's concreting materials and equipment shall be in compliance with the Contract Documents before proceeding.

C. Do not place any concrete until formwork and the placing reinforcement in that unit is complete. Place no concrete before the completion of all adjacent operations which might prove detrimental to the concrete.

D. Brilliantly light the Site so that all operations are plainly visible when concrete mixing, placing, and finishing, continues after daylight. Whenever possible, concrete finishing shall be completed in daylight hours.

E. When placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust and other extraneous matter. Forms for slab, beam and girder construction shall not have tie wire cuttings, nails, or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of any foreign matter during concrete placing.

F. The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the time limits specified shall not be used. Concrete shall not be re-tempered.

G. Concrete shall not be placed if impending weather conditions would impair the quality of the finished Work.

H. Unless otherwise provided, the following requirements shall govern the time sequence on which construction operations shall be carried.

1. Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured for at least 2 curing days. Concrete may be placed in a wall or column as soon as the forms and reinforcing steel placements are approved.

2. Steel beams or forms and falsework for superstructures shall not be erected on concrete substructures until the substructure concrete has cured for at least 4 curing days. Falsework required for superstructures shall not be erected until the substructure has cured for 4 curing days, and shall not be removed until the superstructure has cured.

3.02 EMBEDDED ITEMS

A. Where aluminum anchors, aluminum shapes, or aluminum electrical conduits are embedded in concrete, paint aluminum contact surfaces with zinc rich primer. Allow the paint to thoroughly dry before placing the aluminum in contact with the concrete.

B. Paint steel or other ferrous metal to be mounted on or placed in contact with dry/cured concrete, and coat in accordance with Section 09 96 00.01 “High-Performance Coatings” prior to installation.

C. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.

3.03 JOINTS

A. Expansion Joints and Devices:

1. Workmanship: Exercise careful workmanship in joint construction to separate the concrete sections by an open joint or by the joint materials, and make the joints true to the outline indicated.

2. Expansion Joints: Construct expansion joints and devices to provide expansion and contraction. Construct joints which are to be left open or filled with poured joint material with forms which are adaptable for loosening or early removal. In order to avoid jamming by the expansion action of the concrete and the consequent likelihood of injuring adjacent concrete, remove or loosen these forms as soon as possible after the concrete has initially set. Make provisions for loosening the forms to permit free concrete expansion without requiring full removal.

3. Armored Joints: Carefully construct armored joints to avoid defective anchorage of the steel and porous or honeycombed concrete adjacent to same. Anchor pre-molded materials to the concrete on one side of the joint with approved adhesive. Anchor so that the material does not fall out of the joint.

B. Construction Joints:

1. Construction joints are formed by placing plastic concrete in direct contact with concrete which has attained its initial set. When concrete is specified as monolithic, the term shall be interpreted as the manner and sequence of concrete placement so that construction joints do not occur.

a. Unless noted otherwise, the maximum horizontal spacing of construction joints shall be 40 feet.

b. For slabs on grade, the maximum spacing between two construction joints or between a construction joint and a control joint shall be 15 feet, unless noted otherwise.

c. Unless noted otherwise or approved by the Engineer, the maximum vertical spacing of construction joints shall be 15 feet. If not detailed on the Drawings, construction joint details and locations shall be submitted to the Engineer for approval.

2. Additional horizontal and vertical construction joints, when submitted and approved by the Engineer, may have an impact on reinforcing details. Revise reinforcing details to reflect additional joints.

3. Unless otherwise provided, construction joints shall be square and normal to the forms. Provide bulkheads in the forms for all joints except horizontal joints.

4. At the proper time, clean horizontal construction joints for receiving the succeeding lift using air water cutting. The surface shall be exposed sound, clean aggregate. The air pressure supply to the jet shall be approximately 100 lb. per square inch, and the water pressure sufficient to bring the water into effective influence of the air pressure. After cutting, wash the surface until there is no trace of cloudiness in the wash water.

5. In areas where air water cutting cannot be satisfactorily accomplished, or in areas where it is undesirable to disturb the surface of the concrete before it has hardened, prepare the surface for receiving the next lift by wet sand blasting to immediately remove all laitance and unsound concrete prior to placing of the next lift. Thoroughly wash the surface of the concrete after sand blasting to remove all loose material.

6. Provide construction joints with concrete keyways, reinforcing steel dowels, and waterstops. The method of forming keys in keyed joints shall permit the easy removal of forms without chipping, breaking, or damaging the concrete.

C. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

D. Hardened Concrete: Where new concrete or grout is to be placed in contact with existing or recently hardened concrete, texture the existing or recently hardened surface by chipping or other means so that an irregular surface having a height variance of not less than 1/4 inch is created. The existing or recently hardened concrete shall then be coated with a bonding agent and new concrete or grout placed.

3.04 WATERSTOPS

A. PVC Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work.

1. At formed surfaces, a split form shall be used. The split form shall have a tight fit which prevents misalignment and concrete leakage.

2. The embedded flange of the waterstop must be secured prior to concrete placement. The flange shall be secured at 12 inches on-center by factory installed hog rings or grommets at the outermost rib. Never place nails or screws through the body of the waterstop.

3. All fittings and changes in direction shall be factory fabricated. Only straight butt splices shall be made in the field. Field splices shall be according to the manufacturer's written instructions and as follows:

a. Cut adjoining ends square to form matching edges.

b. Uniformly melt the ends at 380 F using a thermostatically controlled, Teflon coated splicing iron.

c. When a 1/8-inch diameter melt bead develops on each waterstop end, remove the splicing iron and firmly press the two ends together in proper alignment. Hold until

the material has fused and cooled. Allow the splice to cool naturally; do not quench.

B. Self-Expanding Strip Waterstops:

1. Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place.

a. Waterstop shall be bonded to the substrate using a continuous bead of swelling sealant or adhesive as recommended by the manufacturer.

1). ADEKA Ultra Seal P-201.

2). Sika Leakmaster.

2. Install in longest lengths practicable.

3. Protect from moisture, oil, dirt, and sunlight prior to the placement of concrete. Coordinate with manufacturer for additional requirements.

3.05 CONCRETE PLACEMENT

A. Cold Weather:

1. If air temperature has fallen to, or is expected to fall below 40 F during the protection period (a minimum of 48 hours unless longer time frame is recommended by ACI 306R), then cold weather concreting shall be performed in accordance with ACI 306.1.

2. In cases where the temperature drops below 40 F after the concreting operations have been started, sufficient canvas and framework or other type of housing shall be furnished to enclose and protect the structure, in accordance with the requirements of ACI 306R. Sufficient heating apparatus to provide heat shall be supplied, and heating source and protection from combustion gas shall be in accordance with ACI 306.1. The concrete shall be protected when placed under all weather conditions. Should concrete placed under such conditions prove unsatisfactory, remove and replace the concrete at no cost to the Owner.

3. When the air temperature is above 30 F:

a. The minimum concrete temperature at the time of mixing shall be 60 F unless other requirements of ACI 306.1 are met, which may allow for a lower mix temperature.

b. The minimum concrete temperature at the time of placement and during the protection period shall be 55 F unless other requirements of ACI 306.1 are met, which may allow for a lower temperature.

4. The means used to heat a concrete mix shall be in accordance with ACI 306.1.

5. Salts, chemicals, or other foreign materials shall not be mixed with the concrete to preventing freezing. Calcium chloride is not permitted.

B. Hot Weather:

1. Hot weather is defined as any combination of high air temperature, low relative humidity, and wind velocity that impairs the quality of the concrete. Hot weather concreting shall be in accordance with ACI 305.1. Concrete shall be placed in the forms

without the addition of any more water than that required by the design (slump). No excess water shall be added on the concrete surface for finishing. Control of initial set of the concrete and extending the time for finishing operations may be accomplished with the use of approved water reducing and set retarding admixture, as specified.

2. Maximum time intervals between the addition of mixing water and/or cement to the batch, and the placing of concrete in the forms shall not exceed the following (excluding HRWR admixture use):

Concrete Temperature	Maximum time From Water Batch to Placement
Non-Agitated Concrete	
Up to 80 F	30 Minutes
Over 80 F	15 Minutes
Agitated Concrete	
Up to 75 F	90 Minutes
75 F to 89 F	60 Minutes

   a. The use of an approved set-retarding admixture will permit the extension of the above time maximums by 30 minutes, for agitated concrete only.

   b. The use of an approved high range water reducing (HRWR) or hydration-controlling admixture will allow placement time extensions as determined by the manufacturer.

3. The maximum temperature of fresh concrete at time of discharge shall not exceed 95 F. The temperatures of the mixing water shall be reduced by the use of chilled water or ice.

4. The maximum temperature of fresh concrete with high range water reducing admixture shall not exceed 100 F at time of discharge.

5. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.

C. Handling and Transporting:

1. Delivery tickets shall be required for each batch and shall be in accordance with ASTM C94. Each delivery ticket must show plainly the amount of water, in gallons that can be added to the mixer truck at the Site without exceeding the maximum water cement ratio approved for that mix design. Amount of water added must be in proportion to contents of truck.

2. Arrange and use chutes, troughs, or pipes as aids in placing concrete so that the ingredients of the concrete are not segregated. They shall be steel or steel lined. When steep slopes are necessary, equip the chutes with baffles or make in short lengths that reverse the direction of movement. Extend open troughs and chutes, if necessary, inside the forms or through holes left in the forms. Terminate the ends of these chutes in vertical downspouts.

3. Keep chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water before and after placement. Discharge water used for flushing away from the concrete in place.
4. Concrete pumping is permitted and shall comply with ACI 304.2R.
5. Carting or wheeling concrete batches on completed concrete floor slab shall not be permitted until the slab has aged at least 4 curing days. Unless pneumatic tired carts are used, wheel the carts on timber planking so that the loads and impact are distributed over the slab. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

D. Depositing:

1. The method and manner of placing shall prevent segregation or separation of the aggregate or the displacement of the reinforcement. Use drop chutes of rubber or metal when necessary. Prevent the spattering of forms or reinforcement bars if the spattered concrete dries or hardens before it is incorporated into the mass.
2. Fill each part of the forms by directly depositing concrete as near its final position as possible. Work the coarse aggregate back from the face and force the concrete under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms, then running or working it along the forms shall not be permitted.
3. After the concrete has taken initial set, the forms shall not be jarred. No force or load shall be placed upon projecting reinforcement.
4. Deposit the concrete through vertical drop chutes of rubber or metal of satisfactory size when operations involve placing concrete from above, such as directly into an excavated area, or through the completed forms, particularly in walls, piers, columns, and similar structures. Drop chutes shall be made in sections or provided in several lengths so that the outlet may be adjusted to proper heights during placing.
5. Except for drilled shafts, concrete shall not be dropped free more than 10 feet when HRWR admixture is used or 5 feet without HRWR. Place in continuous horizontal layers with a depth of from 1 to 3 feet, depending upon the wall thickness. Each layer shall be soft when a new layer is placed upon it. No more than 1 hour shall elapse between the placing of successive concrete layers in any portion of the structures included in continuous placement.
6. Place required sections in one continuous operation to avoid additional construction joints.
7. If excessive bleeding causes water to form on the surface of the concrete in tall forms, make the mix dryer to reduce the bleeding. In tall walls, place the concrete to a point about 1 foot below the top of the wall and allow to settle for 1 to 2 hours. Resume and complete concreting before set occurs.
8. For slopes greater than two percent, start concrete placement at low end and proceed upslope.

E. Consolidating:

1. Compact each layer of concrete and flush the mortar to the surface of the forms by continuous-working mechanical vibrators. Vibrators which operate by attachment to forms shall not be used. Apply the vibrator to the concrete immediately after deposit. Move vibrator throughout the layer of the newly placed concrete, several inches into the plastic layer below. Thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms until it is well-compacted.

2. Mechanical vibrators shall not be operated so that they penetrate or disturb previously placed layers which are partially set or hardened. They shall not be used to aid the flow of concrete laterally. The vibration shall be of sufficient duration to completely compact and embed reinforcement and fixtures, but not to an extent causing segregation.

3. Keep vibrators constantly moving in the concrete and apply vertically at points uniformly spaced, not farther apart than the radius over which the vibrator is visibly effective. The vibrator shall not be held in one location longer than required to produce a liquified appearance on the surface.

4. When submerged in concrete, internal vibrators shall maintain a frequency of not less than 6000 impulses per minute for spuds with diameters greater than 5 inches and 10,000 impulses for smaller spuds. The vibration intensity (amplitude) shall be sufficient to produce satisfactory consolidation.

5. Provide one vibrator (powered pneumatically or electrically) for each 10 cubic yards of concrete per hour being placed. Provide at least one vibrator, which may be of the gasoline powered type, as a standby for each two vibrators in service. To produce satisfactory consolidation, and based upon the observed performance, the Owner's representative may require the use of a larger sized and powered vibrator.

6. Check vibrators intended for regular service or standby service before beginning concreting operations.

F. Placement in Water:

1. Deposit concrete in water only when dry conditions cannot be obtained. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water flowing through the space where concrete is to be deposited. Pumping of water shall not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.

2. Carefully place the concrete compact mass using a tremie, closed bottom dumping bucket, or another approved method which does not permit the concrete to fall through the water without protection. The concrete shall not be disturbed after being deposited. Regulate depositing to maintain horizontal surfaces.

3. When a tremie is used, it shall consist of a tube constructed in sections having water-tight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work, and shall allow the tremie to be rapidly lowered to retard the flow. The number of times it is necessary to shift the location of the tremie shall be held to a minimum for any continuous placement of concrete. During the placing of concrete, keep the tremie tube full to the bottom of the hopper. When a batch is dumped into the hopper, slightly raise the tremie, but not out

of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. Stop the flow by lowering the tremie. Continue placing operations until the work is completed.

4. When concrete is placed by means of the bottom dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. Lower the bucket gradually and carefully until it rests upon the concrete already placed. Raise it very slowly during the discharge travel to maintain still water at the point of discharge and to avoid agitating the mixture.
5. Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water.

G. Placement in Slabs:

1. Allow concrete in columns, walls and deep beams or girders to stand for at least 1 hour to permit full settlement from consolidation, before concrete is placed for slabs they are to support. Haunches are considered as part of the slab and shall be placed integrally with them.
2. When monolithic slabs are placed in strips, the widths of the strips, unless otherwise specified or indicated, shall insure that concrete in any one strip is not allowed to lie in place for more than 1 hour before the adjacent strips are placed.
3. Immediately before placing concrete, thoroughly dampen the earthen cushion to receive concrete to prevent moisture absorption from the concrete.
4. As soon as concrete placing is complete for a slab section of sufficient width to permit finishing operations, level the concrete, strike off, tamp and screed. The screed shall be of a design adaptable to the use intended, shall have provision for vertical adjustment and shall be sufficiently rigid to hold true to shape during use.
5. The initial strike off shall leave the concrete surface at an elevation slightly above grade so that, when consolidation and finishing operations are completed, the surface of the slab is at grade elevation.
6. Continue tamping and screeding operations until the concrete is properly consolidated and free of surface voids. Bring the surface to a smooth, true alignment using longitudinal screeding, floating, belting, and/or other methods.
7. When used, templates shall be of a design which permits early removal so satisfactory finishing at and adjacent to the template is achieved.
8. While the concrete is still plastic, straightedge the surface using a standard 10-foot metal straightedge. Lap each straightedge pass one-half of the preceding pass. Remove high spots and fill depressions with fresh concrete and re-float. Continue to check with a straightedge during the final finishing operation, until the surface is true to grade and free of depressions, high spots, voids, or rough spots.
9. Check the final surface with a straightedge. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed 1/16 inch per foot from the nearest point of contact. The maximum ordinate shall be 1/8 inch per 10 feet.
10. Unless noted otherwise, where floor drains or hub drains are shown in slabs of buildings, vaults, or treatment basin units and sloping the slab is not indicated, slope

slab to drain on a grade of 1/16 inch per foot with a maximum total slope of 1-1/4 inches. The thickness of slab at floor or hub drain shall be the thickness of slab, as indicated on the Drawings.

H. Placement in Foundations: Place concrete in deep foundations so that segregation of the aggregates or displacement of the reinforcement is avoided. Provide suitable chutes or vertical pipes. When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted and the entire excavation filled with concrete to the elevation of the top of footing. The placing of concrete bases above seal courses is permitted after the forms are free from water and the seal course cleaned. Execute necessary pumping or bailing during concreting from a suitable sump located outside the forms.

I. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on the Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.06 FINISHING FORMED SURFACES

A. Forms for walls, columns, and sides of beams and girders shall be removed as specified in Section 03 11 00 “Concrete Forming.” Patch, repair, finish, and clean concrete after form removal. Finish concrete within 7 days of form removal. Cure concrete as finishing progresses.

B. Air voids, for all types of finishes, are defects and shall be removed by rubbing or patching.

C. Finish Schedule:

Type of Finish	Location
No Finish	Surfaces which are not visible from the inside or outside of the completed structure or more than 12” below finish grade (i.e. back of retaining walls below embankment, etc.)
Rough Finish	NA
Smooth Finish	Surfaces exposed to view and areas below to a point 12” below grade, includes inside of wet wells
Smooth Rubbed Finishes	NA
Plaster Mix Finishes	NA
Light Sand Blast Finish	NA
Medium Sand Blast Finish	NA
Grout-Cleaned Finish	NA
Cork-Floated Finish	NA

D. No Finish: After forms are removed, repair or patch tie holes and defects. Otherwise, no additional finish is required.

E. Rough Finish: Surfaces for which rough finish is indicated or required shall have tie holes and defects larger than 1/4 inch in width or depth patched or repaired. Remove fins flush

with the adjacent surface by rubbing or grinding and dress rough edges. Otherwise, leave surfaces with the texture imparted by the forms.

F. Smooth Finish: Unless otherwise shown on the schedule above, provide smooth form finish for concrete surfaces to be exposed to view. Surfaces to receive a rubbed finish shall have a smooth form finish. The form facing material shall produce a smooth, hard, uniform texture on the concrete. The arrangement of the facing material shall be orderly and symmetrical with a minimum number of seams. Patch tie holes and defects and remove fins flush with the adjacent surface.

G. Smooth Rubbed Finish:

1. Rub surfaces with fluted carborundum stone rubbing at the proper time in the concrete aging process. Rubbing shall remove form marks, surface imperfections, and otherwise smooth, shape, or finish the surface. Proceed with surface rubbings when the forms are removed.

2. After form removal, perform necessary pointing. When the pointing has set sufficiently to permit rubbing, wet surfaces requiring surface finish and rub surface with a No. 16 Carborundum Stone or an abrasive of equal quality. Bring the surface to a paste, to remove all form marks and projections, and to produce a smooth dense surface without pits or irregularities.

3. Carefully spread or uniformly brush the material ground to a paste over the surface and allow to take a reset. The use of cement or plaster to form a surface shall not be permitted.

4. Prepare a 4-by-8-foot panel for the Owner's approval which shows how final finished surfaces will appear. This panel shall be used as a guide for judging the workmanship of surface finish.

H. Plaster Mix Finish:

1. Do not apply plaster mix finish when temperature is 40 F or expected to drop below 40 F within 24 hours after application.

2. Areas to receive a plaster mix finish shall have smooth form finish. Application of the plaster mix shall be either by trowel and float or by spray gun. Surface texture finish shall be determined by the Owner. Areas designated to receive this finish shall receive a two coat application, as specified and in accordance with the manufacturer's recommendations. Form treatments or curing compounds shall be removed on areas receiving a plaster mix finish. Removal of these treatments/compounds shall be in accordance with the manufacturer's requirements for surface preparation.

I. Light Sand Blast Finish: Surfaces to receive a light sand blast finish shall first receive a smooth rubbed finish. Blast the concrete surface with an abrasive (sand or grit) until the aggregate is in uniform relief. The depth of penetration shall be sufficient to remove only the surface mortar. Prepare a 4-by-8-foot panel for the Owner's review. Subsequent sand blast finishing shall match the Sample panels.

J. Medium Sand Blast Finish: Treat surfaces to receive a medium sand blast finish as specified for Light Sand Blast finish, except that the depth of penetration shall be sufficient to remove the surface mortar and expose the surface of some coarse aggregate. Prepare a 4-by-8-foot Sample panel.

K. Form Liner Finish: Finish shall be as specified in Section 03 11 00 "Concrete Forming."

L. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part Portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

M. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part Portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

3.07 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Finish slabs, platforms, and steps monolithically and apply as indicated on the Drawings and the following schedule of finishes:

Type of Finish	Location
Rough Finish	Tank floors that receive grout topping and slabs which receive additional concrete toppings.
Scratch Finish	Surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, Portland cement terrazzo, and other bonded cementitious floor finishes.
Float Finish	NA
Trowel Finish	Slab surfaces exposed to view or to be covered with resilient flooring, carpet, and ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
Trowel and Fine Broom Finish	Surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method
Broom Finish	Exterior concrete platforms, steps, and ramps.
Slip Resistive Aggregate Finish	NA

1. Rough Finish: Provide a rough surface by screeding only without further finish.

2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.

3. Float Finish: Finish surfaces using a float to a true, even plane with no coarse aggregate visible. In the initial floating, while the concrete is plastic, use sufficient pressure on the float to bring excess moisture to the surface for removal. Apply a final "light float" finish to the surface as the concrete hardens. The surface shall have a uniform granular texture and shall meet the straightness requirements.

4. Trowel Finish:

    a. After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

    b. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E1155/E1155M for a randomly trafficked floor surface:

    c. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:

        1). 1/4 inch.

5. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

6. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

7. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

    a. Uniformly spread 25 lb./100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.

    b. After broadcasting and tamping, apply float finish.

    c. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

C. Give sidewalks a brush finish, unless noted otherwise. Score sidewalks at a spacing equal to the width of the walk and edge on each side using a tool with a radius of approximately 1/4 inch.

D. Epoxy Broadcast Overlay System: Clean the surface and prepare for spraying, brushing, or rolling with an epoxy compound. Immediately after applying the epoxy, broadcast the aggregate by hand or machine at 1.5 pounds per square yard.

E. Finishing in Hot, Dry Weather: During periods of high temperature and/or low humidity, take extreme care in finishing the slabs to eliminate initial shrinkage cracks. Following the initial set of concrete, but while the concrete is still "green" continue to finish as required to remove shrinkage cracks which may occur. In hot, dry weather, keep a cement finisher on the job following normal finishing operations for a sufficient length of time to insure the removal of initial shrinkage cracks.

3.08 GROUT FINISHED SEDIMENTATION TANK/BASIN FLOORS

A. Grout shall be normal shrinkage grout, as specified.

B. Prior to the application of grout, operate the sweep mechanism for monitoring:

1. Accurately determine the elevation of a reference point near the end of each arm and monitor that elevation at every 45-degree rotation for two full rotations of the mechanism. The following measurements shall be recorded and if either of the stated criteria is not met, seek guidance from the Engineer prior to grout installation. Elevations shall be measured with respect to the theoretical surface of the earth and not with respect to the basin floor.

    a. Reference point elevations shall not vary from one side of the basin to the other more than 1/2 of an inch (± 1/4-inch).

    b. The reference elevations shall not vary more than one-quarter of an inch (±1/8-inch) for any given reference point on the arms at any given rotation angle when compared between rotations.

2. Monitor the gap between the base of the arms to the top of the structural slab to verify that the minimum required thickness of grout can be achieved in all locations with appropriate clearance for squeegee adjustment.

3. All weight shall be on the arms, including corner sweeps, when verifying gaps.

4. Adjust the arms as necessary to achieve the minimum specified thickness of grout. Notify the Owner and Engineer if the arms are not adjustable and minimum grout thickness cannot be achieved.

5. Verify that the corresponding leading and trailing edges of adjacent blades match in elevations for a seamless transition between blades. The elevations of the corresponding leading and trailing edges shall be as compared either by rotating the mechanism and measuring vertically with respect to a common point on the basin floor or by keeping the mechanism stationary and measuring with respect to the theoretical surface of the earth.

C. Screeds shall consist of wood planking of proper dimension and length with the bottom edge beveled such that not more than half of an inch width is in contact with the grout surface. Attach a light gauge metal (sheet) formed and nailed to the wood with butt joints to the bottom of wood screeds. The sheet metal shall serve as a trowel and prevents the splintering and fraying of the timbers. Firmly attach screeds to the bottom of the truss arms to prevent dislocation in the screeding operations.

D. Prior to the application of grout, thoroughly clean floors of all foreign matter and wet down. With the floor in a saturated surface dry condition and just prior to grouting, sprinkle lightly with cement to improve the bond between the grout and tank bottoms. Block grout from entering any sludge hopper, drain line, etc. Apply grout over the floor surface of the tanks. Grouting shall be according to the Specifications, the recommendations of the equipment manufacturer and the grout manufacturer.

E. Execute grouting by power operation of the equipment in the tank (i.e., by motor turning the mechanism, not by hand turning of the arms). Make final adjustments to truss arms of the equipment and attach a screed to the bottom of both arms for sweeping in the grout. All weight shall be on the arms, including corner sweeps, while placing the grout.

F. Start grouting at the walls of the tanks and spiral inward toward the center. Perform grouting in a workmanlike manner. Excess grout should not be allowed to accumulate in front of the screed and cause the screed to float on top of the grout.

G. Verify the profile of the finish floor by measuring from the arm with screeds removed and not contact between the arm and the floor. The finish grout surface shall vary no more than a range of half of an inch (± 1/4 inch) for any concentric circle in the finished floor.

3.09 MISCELLANEOUS CONCRETE ITEMS

A. Normal Shrinkage Grouting:

1. Prior to grout application, thoroughly clean the surface of all foreign matter and wet down. Thoroughly clean the foundation and the forms set in place and securely anchor, with holes or cracks in forms caulked with rags, cotton waste or dry sand mixture to prevent the loss of grout. The necessary materials and tools shall be on hand before starting grouting operations. Concrete shall be damp when the grout is poured, but shall not have excess water to dilute the grout.

2. After wetting and just prior to grouting, sprinkle the surface lightly with cement to improve the bond between the grout and the surface.

3. After mixing, quickly and continuously place the grout to avoid overworking, segregation and breaking down of the initial set. Mix and place the grout according to the manufacturer's recommendations. Cure grout using wet curing method for concrete. Grout shall receive a steel trowel finish.

B. Non-Shrink Grout:

1. Obtain field technical assistance from the Grout manufacturer, as required, to insure that grout mixing and installation comply with the manufacturer's recommendations and procedures.

2. Saturate the foundation for non-shrink grouts 24 hours before installation and clear of excess water. Free baseplates or bedplates of oil, grease, laitance and other foreign substances.

3. Place grout according to the manufacturer's directions so that spaces and cavities below the top of the baseplates and bedplates are completely filled. Provide forms where structural components of the baseplates or bedplates do not confine the grout. Where necessary and acceptable under the manufacturer's procedures, a round head pencil vibrator, 3/4-inch maximum diameter may be used to consolidate the grout.

4. Steel trowel finish the non-shrink grout where the edge of the grout is exposed to view and after the grout has reached its initial set. Cut off the exposed edges of the grout at a 45-degree angle to the baseplate, bedplate, member, or piece of equipment.

5. Wet curing should occur for at least 3 days, unless specified by manufacturer, with wet rags, wet burlap or polyethylene sheets. Keep cloths constantly wet for the curing cycle.

6. Clean and dry the foundation, baseplate or other surface of epoxy grouts prior to installation. Dry curing is acceptable for epoxy grouts.

7. Use epoxy non-shrink grout under all machinery, pumps, equipment, and where chemicals are present that would abate cementitious non-shrink grouts.

a. Mix, install, cure, and finish epoxy grouts according to the manufacturer's recommendations. Install grout in recommended lifts to prevent excess heat.

3.10 CONCRETE PROTECTION AND CURING

A. General: Give careful attention to proper concrete curing. The curing methods shall be wet curing, sheet materials conforming to ASTM C171, or membrane curing compound conforming to ASTM C309. Membrane curing is not permitted on surfaces to be rubbed or on surfaces to which additional concrete, plaster mix mortar, or terrazzo is to be applied. Unless the curing method is specified otherwise, select the appropriate curing method.

B. Length of Curing Period:

1. A "curing day" shall be any day on which the atmospheric temperature taken in the shade, or the air temperature adjacent to the concrete, remains above 50 F for at least 18 hours.

2. Cure concrete for a period of 7 consecutive days. In cold weather, when curing may be retarded, extend this period to 7 "curing days", up to a limit of 14 consecutive days.

C. Wet Curing:

1. Immediately following the finishing operations, cover concrete slabs, including roof slabs, with wet cotton mats or with a temporary covering of canvas or burlap. Keep thoroughly wet for a period of 4 curing days after the concrete is placed. The covering shall be held in direct contact with the concrete. A temporary covering shall be required when the size of slab, size of mats, or other factors dictate that the mats cannot be placed immediately after the finishing operations without marring the finishing of the slab.

2. Water used for curing shall be free from injurious amounts of oil, acid, alkali, salt, or other deleterious substances.

3. Canvas or burlap covering material shall weigh not less than 12 ounces per square yard. Place the sections with a lap at the edges of at least 8 inches. Saturate cover material with water previous to placing. Keep saturated as long as it remains in place. Use care in the placing of the cover material to prevent marring the concrete surface.

4. When temporary coverings are used, keep them in place only until the slab has sufficiently hardened so that a cotton mat covering can be substituted without marring or disturbing the slab finish. Thoroughly saturate cotton mats before placing and keep the mats on the slab in a saturated condition for a period of at least 4 curing days.

D. Sheet Curing: Sheet materials shall conform to ASTM C171. They shall be in contact with the entire concrete surface and applied according to the manufacturer's recommendations. Patch all holes. Where pedestrian traffic is unavoidable, provide suitable walkways to protect the sheet material.

E. Membrane Curing:

1. Membrane curing shall not be used on surfaces which receive paint, floor hardener, or plaster mix finish or other finish which would be hindered by the use of the curing compound.

2. Cover the surface of the concrete with a continuous, uniform, water-impermeable coating, conforming to ASTM C309 “Liquid Membrane Forming Compounds for Curing Concrete” and apply according to ACI 308.1.

3. Immediately after the removal of the side and end forms, apply a coating to the sides and ends of all concrete. Apply the solution under pressure with a spray nozzle so that the entire exposed surface is completely covered with a uniform film. The rate of application shall insure complete coverage, but the area covered shall not exceed 150 square feet per gallon of curing compound.

4. The coating shall be sufficiently transparent and free of permanent color to not result in a pronounced color change from that of the natural concrete at the conclusion of the curing period. The coating shall, however, contain a dye of color strength to render the film distinctively visible on the concrete for a period of at least 4 hours after application.

5. After application and under normal conditions, the curing compound shall be dry to touch within 1 hour and shall dry thoroughly and completely within 4 hours. When thoroughly dry, it shall provide a continuous flexible membrane free from cracks or pinholes and shall not disintegrate, check, peel, or crack during the required curing period.

6. If the seal is broken during the curing period, immediately repair it with additional sealing solution.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer’s approval.

B. After the tie rods are broken back or removed, thoroughly clean the holes to remove grease and loose particles. Patch holes with structural concrete repair material. After the holes are completely filled, strike off flush excess mortar and finish the surface to render the filled hole inconspicuous.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. If the surface of the concrete is bulged, uneven, or shows honeycombing or form marks, which in the Engineer’s opinion cannot be repaired satisfactorily, remove and replace the entire section.

2. Patch honeycomb and minor defects in all concrete surfaces with structural concrete repair material. Cut back each defective area with a pneumatic chipping tool as deep as the defect extends, but in no case less than 1/2 inch. Prepare the existing concrete according to the recommendations of patching material manufacturer’s. Apply repair material according to the manufacturer’s recommendations. Finish the surface of the patches to match finish on surrounding concrete.

3. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2-inch in any dimension in solid concrete but not less than 1-inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before

bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

4. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

1.

3.12 FIELD QUALITY CONTROL

A. Testing:

1. General:

a. Tests shall be required throughout the Work to monitor the quality of concrete. Samples shall be taken in accordance with ASTM C172.

b. The Engineer may waive these requirements on concrete placements of ten cubic yards or less. However, evidence shall be furnished showing a design mix which meets the Specifications.

c. Unless noted otherwise, testing of the materials, ready mix, transit mix, or central plant concrete will be by an independent testing agency. The Owner will select and pay for this service. A summary of all tests performed will be available. No concrete shall be placed without a representative present at either the plant or at the Site.

d. Unless the Owner's laboratory is on the Site, provide housing for the curing and storage of test specimens and equipment.

2. Slump Test: Slump tests, in accordance with ASTM C143, shall be used to indicate the workability and consistency of the concrete mix from batch to batch. Generally, a slump test shall be made at the start of operations each day, at regular intervals throughout a working day, and at any time when the appearance of the concrete suggests a change in uniformity.

3. Air Content Test: Tests for the concrete's air content shall be made in accordance with ASTM C231 or ASTM C173, at the point of delivery of concrete, prior to placing in forms. The test shall be made frequently to monitor a proper air content uniform from batch to batch.

4. Temperature Test: Test for the concrete's temperature in accordance with ASTM C1064 and as follows: the temperature of the concrete to be placed shall be taken with a thermometer immediately before placement, with the point of measurement being in the chute or bucket. Temperature test shall be performed for each truck. Record temperatures on batch ticket.

5. Compression Test:

   a. Compression test specimens shall be 6-by-12-inch concrete cylinders made and cured in accordance with ASTM C31. If the maximum aggregate size is no larger than 1 inch, 4-by-8-inch concrete cylinders are acceptable. No fewer than two 6-by-12-inch or three 4-by-8-inch specimens shall be made for each test Sample. Samples shall be taken at a minimum of every 50 cubic yards of concrete for each class placed. At least one set of test specimens per day shall be made for each class of concrete used that day. Specimens shall be cured under laboratory conditions specified in ASTM C31. Additional concrete cylinders may be required for curing on the job under actual job curing conditions. These Samples could be required when:

      1). There is a possibility of the air temperature surrounding the concrete falling below 40 F, or rising above 90 F.

      2). The curing procedure may need to be improved and/or lengthened.

      3). It is necessary to determine when the structure may be put into service.

   b. Compression strength tests shall be made on the laboratory-cured and job-cured concrete cylinders at 7 and 28 days, in accordance with ASTM C39. The value of each test result shall be the average compressive strength of all of the cylinders in the test Sample. All cylinders within a test Sample shall be taken at the same time from the same batch of concrete. For the 28-day cylinders, the strength level shall be satisfactory if the averages of all sets of three consecutive strength test results exceed the required design compressive strength, and no individual strength test result falls below the required compressive strength by more than 500 psi.

6. High Early Strength Concrete Test: When Type "III" High Early Strength Portland cement is used instead of Type "I" Portland cement, the minimum allowable 28-day strength for Type "I" Portland cement concrete shall be at 7 days. The ages at time of test for Type "III" shall be 3 days and 7 days, instead of 7 days and 28 days, respectively, for Type "I."
7. Failure to Meet Requirements:
    a. Should the 7-day strengths shown by the test specimens fall below the required values, additional curing shall be performed on those portions of the structures represented by the test specimens at the Contractor's expense. Test cores shall be obtained and tested in accordance with ASTM Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, Designation C 42. If additional curing does not give the strength required, the Owner reserves the right to require strengthening, replacement of those substandard portions of the structure, or additional testing, at the Contractor's expense.
    b. Upon receipt of the Contractor's written request, substandard concrete work may be reexamined in place by nondestructive testing methods or core Samples, in accordance with ACI 301. The services of an independent testing laboratory shall be retained and all expenses paid without compensation from the Owner. Laboratory results shall be evaluated by the Engineer, who shall make the final decision on acceptability of the concrete in question. Core Sample holes shall be repaired.
    c. Nondestructive Testing: : Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
    d. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Engineer.

B. The Owner may withhold payment for any section of concrete which does not meet the requirements of the Specifications. Withheld payment shall be based upon the unit prices established for concrete and reinforcing steel. Payment shall be withheld until the unacceptable concrete has been refinished, removed and replaced or otherwise brought into conformance with the Specifications.

C. PVC Waterstops: Waterstops shall be observed by the Owner's representative prior to concrete placement. Unacceptable splicing defects include:
    1. Misalignment of center bulb, ribs, and end bulbs greater than 1/16 inch.
    2. Bond failure at joint deeper than 1/16 inch.
    3. Misalignment which reduces waterstop cross-section more than 15 percent.
    4. Bubble or visible porosity in the weld.
    5. Visible signs of splice separation when a cooled splice is bent by hand at a sharp angle.
    6. Charred or burnt material.

END OF SECTION

Concrete Mix Design

Project Name: _____

FNI Project Number: _____

Project Location: _____

Owner: _____

General Contractor: _____

Mix Number / Class: _____

A. Mix Design:

Cement	=	_____	lb/yd³
Fly Ash	=	_____	lb/yd³
Other Cementitious Material: _____	=	_____	lb/yd³
Fine Aggregate	=	_____	lb/yd³
Coarse Aggregate	=	_____	lb/yd³
Water	=	_____	lb/yd³
Water Reducing Admixture	=	_____	oz/yd³
High Range Water Reducer	=	_____	oz/yd³
Air Entraining Admixture	=	_____	oz/yd³
Other Admixture: _____	=	_____	oz/yd³
Slump	=	_____	inches
Gross Weight	=	_____	lb/yd³
Air Content	=	_____	percent
Water/Cement Ratio	=	_____	

B. Materials:

	Source	ASTM	Type	Remarks
Cement				
Fly Ash				
Other Cementitious Material: _____				
Fine Aggregate				
Coarse Aggregate				
Water				
Water Reducer				
High Range Water Reducer				
Air Entraining				
Other Admixture: _____				

C. Determination of Average Strength Required (fcr'):

1. Test Records Available:

A. Summary of Test Records (Provide Supporting Documentation):

Test Group No.	No. of Consecutive Tests	Specified Strength (psi)	Standard Deviation (psi)
Average Standard Deviation:			

B. Standard Deviation Modification Factor (ACI 30 1, Table 4.2.3.3.a): ____.

C. Standard Deviation Used: ____.

D. Average Compressive Strength Required: ____.

2. Test Records Not Available:

A. Average Compressive Strength Required (ACI 30 1, Table 4.2.3.3.b, if required): ____.

D. Documentation of Required Average Compressive Strength (Check One):

1. Field Strength:

a. Field Strength Test Records (ACI 30 1, Table 4.2.3.3.a): ____. *Complete Attachment A.

2. Trial Mixtures:

a. Trial Mixtures (ACI 301, Table 4.2.3.3.b, if required): ____. *Complete Attachment B.

I, _____ certify that the above information is correct and all gradations, cement certifications, and test results are located at our place of business for review by the Engineer.

Name: _____ Date: _____

Title: _____

Company: _____

Address: _____

_____

_____

Attachment A

Documentation of Required Average Strength – Field Strength Records

(ACI 301, 4.2.3.4.a)

A. Summary of Test Records (Provide Supporting Documentation):

Test Record No.	No. of Tests in Record	Duration of Record (days)	Water-Cementitious Materials Ratio	Average Strength (psi)

B. Interpolation used? _____.

1. Provide an interpolation calculation or plot of strength versus proportions.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Source of each material used.
4. Amount of water.
5. Proportions of each aggregate material per cubic yard.
6. Gross weight per cubic yard.
7. Measured slump.
8. Measured air content.
9. Results of consecutive strength tests.

END OF ATTACHEMENT A

Attachment B

Documentation of Required Average Strength – Trial Mixtures

(ACI 301, 4.2.3.4.b)

A. Summary of Test Record(s):

Trial Mix No.	7-Day Tests		28-Day Tests		Water-Cementitious Materials Ratio	Slump (in)	Air Content (percent)	Temperature (F)
	No. of Test Cylinders	Strength (psi)	No. of Test Cylinders	Strength (psi)				

B. Maximum water-cementitious materials ratio _____.

1. Provide an interpolation calculation or plot of strength versus water-cementitious materials ratio.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Amount of water used in trial mixes.
4. Proportions of each aggregate material per cubic yard.
5. Gross weight per cubic yard.
6. Measured slump.
7. Measured air content.
8. Compressive strength developed at 7 days and 28 days, from not less than three test cylinders cast for each 7-day and 28-day test.

END OF ATTACHMENT B

DIVISION 05

METALS

05 50 00 METAL FABRICATIONS

1.00 GENERAL

1.01 RELATED DOCUMENTS

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

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Metal nosings and treads.

2. Grout.

B. Record Data: AIS Certifications

C. Shop Drawings: Show fabrication and installation details for metal fabrications.

Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.03 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

B. Welding certificates.

1.04 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code - Steel.”

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, “Structural Welding Code - Steel.”

2. AWS D1.2/D1.2M, “Structural Welding Code - Aluminum.”

3. AWS D1.6, “Structural Welding Code - Stainless Steel.”

1.05 PROJECT CONDITIONS

Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.06 COORDINATION

Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

2.00 PRODUCTS

2.01 METALS, GENERAL

Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

A. Steel Plates, Shapes, and Bars: As indicated.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A240 or ASTM A666, Type 316L.

C. Stainless-Steel Bars and Shapes: ASTM A276, Type 316L.

2.03 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B632, Alloy 6061-T6.

D. Aluminum Castings: ASTM B26, Alloy 443.0-F.

2.04 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A325, Type 3; with hex nuts, ASTM A563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

Hot-dip galvanized or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

2.07 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.08 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Dull Satin Finish: No. 6.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.09 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

3.00 EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.03 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's “Specification for Structural Joints Using ASTM A325 or A490 Bolts.”

C. Welded Connections: Field welds will be 100 percent visually inspected according to AWS D1.1.

1. Full penetration welds and other welds as specified: In addition to 100 percent visual inspection, 10 percent of connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
    a. Liquid Penetrant Inspection: ASTM E165.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1. Corrective measures shall be taken when welding is unsatisfactory or indicates inferior workmanship. Chip and grind if the removal of part of the weld or a portion of the base metal is required. Where deposition of additional weld material is necessary, the sides of the area to be welded shall have no less than one to one (1:1) slope to allow room for

depositing new material. Correct defective or unsound welds by the removal and replacement of the entire weld using the following procedures:

a. Excessive Convexity: Reduce to size by removal of excess weld metal by grinding.

b. Shrinkage Cracks, Cracks in Base Metal, Craters and Excessive Porosity: Remove defective portions of base and weld material down to sound metal, and deposit additional sound material.

c. Undercutting, Undersize, and Excessive Concavity: Clean and deposit additional weld metal.

d. Overlapping and Incomplete Fusion: Remove and replace the defective portion of the weld.

e. Slag Inclusion: Remove those parts of the welds containing slag. Fill with sound weld metal.

f. Removal of Adjacent Base Metal during Welding: Clean and form full size by depositing weld material.

2. Remove cracked welds throughout their length.

3. Where work performed subsequently to the making of the deficient weld has rendered the weld inaccessible, or has caused new conditions which make connection of the deficiency dangerous or ineffectual, restore the original conditions by removing welds or members, or both before making the necessary corrections. Another option is to compensate for the deficiency with additional work according to the revised design, approved by the Engineer.

4. Cut apart and reweld improperly fitted and misaligned parts.

5. Straighten members distorted by heat of welding using mechanical means or by carefully supervised application of a limited amount of localized heat. Heated areas shall not exceed 1200 degrees Fahrenheit as measured by Tempilsticks. Parts to be heated for straightening shall be free from external stress forces, except when mechanical means are used in conjunction with heat application.

6. If faulty welding or its removal for rewelding damages the base metal so that, in the Engineer's judgment, it is not in accordance with the intent of the Contract Documents, remove and replace the damaged material and compensate for the deficiency in a manner acceptable to the Engineer.

7. Maximum space between pieces or members for fillet welds shall be 1/16 inch. Only effective portion shall be considered in measuring fillet welds.

END OF SECTION

DIVISION 08

OPENINGS

08 31 00 FLOOR ACCESS DOORS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install access doors as indicated on the drawings or specified herein.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and include:

A. Record Data:

1. Manufacturer’s Data Sheets
2. AIS Certifications
3. Warranty Documentation

B. O&M Data

1.03 DELIVERY AND STORAGE

Ship products in protective wood crates. Leave in crates until ready to install. Store on wood platform raised 6" above surrounding grade and protect with weather resistant covering.

1.04 JOB CONDITIONS

Floor access door frames shall be set into forms as concrete is placed. Be sure that frames are set and braced to prevent movement during placement of concrete.

1.05 GUARANTEES AND WARRANTY

Manufacturer shall warrant that the complete system shall be free from defective material and workmanship for a period of five (5) years from date of substantial completion. The warranty shall be provided in writing starting from the date of acceptance by the Owner.

2.00 PRODUCTS

2.01 FLOOR ACCESS DOORS

A. Floor access door channel frames shall be 6061-T6 aluminum. Channel frame shall be provided with anchor flange around the perimeter.

B. Door leaf shall be 1/4" 5086 aluminum diamond pattern to withstand a live load of 300 psf. Door shall have compression spring operators for easy operation, and an automatic hold-open

arm with release handle. A snap lock with removable handle shall be provided. The locked hatch will control unauthorized entry to the vault.

C. A 1-1/2" drainage coupling shall be located in the corner of the frame.

D. All hardware including the latch and lifting mechanism assemblies, hold open devices, brackets, hinges, pins and fasteners shall be 316 stainless steel.

E. Mill-finish aluminum frame must have bituminous coating applied to the exterior where in contact with concrete.

F. Approved Manufacturers:

1. Halliday
2. U.S.F. Fabrication
3. Bilco
4. EJ
5. Approved Equal

2.02 GRATED FALL PROTECTION SYSTEM

A. Where indicated on the plans or within this specification, hatches shall be protected with a grated fall protection system.

B. Design of grate shall assure that the fall through protection is in place before the door(s) of the hatch can be closed.

C. Grates shall incorporate a pull opening arm, designed so the grate can be pulled open.

D. Opening arms shall include a hasp to allow the hatches to be locked with a pad lock in the closed position.

E. Safety grate shall be rated for 300 lbs/sq. ft.

F. Safety grate shall have permanent hinging system and be lockable in the 90-degree open position.

G. Aluminum safety grate shall be coated with a safety orange color. Coating shall be a thermosetting, powder coat finish, 2-4 mils., minimum.

H. Materials

1. Grate material shall be 6061 aluminum for bars, angles and extrusions. 1/4” diamond plating shall be 5086 aluminum.
2. All hardware and hinges shall be constructed of 316 stainless steel.

I. Approved Manufacturers:

1. Safe-Hatch
2. Approved Equal

3.00 EXECUTION

3.01 FLOOR ACCESS DOOR INSTALLATION

A. Floor access doors and frames shall be installed in accordance with manufacturer's written instructions. Access door frames shall be cast into concrete structures. Concrete shall be worked around frame to ensure complete embedment of anchors. Frame shall be secured to prevent movement during placement of concrete. Frames shall be level.

B. Provide PVC drains for access door integral drains. Connect drain piping to drain outlet of channel frame and extend to nearest floor drain or sump. Drain shall extend to within 1 foot of floor drain of sump and shall not be routed across any access ladders or floor walking surfaces.

C. Floor access door frames shall be set level within 3/32" across diagonal corners, unless floor slab is designed to be out of level, then the access door shall be set to same place as floor slab.

D. Aluminum access door frames in contact with concrete shall be given a heavy coat of bituminous paint prior to installation.

3.02 SCHEDULE

Hatch Location	Hatch Dimension	Hatch Loading	Leaf Construction	Grated Fall Protection
LS #4 Wet Well Pump Hatches (1 triple leaf unit; 3 doors)	108” L x 48” W	300 psf	Triple Leaf, single door	Yes
LS #4 Maintenance Hatch (1 each)	36” L x 36” W	300 psf	Single Door	Yes
LS #17 Wet Well Pump Hatches (1 each)	60” L x 48” W	300 psf	Double Door	Yes
LS #35 Wet Well Pump Hatches (1 double leaf unit; 2 doors)	26” L x 34” W	300 psf	Double Leaf, single door	Yes
LS #35 Valve Vault Access Hatches (1 each)	46” L x 34” W	300 psf	Single Door	Yes

Notes:

A. Provide Safety Grate retrofit for existing hatches at Lift Stations Nos. 10 and 25 per Section 44 42 56.04 “Submersible Pumps”.
B. Refer to contract drawings for orientation of hinges.
C. Hatch dimensions indicate unobstructed clear opening, including safety grating.

END OF SECTION

DIVISION 09

FINISHES

09 96 00.01 HIGH-PERFORMANCE COATINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to apply protective coatings to material and equipment as specified herein, including the preparation of surfaces prior to application of coatings.

B. Protective coatings are special coatings to be used at specific locations or on specific surfaces as indicated herein and are complementary to the coating surfaces specified in Section 09 96 01 “Concrete Protective Coatings” in that every surface of every description, except those which are specifically noted not to receive a coating finish, must be covered by a paint system as specified in this Section or in Section 09 96 01 “Concrete Protective Coatings”.

C. Protective coatings must be applied to the following surfaces:

1. Metal surfaces located outside of buildings and other structures anywhere on the Site.
2. New piping and Valves
3. Existing piping systems
4. Petrolatum (Wax) Tape at the following locations:
    a. Buried flexible couplings

D. The following must not be coated and must be protected from drips, overspray, etc. unless indicated otherwise

1. Stainless steel piping, materials and equipment
2. Galvanized steel piping, materials and equipment unless specifically indicated to be coated.
3. Aluminum materials and equipment
4. Interior electrical items

E. Special applications for painting include the following:

1. Aluminum surfaces in contact with or embedded in concrete must be treated in accordance with Section 03 30 00 “Cast-In-Place Concrete.”
2. Buried pipe and valves must receive a shop applied protective coating as described in the appropriate section of the Specifications.

F. Contain, treat, and dispose of any dust, spray, drainage, or spillage resulting from coating operations. It is the Contractor’s responsibility to determine if the materials to be disposed of are classified as Hazardous Waste. Disposed of waste, hazardous or otherwise, must be in accordance with applicable regulations. The Contractor must be aware of and understand the regulations concerning disposal of waste generated by coating operations.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers: Products which comply with the Contract Documents and are manufactured by the following companies will be acceptable:

1. Tnemec Company, Inc.
2. Carboline.
3. PPG Protective & Marine Coatings
4. The Sherwin-Williams Company.
5. Akzo Nobel / International Paint, LLC.
6. ICI Devoe High Performance Coatings.
7. Plasite Protective Coatings.

It is desired that the paint products be furnished by as few manufacturers as possible to meet the requirements of the Specifications. Coating products of the same type must be supplied by the same manufacturer. Do not mix products from different sources.

B. Applicator's Qualifications: Applicators must be qualified in this line of work and have a minimum of 5 years' experience in the application of the protective coatings of the types specified herein. Submit a list of recent projects and names of references for those projects.

C. Product Quality:

1. Use only the coatings specified in this Section. Use only those thinners and solvents recommended by the manufacturer, only in the amounts necessary to produce the manufacturer's recommended spreading rate, and in amounts not exceeding the maximum quantities stated in the manufacturer's literature.
2. The coating material must not show excessive settling in a freshly opened full can and must be easily re-dispersed with a paddle to a smooth, homogeneous state. It must show no curdling, livering, caking, or color separation and must be free of lumps or skim surfaces.

D. Inspection

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' notice prior to start of surface preparation work or coating application work.
3. Perform Work only in the presence of Engineer, unless Engineer grants prior approval to perform such Work in Engineer's absence. Approval to perform Work in the Engineer's absence is limited to the current day unless specifically noted to extend beyond the completion of the work day.
4. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, must not be construed to relieve the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

5. The Contractor is solely responsible for testing for this Section, at no further cost to the Owner. The Engineer may also make such tests if it is considered necessary. Cooperate with the Engineer, providing equipment, scaffolds, and other equipment as requested by the Engineer.

E. Testing Equipment: Furnish the testing apparatus necessary for testing coatings, including the following:

1. One set of U.S. Department of Commerce thickness calibration plates, certified by the National Bureau of Standards, to test dry film thickness.
2. Wet-film thickness gauges. Give one to Owner's representative. Each painter must keep one to test paint as it is applied.
3. One electronic dry-film thickness gauge capable or measuring 0-200 mils with calibration standards approved by the Bureau of Standards.
4. One Elcometer 319 Dewpoint Meter or approved equal.
5. One Tinker and Rasor Model M 1 Holiday Detector and recommended wetting agent and/or High Voltage Holiday Detector if required for coating thickness specified.
6. One set of SSPC VIS 1**,** 3 and 4 **-** Visual Standards as applicable.

F. Testing Reports: Submit an inspection report for each coating applied on the Project. The testing report must be completed on a form furnished by the Engineer and must bear the signature of the Contractor and the Owner's representative.

G. The Contractor must schedule a construction conference prior to any field work being completed. The meeting will be onsite and will include the Owner, Contractor, painting superintendent, Engineer, Owner's Representative and Coating Manufacturer's Representative. At this meeting the coating plan and schedule will be reviewed in detail.

1.03 SUBMITTALS

A. Submittals must be in accordance with Section 01 33 00 "Document Management".

B. The following Record Data for products, including manufacturer's data sheets, are due prior to ordering coating and surface preparation materials:

1. Coating Manufacturer's color selection literature for coating materials and caulk.
2. Sample warranty document for products.
3. Provide certification from the manufacturer that all coatings will not contain more than 0.06% by weight of lead in the cured coating for each coat applied.
4. Coating Manufacturer's Product Information and Safety Data Sheets (SDS) for each coating and caulk material. Product Information must include the following:
    a. The Manufacturer's published instructions for use in specifying and applying all proposed coatings.
    b. Application instructions written and published by the Coating Manufacturer.
    c. All anticipated limitations, precautions and requirements that may adversely affect the coating, that may cause unsatisfactory results after the application or that may cause the coating not to serve the purpose for which it was intended, must be

clearly and completely stated in the instructions. Limitations and requirements must include, but are not necessarily limited to the following:

1) Surface preparation
2) Method(s) of application
3) Thickness of each coat (maximum and minimum DFT)
4) Drying and curing time of each coat
5) Time (minimum and maximum) allowed between coats
6) Thinner and use of thinner
7) Proper mixing of coating before application
8) Weather limitations during and after application (temperature and humidity, time weighted)
9) Physical properties of coating, including percent solids content by volume
10) Equipment settings (air cap, fluid tip, equipment pressure settings, etc.)
11) Pot life at various temperature and humidity conditions.
12) Provide documentation that interior coating system is compatible with the cathodic protection system.

C. The following samples are required prior to ordering the materials:

1. Three (3) samples of selected exterior finish colors for approval on 6” x 6” swatches. Label each swatch with the manufacturer’s name, coating name/type, color name and number.

D. The following Record Data is required prior to coating work:

1. Coating Plan:

a. Anticipated coating process schedule by date, including dates when hold-point inspections are anticipated. Schedule must indicate detailed activities on a daily basis.

b. Detailed procedures and schedule for all pre-cleaning, surface preparation and application of coating, including touch-up and repair procedures for all coating systems.

c. Recoat schedule on the submitted coating materials.

d. Data sheets must include curing characteristics and recommendations regarding complete coating curing.

e. Provide a written plan documenting how spent cleaning debris and/or paint over spray or droplets will be contained/confined to the jobsite and tank site during the surface preparation and coating application operations. Reasonable care must be exercised by the Contractor to prevent damage, nuisance, or hazardous conditions to adjacent or nearby property Owners. Include all materials and method to be used for protection of exterior surfaces, and allow for recovery and disposal of paint scraps and blast media.

2. Provide documentation on proposed containment system methods for blasting and coating operations.

3. The Contractor must submit evidence of notification of the appropriate office of the Texas Commission on Environmental Quality (TCEQ) prior to abrasive blasting as required. Submit copies of any obtained permits.

4. Coating Manifest - Within 48 hours of coating delivery to the job site, the Contractor must record the batch number stamped on each coating container and submit a typed list to the Owner's Representative. Minimum information required is listed below.

   a. Date of delivery to job site

   b. Name and signature of Superintendent recording the data

   c. List of batch number including corresponding coating identification, color, date of manufacture and volume of each container

E. The following Certified Test Report(s) are required prior to coating work:

1. SDS sheets for all abrasive to be used on the project.

2. Certification and laboratory test results indicating recycled metallic abrasive per SSPC-AB 2 or 4 and atomic absorption test results.

1.04 STANDARDS

A. The applicable provisions of the following standards apply as if written here in their entirety. Adhere to the latest standards and codes published by the following organizations.

B. In the event of a conflict between the published standards, codes, and this Section, the more stringent requirement govern as interpreted by the Engineer.

1. ANSI (American National Standards Institute)

ANSI/NSF Standard 61	Drinking Water Components

2. ASTM (American Society for Testing and Materials)

ASTM D 523	Standard Test Method for Specular Gloss
ASTM D 610	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D 4214	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D4259	Standard Practice for Abrading Concrete
ASTM D4260	Standard Practice for Liquid and Gelled Acid Etching of Concrete
ASTM D 4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D 4285	Standard Test Method of Indicating Oil and Water in Compressed Air
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tester
ASTM D4787	Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Pull-Off Adhesion Testers
ASTM D7682	Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty
ASTM E337	Standard Practice Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

3. AWWA (American Water Works Association)

AWWA C210	Liquid-Epoxy Coating and Linings for Steel Water Pipelines
AWWA C222	Polyurethane Coatings and Linings for Steel Water Pipe and Fittings

4. Consumer Product Safety Act, Part 1303

5. Environmental Protection Agency (EPA)

63 FR 48848	Clean Air Act – National Volatile Organize Compound Emission Standards for Architectural Coatings

6. International Concrete Repair Institute (ICRI)

Technical Guideline No. 03732	Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers and Polymer Overlays
Standard 310.2	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays and Concrete Repair with CSP Chips

7. NACE International (National Association of Corrosion Engineers)

NACE TPC2	Coating and Lining for Immersion Service: Chapter Safety, Chapter 2 Surface Preparation, Chapter 3 Curing, and Chapter 4 Inspection
NACE SP0178	Design Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service
NACE SP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0178	Surface Finishing of Welds Prior to Coating; Weld Replica Only to be used with NACE SP0178
NACE RP0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape

8. National Association of Pipe Fabricators (NAPF)

NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

9. OSHA (Occupational Safety & Health Administration)

1915.35 Standards - 29CFR	Painting
1926.62 Standards – 29 CFR	Lead

10. SSPC (Society for Protective Coatings)

SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC-VIS 3	Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning
SSPC Vol. 1	Good Painting Practices
SSPC-AB1	Mineral and Slag Abrasives
SSPC-AB2	Cleanliness of Recycled Ferrous Metallic Abrasives
SSPC-AB3	Ferrous Metallic Abrasives
SSPC-AB4	Recyclable Encapsulated Abrasive Media in a Compressible Matrix
SSPC-SP1	Solvent Cleaning
SSPC-SP2	Hand Tool Cleaning
SSPC-SP3	Power Tool Cleaning
SSPC-SP11	Bare Metal Power Tool Cleaning
SSPC-SP I6	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-PA 1	Shop, Field and Maintenance Painting of Steel
SSPC-PA 2	Determining Compliance to Required DFT
SSPC-PA 10	Guide to Safety and Health Requirements for Industrial Painting Projects
SSPC-PA 17	Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements
SSPC-Guide 6 (CON)	Containment of Debris
SSPC-Guide 12	Illumination of Painting Projects
SSPC-Guide 15	Retrieval and Analysis of Soluble Salts

11. SSPC/NACE International Joint Standards

SSPC-SP5/NACE 1	White Metal Blast Cleaning
SSPC-SP6/NACE 3	Commercial Blast Cleaning
SSPC-SP7/NACE 4	Brush - Off Blast Cleaning
SSPC-SP10/NACE 2	Near - White Metal Blast Cleaning
SSPC-SP13/NACE 6	Surface Preparation of Concrete

12. Texas Commission on Environmental Quality (TCEQ)

30 TAC Chapter 290 Subchapter D	Rules and Regulations for Public Water Systems

1.05 DELIVERY AND STORAGE

A. Deliver coating products to the Site in original unopened containers, with manufacturer's label and batch number attached. Do not apply products until the Owner's field representative has approved the product for use.

B. Use one location at each site for the storage of coating products. Protect the floor from spills and other damage. Protect the products from extreme heat or cold. Keep containers covered. Keep the storage rooms clean of trash and debris. Dispose of oily or used rags daily. Under no circumstances will they be allowed to accumulate. Take precautions to prevent fires. The storage of flammable liquids must comply with the City, State, or other fire codes.

C. Storage of coatings and other products must be in accordance with the manufacturer's requirements. Coatings that have been damage or not stored properly must not be applied and must be removed from the site.

D. All products and coatings that are not approved for the project must be removed from the site and must not be stored at the site.

E. All materials must be delivered to the job site in original sealed containers with the date of manufacture and batch number stamped thereon by the Coating Manufacturer. Materials are subject to random observations by the Owner's Representative at the job site.

1.06 ENVIRONMENTAL CONDITIONS:

A. Do not apply coatings under conditions that are unsuitable for the production of good results. Remove trash and debris from enclosed buildings and thoroughly clean prior to application of coatings. Do not begin application of coatings in areas where other trades are working, or where construction activities result in airborne dust or other debris. Do not apply coatings in conditions which do not conform to the recommendations of the coatings manufacturer.

B. Coatings must only be applied when conditions fall within the parameters listed in the manufacturer's printed data.

C. Contractor must provide dehumidification equipment sized to maintain dew point temperature 5˚ F or more above surface temperature of metal surfaces to be prepared and coated.

D. Do not apply any coatings when weather conditions are unfavorable. In the event that climatic conditions are not conducive for best results, postpone application of coatings until conditions conform to the manufacturer's recommendations and the provisions of this Section.

E. Do not apply coatings to a wet or damp surface in wet or damp weather conditions, or when there is dust in the air. Surfaces exposed to direct sunlight must be shaded by awnings or other protective devices while coatings are being applied, if recommended by coating manufacturer. When necessary, provide temporary heating devices of a type that produces no fumes or water vapor which will discolor the paint system.

F. Heating and Dehumidification

1. Dehumidification equipment must be used to control the environment during surface preparation, rehabilitation, coating application and coating curing at no additional cost to the Owner, if acceptable environmental conditions cannot be met.

   If the Contractor cannot meet the required environmental conditions to apply the interior coating system per this specification and the coating manufacturer's written recommendations, Contractor will cease operations until approved dehumidification equipment has been provided and acceptable environmental conditions are achieved.

   If coating system is applied without dehumidification or in conditions not acceptable by this specification and by the coating manufacturer's written requirements, Contractor must fully remove coating system applied and replace per the Engineer's direction.

2. The Contractor must furnish all labor, materials, equipment, fabrication and quality control inspections, and all other incidentals required to control and maintain the environment of the reservoir within the parameters stated in this specification and must incorporate these and any other expenses into their bid.

3. The Owner reserves the rights, in the event the dehumidification equipment is not performing to the minimum requirements stated in this specification, to require the Contractor to modify and or add additional equipment to satisfy the conditions of this specification, at the sole cost to the Contractor.

4. It is the Contractor's responsibility to provide adequate dehumidification equipment to meet this specification and Coating Manufacturer's requirements. The Coating Manufacturer's limits of surface temperature, tank inside air temperature and relative humidity requirements will govern, if more stringent than the requirements stated within this specification.

G. Forced Ventilation

1. Provide continuous forced fresh air ventilation when working inside of containment systems or enclosed areas that are not openly vented from the beginning of surface preparation through final coating operations and coating curing.

2. Forced ventilation must be supplied per the recoat time required by the coating manufacturer and at least 48 hours after the final coat has been applied.

3. From the beginning of interior coating applications to until the coating system is cured, the Contractor must monitor the air for the lower explosion limit (LEL) as published in the Coating Manufacturer's product SDS's.

4. Contractor is responsible for supplying, installing and maintaining the forced ventilation system.

H. Containment System

1. Contractor must provide containment methods, either full or partial, which allows for the containment of the environmentally sensitive waste, dust and paint over spray that will be generated during the abrasive blasting and painting operation.

2. Minimum Containment for Field Surface Preparation

   a. Provide a minimum SSPC Guide 6 (CON) Class 3A.D1.E3 containment system when dry abrasive blasting.

b. Provide a minimum SSPC Guide 6 (CON) Class 2W containment system when wet abrasive blasting. All water must be contained and properly disposed of.

c. Provide a minimum SSPC Guide 6 (CON) Class 2P.E3 containment system when power tool cleaning.

3. The ground surrounding the project area must be protected from all debris, emissions, dust, and other materials generated in the cleaning operations with a minimum of two layers of polyethylene covered with plywood or the same material used for the perimeter containment system.

4. Containment is not required when blasting on the interior of a completely enclosed area (i.e. roof is in place) as long as no visible emissions are created.

5. The Contractor must ensure that no spent cleaning/blasting debris, dust, overspray, coating droplets, or emissions of any kind, escape to the atmosphere, or to adjacent buildings, private property, work sites, parking lots, etc.

6. The Owner reserves the right to stop work or require containment, additional containment or different containment methods if the Contractor's operations create a nuisance beyond the tank site property line in the sole opinion of the Owner, the Engineer, the Owner's Representative, any regulatory agency, or neighbor. All costs of providing an adequate containment system must be included by the Contractor in the Base Bid.

7. The Contractor must be responsible for all materials that are used and for any apparatus used to contain dust emissions, debris, overspray, and coating droplets. The containment system attachments to existing or proposed structures must be designed by a professional engineer (P.E.) registered in the State of Texas not to impose excessive loading on the structure. The Contractor must submit the P.E. designed and sealed details of the containment system on the tank.

   Any damage to the structure(s) as a direct or indirect result of the containment system must be repaired or sections replaced by the Contractor at no additional cost to the Owner. Neither the Owner nor the Owner's Engineer assumes any responsibility for the structural ability of the structure to support the containment system.

8. If tarps are used as part of the containment system, the tarps must be an impervious, solid, flame-resistant material, reinforced with a fiber mesh and must allow as much light as possible to pass through the material.

I. Visible Emissions

1. Contractor must control visible emissions and releases while dust producing activities are underway.

2. Visible emissions more than SSPC Guide 6, Level 1 (1% of the workday or 5 minutes in an 8-hour shift) are unacceptable. Sustained emissions of more than 1 minute, regardless of the total time of emissions for the day is unacceptable. If unacceptable emissions are observed, Contractor must shut down immediately and correct the situation and clean up any debris generated from the release to the satisfaction of the Engineer before continuing work.

1.07 WORKING CONDITIONS:

A. Provide adequate lighting at any location that coatings are being applied or testing is performed. Illumination must be of sufficient intensity to achieve good results. Provide explosion-proof lighting when required.

B. Temporary ladders and scaffolds must conform to applicable safety requirements. Erect temporary scaffolds where needed to cover large areas. Provide ladders or scaffolding during testing procedures.

1.08 GUARANTEES

A. Protective coating must be guaranteed for a period of 1-year from the date of the Owner's acceptance of the Project.

B. A warranty inspection must be conducted prior to the end of the warranty period. Any defective work discovered at this date must be corrected by the Contractor in accordance with the Contract Documents at no additional cost to the Owner.

2.00 PRODUCTS

2.01 GENERAL COATING REQUIREMENTS

A. All coatings must be free of heavy metals such as arsenic, barium, chromium, selenium, silver, lead, mercury and cadmium.

B. All coatings in contact with potable water must be certified as per ANSI/National Sanitation Foundation (NSF), Standard 61.

C. All coatings submitted or used on this project must comply with the EPA's Clean Air Act for maximum VOC (volatile organic compound) limits.

D. Finish coatings must be from the same batch.

2.02 MATERIALS

A. Coating products are to be as follows:

Type A - Alkyd-Phenolic Universal Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 37H Chem-Prime H.S.
Sherwin-Williams	Kem Kromik Universal
Akzo Nobel / International Paint, LLC	Interlac 573
Devoe Coatings	Devprime 1403
Carboline	Carbocoat 150UP
PPG	Multiprime 4360

Type B - Epoxy-Polyamide Primer	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Copoxy Primer
Akzo Nobel / International Paint, LLC	Intergard 251; Intergard 269 for valves and gates, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Devran 201V Series
Carboline	890
PPG	Amercoat 385

Type C – Penetrating Epoxy Pre-Primer	
Manufacturer	**Approved Coating**
Tnemec	Approved Equal
Sherwin-Williams	Macropoxy 920 Pre-Prime
Akzo Nobel / International Paint, LLC	Interbond 600
Devoe Coatings	Approved Equal
Carboline	Rustbond Penetrating Sealer
PPG	Amerlock Sealer

Type D - Inorganic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-98 Tneme-Zinc
Carboline	Carbozinc 12 VOC
Sherwin-Williams	Zinc Clad II Plus
PPG	Dimetcote 9 VOC
Approved Manufacturer	Approved Equal

Type E - Organic Zinc Primer (Minimum 80% Zinc by Weight)	
Manufacturer	**Approved Coating**
Tnemec	Series 90-97 or 90G-1K97 Tneme-Zinc
Carboline	Carbozinc 859
Sherwin-Williams	Corothane I Galvapac
PPG	Amercoat 68HS
Akzo Nobel / International Paint, LLC	Interzinc 52
Approved Manufacturer	Approved Equal

Type F – Alkyd Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 2H Hi-Build Tneme-Gloss
Sherwin-Williams	DTM Alkyd Enamel
Akzo Nobel / International Paint, LLC	Interlac 665
Devoe Coatings	Devlac 1431
Carboline	Carbocoat 8225
PPG	Fast Dry 35

Type G - Epoxy-Polyamide Coatings	
Manufacturer	**Approved Coating**
Tnemec	Series 66
Sherwin-Williams	Macropoxy 646 Epoxy
Akzo Nobel / International Paint, LLC	Intergurd 475HS; Interseal 670HS for valves and gates, PVC pipe and conduit, submerged structural steel and misc. metals, and submerged piping
Devoe Coatings	Bar-Rust 235
Carboline	Carboguard 60
PPG	Amerlock 385

Type H - Epoxy-Polyamide Coatings for Potable Water (NSF 61 Certified)	
Manufacturer	**Approved Coating**
Tnemec	Series 20 Pota-Pox or N140 Pota-Pox Plus
Sherwin-Williams	Tank Clad Epoxy
Akzo Nobel / International Paint, LLC	Interline 850 or Interseal 670HS (NSF colors)
Devoe Coatings	Bar-Rust 233H Series
Carboline	Carboguard 61
PPG	Amerlock 2/400

Type I - Aliphatic Polyurethane Enamel	
Manufacturer	**Approved Coating**
Tnemec	Series 1074 Endura-Shield II
Sherwin-Williams	Hi-Solids Polyurethane
Akzo Nobel / International Paint, LLC	Interthane 990 Series
Devoe Coatings	Devthane 379 Series
Carboline	Carbothane 133HB (Satin) or Carbothane 134HG (High Gloss)
PPG	Pitthane Ultra Series

Type J - Silicone Aluminum Coatings For High Temperature	
Manufacturer	**Approved Coating**
Tnemec	Series 39 Silicone Aluminum
Sherwin-Williams	Silver Brite Aluminum B59S8
Akzo Nobel / International Paint, LLC	Intertherm 50 Series
Devoe Coatings	Intertherm 50 Series
PPG	Hi-Temp 500
Carboline	Carbozinc 11; Finish: Thermaline 4700 Series (up to 1000°F); Thermaline 4900 (up to 450°F)

Type K- Epoxy Concrete Coating	
Manufacturer	**Approved Coating**
Tnemec	Series 46H-413 Hi-Build Tneme-Tar
Sherwin-Williams	Tar Guard Epoxy
Akzo Nobel / International Paint, LLC	Interzone 954
Devoe Coatings	Devtar 5A Series
PPG	Amercoat 78HB Coal Tar Epoxy
Carboline	Bitumastic 300M

Type L – Novolac Vinyl Ester/Novolac Epoxy Concrete Coating – High Friction Surface (HFS)	
Manufacturer	**Approved Coating**
Tnemec	Series G436 Perma-Shield / Chembloc Series 252SC
Sherwin Williams	Dura-Plate 8200
Akzo Nobel / International Paint, LLC	Ceilcote 380 / 242GF Flakeline System
PPG	SFT 675 / FlakeRez 8303
Carboline	Carboguard 510 Series / Plasite 4500 Series

Type M - High Solids Epoxy Siloxane	
Manufacturer	**Approved Coating**
Carboline	Carboxane 2000
Sherwin-Williams	Sher-Loxane 800
PPG	PSX 700 Polysiloxane
Approved Manufacturer	Approved Equal

Type N - Epoxy Mastic	
Manufacturer	**Approved Coating**
Carboline	Carbomastic 15
Sherwin-Williams	Epoxy Mastic II
PPG	Amerlock 2/400 AL
Tnemec	Chembuild Series 135
AkzoNobel/International Paint, LLC	Interseal 670HS

Type O – Elastomeric Polyurethane Hybrid	
Manufacturer	**Approved Coating**
Carboline	Reactamine 760 Series
Sherwin-Williams	Sherflex S
PPG	Amerthane 490
Tnemec	Elasto-Shield Series 406
AkzoNobel/International Paint, LLC	Polibrid 705E Elastomeric

Type P – Glass Flake Reinforced Epoxy	
Manufacturer	**Approved Coating**
Carboline	Approved Equal
Sherwin-Williams	Sher-Glass FF
PPG	Amerlock 2/400 GF
Tnemec	Tnemec Series G435
AkzoNobel/International Paint, LLC	Approved Equal

Type Q – 100% Solids Epoxy for Wastewater	
Manufacturer	**Approved Coating**
Carboline	Plasite 4550-S Novolac Epoxy
Sherwin-Williams	Dura-Plate 6000 Amine Epoxy
PPG	Novaguard 890 or Novaguard 810 Novolac Epoxy
Tnemec	Perma-Glaze Series G435 or Series G436 Modified Polyamine Epoxy
AkzoNobel/International Paint, LLC	Approved Equal

Type R – CMU Acrylic Block Filler	
Manufacturer	**Approved Coating**
Carboline	Sanitile 100
Sherwin-Williams	Pro Industrial Heavy Duty Block Filler
PPG	Speedhide 6-15XI
Tnemec	Envirofill Series 130

Type S – Waterborne Acrylic	
Manufacturer	**Approved Coating**
Carboline	Sanitile 120
Sherwin-Williams	Pro Industrial Multi-Surface Acrylic Semi-Gloss
PPG	Perma-Crete Pitt-Flex 4-110XI
Tnemec	Enviro-Crete Series 157

B. PETROLATUM (WAX) TAPE

Petrolatum (wax) tape must be installed per the manufacturer's written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.

Approved Manufacturers:

1. Trenton Corp. - Trenton Primer and #1 Wax-tape
2. Denso North America, Inc. – Denso Paste and Densyl Tape
3. Approved Equal

C. Pipe Wrap Tape System

1. System must be designed to mechanically protect coated piping from corrosion and abrasion in above ground, below ground and submerged conditions and be compatible with specified pipe coating system(s).
2. System must be UV resistant and may be constructed of HDPE, PVC, or fiberglass with an adhesive backing on one side for application to coated piping.
3. System must include a fiberglass reinforced outer shield for abrasion resistance and be able to be top coated for aesthetics.
4. Approved Manufacturers:
    a. SealForLife
    b. Denso North America, Inc.
    c. Approved Equal

2.03 COLOR SELECTION

A. The color chart must include the complete available range of colors, including tints and shades. The Owner will select the colors during construction.

B. Use a multi-color system coating for any surface receiving more than one coat. Each coat must be tinted differently from the preceding coat in a manner that will allow the various coats to be easily distinguished. Colors must generally be from light to dark shades, but the Contractor may have the option to select tint shades to insure coats will receive adequate coverage without bleeding or otherwise showing through the preceding coat.

C. Piping and equipment must be color coded in accordance with the requirements of the Texas Commission on Environmental Quality (TCEQ).

3.00 EXECUTION

3.01 GENERAL

A. All coatings must be applied in strict conformance with the Coating Manufacturer's published specifications, this specification or as approved by the Engineer.

B. Surfaces which will be inaccessible after installation must be coated prior to installation, or must be coated and approved in stages as the work is installed.

C. The Engineer will approve surfaces for application of coatings at each stage. Any material that is coated prior to the Engineer's approval will be stripped back to bare metal and repainted.

D. At least 7-days or as required by the coating manufacturer, must be allowed for drying of finished surfaces before any machinery can be placed into service.

E. The number of coats called for in this specification are considered the minimum required. If more coats are required to provide the specified dry film thickness or for complete coverage and uniform appearance, they must be provided at no additional cost to the Owner.

3.02 STEEL SURFACE PREPARATION

A. The adequacy of the preparation of steel surfaces will be determined by comparing the surface with SSPC VIS 1 “Pictorial Surface Preparation Standards for Painting Steel Surfaces” and SSPC VIS 3 “Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning.” Prepare surfaces in accordance with the following requirements:

1. SSPC-SP1 “Solvent Cleaning”
2. SSPC-SP2 “Hand Tool Cleaning”
3. SSPC-SP3 “Power Tool Cleaning”
4. SSPC-SP5 / NACE 1 “White Metal Blast Cleaning”
5. SSPC-SP6 / NACE 3 “Commercial Blast Cleaning”
6. SSPC-SP7 / NACE 4 “Brush-Off Blast Cleaning”
7. SSPC-SP10 / NACE 2 “Near-White Blast Cleaning”
8. SSPC-SP11 “Power Tool Cleaning to Bare Metal”

B. The resulting surface profile must be in accordance with the coating manufacturer’s recommendations.

C. “Solvent Cleaning” must be performed prior to subsequent surface preparation, including abrasive blast cleaning.

D. All sharp edges and welds must be ground smooth to a rounded contour and all weld splatter must be removed prior to abrasive blasting. Edges of metal to be coated must be rounded to a minimum of 1/16” radius of chamfered a minimum of 1/16” at an angle of 45-degrees.

E. Welds and adjacent areas:

1. Prepared such that there is:
    a. No undercutting or reverse ridges on the weld bead.
    b. No weld spatter on or adjacent to the weld or any other area to be painted.
    c. No sharp peaks or ridges along the weld bead.
    d. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.
2. Weld profiles must conform to NACE RP0178, Profile ‘D’.

3.03 DUCTILE IRON PIPE AND FITTINGS SURFACE PREPARATION

A. Prepare surfaces in accordance with the following requirements:

1. NAPF 500-03-01 “Solvent Cleaning”
2. NAPF 500-03-02 “Hand Tool Cleaning”

3. NAPF 500-03-03 “Power Tool Cleaning”
4. NAPF 500-03-04 “Abrasive Blast Cleaning for Ductile Iron Pipe”
5. NAPF 500-03-05 “Abrasive Blast Cleaning for Cast Ductile Iron Fittings”

B. “Solvent Cleaning” must be performed prior to subsequent surface preparation as specified in NAPF 500-03.

3.04 PETROLATUM (WAX) TAPE

A. Petrolatum (wax) tape must be installed per the manufacturer’s written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.

B. Tape must be installed on all buried flexible couplings and at locations indicated on the drawings and as specified.

3.05 PIPE WRAP TAPE SYSTEM

A. Tape must be installed per the manufacturer’s written recommendations. Provide all primers and appurtenant materials as required for installation per the recommendations.

B. Tape must be installed on all piping at the transition between above grade and below grade. Coat piping a minimum of 2-feet vertically above and below the ground surface.

C. Paint wrap to match adjacent piping.

3.06 CONCRETE SURFACE PREPARATION

A. The adequacy of the preparation of concrete surfaces will be determined by comparing the surface with ICRI Surface Finish Comparators. Prepare surfaces in accordance with the following requirements and the coating manufacturer’s recommendations:

1. SSPC-SP13 / NACE 6 – Surface Preparation of Concrete
2. ICRI CSP 3 – 5, or as required by the coating manufacturer.

B. Allow a minimum of 28-days curing time to elapse before coatings are applied. Concrete surfaces which are scheduled to receive coatings must be in accordance with the coating manufacturer’s moisture requirements. Contractor must provide any primers required by the coating manufacturer to address outgassing, as needed.

C. Contractor must field verify that the pH of the concrete is suitable for application per the coating manufacturer’s product requirements.

D. Bug holes, air pockets, voids or imperfections in the concrete surface must be filled or patched with a cementitious resurfacing material approved by the coating manufacturer.

E. All coating terminations points, including from concrete to metal are to include a ¼” key cut.

F. Concrete Surface Preparation Inspection:

1. Adhesion Testing:

a. Tensile testing of the surface preparation must be performed by the Contractor using a Type 4 or Type 5 pneumatic adhesion testing equipment in accordance with ASTM D7234 using 2-inch diameter dollies for concrete surface adhesion testing. Provide a minimum of three tests (dollies) per area and coating system. Engineer will select location of test dollies.

b. Concrete surface or applied coating must be scored for concrete adhesion testing.

c. Adhesive failure greater than 50 percent of the dolly surface area indicate inadequate surface preparation.

d. Cohesive failures which results in loss of sound concrete will be acceptable provided the loss is greater than 50 percent of the dolly surface area.

e. Low adhesion cohesive failures with a thin layer of concrete due to weak concrete or laitance over 50 percent of the dolly surface will be rejected.

2. Concrete Soundness:

   Concrete soundness will be determined using the scratching or hammer impact methods as defined in SSPC SP-13.

3. Moisture Content:

   Moisture must be tested as specified in SSPC SP-13 and in accordance with ASTM D 4263 and F 1869 (for conditioned spaces). Moisture content cannot exceed the moisture content recommended by the coating manufacturer.

3.07 SURFACE PREPARATION

A. Clean and degrease surfaces prior to abrasive blasting by solvent cleaning as specified using solvents, detergent/water, emulsions, and steam. Proposed method must be documented in the coating plan. Contractor must contain and properly dispose of all runoff and debris from cleaning.

B. If the following conditions exist or are prevalent, surface preparation and coating must be delayed or postponed until conditions are favorable. Each day's coating must be completed in time to permit the film sufficient drying time prior to damage by atmospheric conditions or changes. No surface preparation can begin or coating applied:

1. When the surface, air or material is below or above the Manufacturer's printed instructions.

2. When surfaces are wet or damp.

3. During weather conditions of rain, snow, fog or mist.

4. When the air and steel temperature is less than 5° F above the dew point temperature.

5. If the relative humidity is above 85%.

6. When it is expected that the dew point, air and/or surface temperature will be below or above the Coating Manufacturer's recommended temperatures within four (4) hours after applications of coating, minimum. Coating manufacturer may require additional time between application and temperature and weather changes.

C. Shop Surface Preparation

1. Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints. Work is subject to the Engineer's approval before shipment to the jobsite.
2. Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed and approved by the Engineer may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternate to shop blast cleaning. Blast clean and prime in accordance with the Specifications.
3. Prepare surfaces by abrasive blasting as specified and apply shop prime coat. Shop primed steel plates must not have primer extended within 4-inches along all edges to be welded. All primer within 4-inches of an area to be welded must be removed prior to welding. Welding of painted surfaces will not be allowed.

D. All pre-assembled shop primed items must be prepared in accordance with these specifications and inspected by the Owner's Representative before and after priming.

E. Abrasive Blasting

1. Prior to commencing abrasive blasting operations, the Contractor must perform a test blast to verify that the surface cleanliness and profile meet the requirements of the specification and meet the coating manufacturer's requirements for the coating to be applied. If the test section does not meet the requirements, the Contract must make changes to the abrasive materials and/or methods to provide suitable blast.
2. Abrasive blast only the amount of surface area which can be primed the same day or before any rust starts to form, whichever occurs first. Areas which are not painted the same day must be re-blasted on the day the prime coat is applied.
3. Shrouding or recovery of all blast material will be mandatory during all exterior blasting.
4. The CONTRACTOR must contain all waste and process discharge in accordance with the accepted methods for the process and materials that are in abatement.
5. Where abrasive blast cleaning will not remove or properly prepare metal surfaces, hand and/or power tool cleaning must be used to remove such conditions as weld splatter, laminations and radius-sharp edges. Hand tool or power tool must be used on areas less than two (2) foot diameter or smaller or on corners and edges.
6. All abrasive blast equipment must be equipped with, including but not limited to the following:
    a. Noise reducing devices
    b. Hose coupling safety devices
    c. Electrical grounding devices
    d. Moisture traps and filters
    e. Fresh air hoods for all blasters
    f. "Dead Man" switches on all blast hoses
    g. Air Dryers

F. Surface profile must be in accordance with manufacturer's printed requirements.

G. The adequacy of the preparation of surfaces must be determined by comparing the surface with SSPC VIS 1, SSPC VIS 3, NACE RP0178 and ICRI Surface Finish Comparators.

H. Adequate surface preparation must be verified throughout surface preparation per SSPC-PA 17. Minimum testing requirements:

1. Test the surface profile within the first 15-minutes and one additional time during each work shift or 12-hour period, whichever is shorter for each gun or blasting apparatus used or at any time the process producing the acceptable profile indicated above is changed, as interpreted by the Engineer.

2. Select a minimum of three 6-inch square locations and take two readings. The average to the two readings is a “profile measurement.” The group of three locations is the “location average.” The location average must be within the specified profile range.

3. Contractor must report the location averages (lowest location average and highest location average, and the profile measurement for each surface preparation apparatus.

4. If the substrate has been previously coated, an existing profile may exist. Contactor must adjust blast media size to ensure that the resulting surface profile meets the profile required.

I. Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in the specifications or in paint manufacturer's specifications, they are understood to refer to the applicable specifications indicated.

J. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacuum-blasting methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application will apply.

K. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wiped with a tack cloth.

3.08 PREPARATION OF HOT-DIP GALVANIZED COATED STEEL, STAINLESS STEEL AND NON-FERROUS METALS

A. For galvanized coated steel, remove all soluble and insoluble contaminants. Prepare hot-dipped galvanized coated iron and steel products in accordance with ASTM D 6386.

B. Abrasive blast per SSPC-SP I6 to achieve an angular anchor profile as required by the coating manufacturer.

C. Contractor is responsible for coordinating with the coating manufacturer to verify compatibility of the specified coating system with the provided surface preparation.

3.09 PREPARATION OF EXISTING COATED OR SHOP PRIMED SURFACES:

A. General:

1. Factory-applied primers to equipment must be those specified or verified by the Contractor to be compatible with the specified coating systems. Where possible, notify manufacturers which shop prime coats will be required in order to be compatible with field-applied finish coats.

Where equipment is purchased which has the manufacturer's standard primer or a factory finish which is other than as specified in this section, remove the factory-applied paint system or apply passivators or other special coatings as required to make the surface compatible with the finish coat specified.

2. Do not apply any coating to machinery, piping, or other surfaces before testing has been completed and systems approved. Any damage to coatings resulting from subsequent corrective procedures must be stripped back to bare metal and repainted with the appropriate paint system as directed by the Engineer.
3. Check for compatibility when applying coatings over existing coatings. Apply a test patch of the recommended coating system, covering at least 2 to 3 square feet or as directed by the Engineer. Allow to cure one week before testing adhesion per ASTM D3359 in the presence of the Engineer. If adhesion does not meet the manufacturer's published data, consult with the Engineer.
4. Shop primed or coated surfaces must be reviewed with the Engineer to determine if the extent of damage to the coating and suitability of finish coats to adhere to shop applied coats.
5. If a cured epoxy, polyurethane, or plural-component material is to be top coated provide brush-off blast as specified herein or as recommended by the coating manufacturer.
6. Surface preparation recommendations of coating manufacturer are subject to approval of the Engineer.

B. To be Recoated or Final Coated:

1. Solvent clean.
2. Perform touch-up repairs of existing coating.
3. Asphaltic coated ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.

C. Touch-up Repairs:

1. Clean loose, abraded, or damaged coatings to substrate by power tool to bare metal per SSPC-SP11 and/or NAPF 500-03-03 "Power Tool Cleaning."
2. Feather surrounding intact coating.
3. Apply one spot coat of the specified primer to bare areas overlapping the prepared existing coating.
4. Apply one full finish coat of the specified primer or finish coat(s) overall.

D. Application of a Cosmetic Coat:

1. The exact nature of shop-applied coatings is not known in all cases.
2. Check compatibility by application to a small area prior to starting the coating.
3. If lifting or other problems occur, request disposition from the Engineer.

3.10 APPLICATION

A. The Contractor and painting technicians are responsible for the application of the coating system and must have current applicator approvals from the Coating Manufacturer, as required.

B. After abrasive blast cleaning, dust and spent abrasive must be removed from the surfaces by vacuum process or with clean, dry, oil-free compressed air.

C. The prime coat must be applied as soon as possible after the blasting and surface cleaning is completed, inspected and approved by the Inspector. Blasted surfaces must be coated before rust forms on the surface. No prepared surface will be allowed to receive a coating if "rust bloom" or surface discoloration has occurred. All blasted surfaces must be coated to within 6-inches of the edge of a blasted area. No visible rust must be coated under any circumstances, including rust bloom or if discoloration has occurred, regardless of elapsed time between blasting and coating. Leave an uncoated strip of exposed metal to clearly identify where abrasive blasting was halted.

D. Provide mist coat if recommended by the Coating Manufacturer.

E. All weld seams, gaps, edges, bolts and difficult areas to coat must receive a stripe coat. Stripe coat must be a contrasting color. Stripe coat may be applied with intermediate or finish coating, but must be applied prior to the installation of the finish coat.

F. The Contractor must apply each coat at the rate and in the manner specified by the Coating Manufacturer, except as may be modified herein. If material has thickened or must be diluted for application, coating must be built up to achieve the dry film thickness as specified for each coat of the complete system.

G. Maximum and minimum DFT must be per the supplied Coating Manufacturer's printed requirements and as required by this specification. DFT will be measured per SSPC-PA 2, Level 2 with an allowable measurement of spot DFT of:

   1. Minimum DFT, as specified.

   2. 120% of maximum DFT specified.

H. The Contractor and painting technicians are responsible for the application of coating system and must have current applicator certifications from the Coating Manufacturer. Submit certifications with coating submittal.

I. Coatings which have an expired shelf or pot life may not be used and must be removed from the site.

J. Coating must be applied by skilled workmen and must be brushed out or sprayed evenly, without runs, crazing, sags, or other blemishes.

K. Sand between coats to remove over spray and dry fall.

L. Apply the first coat to the surface, including cutting in around edges, before the second coat is applied. The second coat and any successive coats must not to be applied before notifying the Owner's field representative and obtaining approval. Each coat must be tested before the successive coat is applied.

M. The coating curing period must be adjusted to compensate for less than adequate weather conditions, as recommended by the Coating Manufacturer, for complete curing of the entire coating system. The full curing time recommended by the manufacturer must be provided.

N. Coating must be continuous and must be accomplished in an orderly manner to facilitate proper inspection control.

O. Where a roller or brush is used to apply the coating, additional coats may be necessary to achieve the recommended dry film thickness and/or to achieve total coverage of the underlying surface. Coated surfaces must be totally free of all roller nap, roller marks, brush bristles and brush marks.

P. When using conventional coating spray equipment for coating operations, effective oil and water separators combined with after coolers or deliquescent dryers must be used in compressed air lines to remove detrimental oil and moisture from the air. Separators must be placed as far as practical from the compressor. Compressors must be tested periodically by the Contractor for oil and water contamination of compressed air. Testing must follow ASTM D4285 "Standard Test Method of Indicating Oil and Water in Compressed Air". All compressor units found to produce unacceptable amounts of oil and or water, as determined by results of ASTM D4285 test data must be replaced with a compressor that is acceptable.

Q. For porous surfaces, such as concrete or masonry, a prime coat may be thinned to provide maximum penetration and adhesion. The type and amount of thinning must be determined by the coating manufacturer and is dependent on surface density and type of coating.

R. Concrete and Steel Floors and Walks, including Bulk Storage Areas

1. Provide non-skid surface in walkway areas and on floors.

2. Contractor is to include non-skid additive such as aluminum oxide to coatings or may use 50 mesh dry wash silica sand broadcasted into the film and back rolled to encapsulate as recommended by the coating manufacturer.

3. Contractor is to provide a test area to confirm with Owner that the non-skid surface is adequate and consistent. Contractor must modify method or products used as required to provide an acceptable surface.

3.11 WATER AND WASTEWATER PIPE COLORS

General coating colors in accordance with the TCEQ are as follows for general selection of pipe coatings. Contractor must provide samples for Engineer's approval prior to ordering as specified.

Pipe/Pumps/Valves System Description	Color
Sewage	Grey

3.12 FIELD QUALITY CONTROL

A. Field Tests: Make wet film tests during painting operations to assure proper thicknesses of coating are being applied. After each coat has been applied, test the paint film thickness with a nondestructive, magnetic type thickness gauge. The total dry-film thickness for each coat must be per 3.09.G. Apply additional coats until the specified thickness is reached or exceeded.

B. Holiday Testing

1. Holiday testing must be performed in accordance with NACE SP0188 or ASTM D5162 for steel substrates and ASTM D4787 for concrete substrates.

2. Test the entire surface of coated steel and piping in moderate or severe environments, as determined by the Engineer, with a holiday detector. For thickness between 10 and 20 mils (250 to 500 microns) a non-sudsing type wetting agent, as recommended by the holiday detector manufacturer, must be added to the water prior to wetting the detector sponge.

3. Holiday detect coatings in excess of 20 mils with high voltage holiday testers as recommended by the coating manufacturer.

4. Mark and repair failures in accordance with the manufacturer's printed instructions, then retest failure areas. No failures or other irregularities will be permitted in the final coats. Areas containing holidays must be repaired until tests indicate no holidays.

3.13 PROTECTION OF SURFACES NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering the motors.

3.14 DAMAGED COATINGS, PINHOLES, AND HOLIDAYS:

A. Feather edges and repaired in accordance with the recommendations of the paint manufacturer.

B. Repair fusion bonded coatings to be as recommended by the original applicator. Applicator must provide liquid repair kits for this purpose as recommended by the coating manufacturer.

C. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.15 UNSATISFACTORY APPLICATION:

A. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer.

Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.

B. Evidence of runs, bridges, shiners, laps, or other imperfections are cause for rejection.

C. Repair defects in coating system per written recommendations of coating manufacturer.

D. Leave all staging up until the Engineer has inspected the surface or coating. Replace staging removed prior to approval by Engineer.

3.16 COATING INSPECTION

A. General:

1. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.

2. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.

3. Give particular attention to edges, angles, flanges, and other areas where insufficient film thicknesses are likely to be present and ensure proper millage in these areas.

B. Coating Thickness Testing:

1. Owner’s Representative may conduct coating thickness testing as necessary and without limitation.

2. Measure coating thickness specified in mils with an electronic type dry film thickness gauge.

3. Check each coat for the correct millage.

4. Tests for concrete coating thickness may be taken using a Tooke Gauge or gauge approved for testing coatings over concrete substrates. Contractor must repair coating after thickness testing, if required.

C. Coating Continuity (Holiday) Testing:

Owner’s Representative will witness holiday testing performed by the Contractor.

3.17 CLEAN AND ADJUST

A. Promptly remove trash and debris resulting from painting operation from the Site. Remove drop cloths, masking tapes and other protective coverings. Remove paint spills, splatters, overlap of paint from adjacent material and other defects. Spot paint nicks and other defects.

B. Remove paint containers and waste products. Thoroughly clean paint storage rooms, removing spilled paint from walls and floors.

C. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.18 SCHEDULES

Protective coatings must be applied in accordance with the following paint schedule. If additional or alternate primers, etc. are recommended by the coating manufacturer for any of the coatings specified, they must be provided at no additional cost to the Owner to provide a complete and compatible coating system, as approved by the Engineer.

PROTECTIVE COATINGS PAINT SCHEDULE

System	Application Description	Surface Prep:	Product Type	No. of Coats	DFT/Coat (mils)
No. 1	**Above-Grade Interior/Exterior Steel and D.I. Piping Non-Immersion/Non-Corrosive Environment** All metal surfaces new and existing, such as inside pump station buildings, exterior piping and valves, exterior structural steel, etc. **Application Notes:** 1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field. 2. Proposed Field Coated and Existing Previously Coated Piping and Valves - Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and top coat as indicated. 3. Due to the coastal region, Contractor must wash all surfaces per SSPC SP1 prior to application of the next coat.	**For New Piping and Valves:** SSPC-SP1 SSPC-SP6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP1 SSPC-SP3 NAPF 500-03-01 NAPF 500-03-03	TYPE N – Epoxy Mastic TYPE C – Penetrating Epoxy Pre-Primer TYPE M – Stripe Coat Type M - HS Epoxy Siloxane	1 1 2	5.0 2.0 5.0 – 7.0
				Total Minimum Dry Film Thickness	12 mils

System	Application Description	Surface Prep:	Product Type	No. of Coats	DFT/Coat (mils)
No. 2	**Metal Piping and Valves – Immersion in Wet Wells Moderate to Severe Environment (Non-Potable)** Exterior/interior surfaces of submersed valves & pumps, penstocks, piping, sewer interceptors, wastewater vessels, settling tanks and buried piping connecting to them for severe conditions with exposure to H2S gas, including wastewater digesters, etc. **If the wet well is being recoated as specified in section 09 96 01 "Concrete Protective Coatings" coat piping with the same epoxy system.** **Application Notes:** Coating may be applied in two coats, as recommended by the manufacturer.	SSPC-SP1 SSPC-SP10 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05	Type Q – 100% Solids Epoxy for Wastewater	1 - 2	40.0
				Total Minimum Dry Film Thickness	40 mils

System	Application Description	Surface Prep:	Product Type	No. of Coats	DFT/Coat (mils)
No. 3	**New and Existing Metal Piping and Valves within Vaults and Under Insulation** **Moderate to Severe Environment** All metal surfaces new and existing that will be installed in areas where temporary submerged conditions can occur, such as within vaults and for piping and valves covered with insulation. **Application Notes:** 1. Proposed piping and valves may be provided with factory applied prime coat(s), with fusion bonded epoxy or Type H epoxy. For damaged factory applied coatings spot prime with Epoxy Mastic. Provide application of Type C and Type M coatings in the field. 2. Proposed Field Coated and Existing Previously Coated Piping and Valves - Prepare as indicated and provide full coat of Epoxy Mastic and continue with stripe, intermediate and topcoat as indicated. 3. Due to the coastal region, Contractor must wash all surfaces per SSPC SP1 prior to application of the next coat.	**For New Piping and Valves:** SSPC-SP1 SSPC-SP6 NAPF 500-03-01 NAPF 500-03-04 NAPF 500-03-05 **For Previously Coated Piping and Valves:** SSPC-SP1 SSPC-SP3 NAPF 500-03-01 NAPF 500-03-03	TYPE N – Epoxy Mastic TYPE C – Penetrating Epoxy Pre-Primer TYPE G - Stripe Coat TYPE G – Epoxy-Polyamide	1 1 2	4.0 2.0 4.0
			Total Minimum Dry Film Thickness		12 mils

System	Application Description	Surface Prep:	Product Type	No. of Coats	DFT/Coat (mils)
No. 4	**CMU Block Coating** **Moderate to Severe Coastal Environment** All exterior wall surfaces of new and existing CMU blocks at Lift Station 10. **Application Notes for New CMU Blocks:** 1. For new CMU blocks, prepare as indicated and apply Type R Acrylic Block Filler. 2. Apply Type S Waterborne Acrylic coats as necessary to achieve total of 6 mils minimum DFT as indicated. **Application Notes for Existing Previously Coated CMU Blocks:** 1. For existing, previously coated CMU blocks, abrade all surfaces per SSPC-SP2 and SSPC-SP3 to remove gloss. 2. Apply Type S Waterborne Acrylic coats as necessary to achieve total of 6 mils minimum DFT as indicated. **General Notes:** 1. Wash all surfaces per SSPC-SP1 prior to coating if left overnight to remove soluble salts from surfaces. 2. Color must match existing coatings.	**For New CMU Blocks:** SSPC-SP1 **For Previously Coated CMU Blocks:** SSPC-SP1 SSPC-SP2 SSPC-SP3	TYPE R – Acrylic Block Filler TYPE S – Waterborne Acrylic	1 1	8.0 – 12.0 6.0
				Total Minimum Dry Film Thickness	14 mils

END OF SECTION

09 96 01 CONCRETE PROTECTIVE COATINGS

1.00 GENERAL

1.01 SCOPE OF WORK

A. The Contractor must furnish all labor, materials, equipment and incidentals necessary to apply protective coatings as shown on the Plans or as specified herein, including the preparation and/or repair of surfaces prior to application of coatings.

B. Protective coatings must be applied to concrete surfaces at the following locations:

1. Lift Station Wet Wells; all interior concrete surfaces

2. Existing concrete manholes and any exposed concrete surfaces on proposed manholes.

C. Provide epoxy coatings on proposed ductile iron piping within wet wells, 20 mils min. Prepare piping as recommended by coating manufacturer.

D. Contain, treat, and dispose of any dust, spray, drainage, or spillage resulting from coating operations. It is the Contractor's responsibility to determine if the materials to be disposed of are classified as Hazardous Waste. Disposal of waste, hazardous or otherwise, must be in accordance with applicable regulations. The Contractor must be aware of and understand the regulations concerning disposal of waste generated by coating operations.

E. Contractor will ensure that coating manufacturer's technical representative will be on-site prior to application. The technical representative must confirm, with a follow-up report, that surface preparation and coating application processes were performed in compliance with the coating manufacturer's written guidelines.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer must have an authorized technical specialist that will be available during construction.

2. Products must be manufactured in the United States.

B. Applicator's Qualifications: Applicators must be qualified in this line of work and have a minimum of five (5) years' experience in the successful application of the protective coatings of the types specified herein.

C. Testing: Protective coatings must be applied under quality control procedures that include inspection of surface preparation before each coat. Do not proceed with the next step until the Owner's Representative has approved the previous step. The Contractor is solely responsible for all testing for this work. The Owner's Representative may request additional

tests, if it is considered necessary. Cooperate with the Owner, providing equipment, scaffolds, and other equipment as requested by the Owner for inspection purposes.

1.03 SUBMITTALS

Submittals must be in accordance with Section 01 33 00 “Document Management” and will include:

A. Coating Plan

1. Anticipated coating process schedule by date, including dates when hold-point inspections are anticipated. Schedule must indicate detailed activities performed daily.

2. Detailed procedures and schedule for all pre-cleaning, surface preparation and application of coating, including touch-up and repair procedures for all coating systems.

3. Recoat schedule on the submitted coating materials.

4. Data sheets complete with a graduated scale or curve, produced by the coating manufacturer, with curing characteristics and recommendations regarding complete coating curing.

5. Provide a written plan documenting how spent cleaning debris and/or paint over-spray or droplets will be contained/confined to the Site during the surface preparation and coating application operations. Reasonable care must be exercised by the Contractor to prevent damage, nuisance, or hazardous conditions to adjacent or nearby property owners. Include all materials and method to be used for protection of exterior surfaces and allow for recovery and disposal of paint scraps and blast media.

6. Provide written plan documenting how paint and/or abrasive damage to automobiles and property will be addressed, including a process for quick removal of the paint or abrasive, and how the Work will be accomplished (this will not relieve the Contractor from the responsibility of setting claims for damage, but is intended to expedite and minimize said claims).

B. Shop Drawings

1. Manufacturer’s product data sheet for each coating type, including surface preparation requirements, recommended spreading rates, application procedures, recommended primers, environmental limits (temperature, humidity, and dew point) and other instructions.

2. Safety Data Sheets (SDS) for all coatings, solvents, etc.

C. Record Data

1. Applicator’s qualifications, including training certificates for those who will be performing the coating application.

2. Manufacturer's statement regarding applicator instruction on product use and application.

3. Coating manufacturer's statement confirming compatibility of coating with proposed concrete resurfacer, primers, etc.

4. Warranty documentation.

5. Certified Material Test Reports.

6. Results of pH testing of concrete substrates in accordance with ASTM D4262.

7. Documentation of Field Testing:

   The location and results of the coating DFT tests will be documented during field testing. The documentation will include test method and procedure used, equipment used, air temperature, surface temperature, humidity, dew point, quantity of structure(s) lined (square footage covered), number of gallons of lining compound expended and materials used. If a location fails a test, the failing result will be included in the documentation along with what actions were taken to repair the failing area and the results of the subsequent retest of the area. After successful completion of the coating installation, this documentation will be submitted to the Owner as Record Data. This documentation must be included in the weekly inspection reports.

1.04 REFERENCE STANDARDS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by designation only. In the event of a conflict between the published standards, codes, and this Section, the more stringent requirement will govern.

A. AMPP (Association for Materials Protection and Performance):

SSPC Vol. 1	Good Painting Practices
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 2	Determining Compliance to Required DFT
SSPC Guide 6 (CON)	Containment of Debris
SSPC Guide 12	Illumination of Painting Projects
SSPC-SP 13/NACE 6	Surface Preparation of Concrete

B. ASTM International (American Standards for Testing and Materials International):

ASTM C307	2012 Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

ASTM C531	2018 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	2012 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	2012 Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C884	2010 Standard Test Method for Thermal Compatibility Between Concrete and an Epoxy-Resin Overlay
ASTM C1028	2007 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
ASTM D543	2014 Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D638	2014 Standard Test Method for Tensile Properties of Plastics
ASTM D695	2015 Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D790	2017 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D1653	2013 Standard Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride Moisture Emissions Test
ASTM D2240	2015 Standard Test Method for Rubber Property-Durometer Hardness
ASTM D2584	2018 Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D4060	2014 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4258	2017 Standard Practice for Surface Cleaning Concrete for Coating

ASTM D4262	2018 Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	2018 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4272	2015 Standard Test Method for Total Energy Impact of Plastic Films by Dart Drop
ASTM D4414	2013 Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4541	2017 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testing
ASTM D4787	2018 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
ASTM D6132	2017 Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage
ASTM D7234	2012 Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testing
ASTM E337	2015 Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
ASTM F1869	2016 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	2019 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
ASTM F2659	2015 Standard Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using a Non-Destructive Electronic Moisture Meter
ASTM G210	2018 Standard Practice for Operating the Severe Wastewater Analysis Testing Apparatus

C. International Concrete Repair Institute (ICRI):

Standard 310.2R	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.05 JOB CONDITIONS

A. Store coating materials at temperatures of between 50˚F and 90˚F, or as recommended by the Manufacturer.

B. The material must provide a permanent impermeable, high strength, monolithic lining for concrete structures that is sulfuric acid corrosion, hydrogen sulfide gas, abrasion and impact resistant.

C. All steps of the coating system will be subject to observation prior to progression to succeeding steps. Phases of observation will include, but not be limited to:

1. Pre-cleaning (before surface preparation) survey of facilities to be resurfaced or primed.

2. During surface preparation and prior to coating application.

3. During and immediately after each coating application.

4. Final coating observation.

D. Environmental Conditions

1. Do not apply coating under conditions that are unsuitable to produce good results. Do not begin application of coatings in areas where other trades are working, or where construction activities result in airborne dust or other debris. Do not apply coatings in conditions which do not conform to the recommendations of the coating manufacturer.

2. Coatings must only be applied when conditions fall within the parameters listed in the manufacturer's printed data.

3. Concrete must be cured for 30 days minimum and attain the required strength before coating is applied.

4. Do not apply any coatings when weather conditions are unfavorable. If climatic conditions are not conducive for best results, postpone application of coatings until conditions conform to the manufacturer's recommendations and the provisions of this Section. Do not apply coatings to a wet or damp surface in wet or damp weather conditions, or when there is dust in the air. Surfaces exposed to direct sunlight must be shaded by awnings or other protective devices while coatings are being applied. When necessary, provide temporary heating devices of a type that produces no fumes, and which will not discolor the paint system.

E. Working Conditions

1. Provide adequate lighting at any location that coatings are being applied or testing is performed. Illumination must be of enough intensity to allow for safe working conditions and ability to properly apply and test the coating. Provide explosion-proof lighting when required.

2. Temporary ladders and scaffolds must conform to applicable safety requirements. Erect temporary scaffolds where needed to cover large areas. Provide ladders or scaffolding during testing procedures.

F. Forced Ventilation

1. Provide continuous forced fresh air ventilation when working inside of containment systems or enclosed areas that are not openly vented from the beginning of surface preparation through final coating operations and coating curing.

2. Forced ventilation must be supplied per the recoat time required by the coating manufacturer and at least 48 hours after the final coat has been applied.

3. From the beginning of interior wet and/or dry coating application and until the coating is cured, the Contractor must monitor the air for the lower explosion limit (LEL) as published in the coating manufacturer's project SDS's.

4. Contractor is responsible for supplying, installing and maintaining the forced ventilation system.

G. Contractor must conform to all local, state, and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

H. Confined space entry program and other required safety training certificates must be submitted by Contractor, as necessary to perform the specified work.

I. Exterior concrete waterproofing has not been specified. Coating manufacturer must ensure that their product will perform and warranty the product provided. If additional waterproofing coatings are required, but not specified, they must be provided at no additional cost to the Owner.

J. Existing concrete surfaces may have low pH's. It is the Contractor's responsibility to evaluate the existing concrete's pH and provide compatible products, materials, and additional surface preparation at no additional cost to the Owner.

1.06 GUARANTEES

A. Contractor must warrant all work against defects in materials and workmanship for a period of ten (10) years from the date of final acceptance of the project. Contractor must, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said ten (10) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner. If the manufacturer's standard warranty does not extend to ten years, manufacturer must provide documentation of extended warranty.

B. A warranty inspection must be conducted annually for the entire warranty period with the manufacturer present. Any defective work discovered must be corrected by the Contractor

in accordance with specifications at no additional cost to the Owner. Other corrective measures may be required during the warranty period.

1.07 DELIVERY AND STORAGE

A. Deliver coating products to the Site in original unopened containers, with manufacturer's label, batch number, warning labels, contents (by volume) attached. Do not apply products until the Owner's Representative has approved the product for use. Stored materials are subject to random observations by the Owner's Representative.

B. Use one location at each site for the storage of coating products. Protect the floor from spills and other damage. Protect the products from extreme heat or cold. Keep containers covered. Keep the storage rooms clean of trash and debris. Dispose of oily or used rags daily. Under no circumstances will they be allowed to accumulate. Take precautions to prevent fires. The storage of flammable liquids must comply with the City, State, or other fire codes.

C. Storage of coating products and associated materials must be in accordance with the manufacturer's requirements. Coatings that have been damaged or not stored properly must not be used and must be removed from the Site.

D. All products and coatings that have not been approved for the Project must be immediately removed from the Project Site.

E. All materials must be delivered to the Site in original sealed containers with the date of manufacture and batch number stamped thereon by the coating manufacturer. Materials are subject to random observations by the Owner's representative at the Site.

2.00 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Contractor is responsible for providing all bonding agents, primers and other coatings required to apply the products as recommended by the coating manufacturer and as specified at no additional cost.

A. Epoxy Concrete Coating

1. Raven Chemicals - Raven 405 Series Epoxy applied at 125 mils minimum DFT.

2. Carboline - Plasite 4500 S Epoxy Liner applied at 125 mils minimum DFT. (Coating may be applied in multiple coats to meet minimum DFT.)

3. Sherwin Williams – Dura-Plate 6000 Reinforced Epoxy applied at 125 mils minimum DFT. (Coating may be applied in multiple coats to meet minimum DFT.)

4. Quadex – Structure Guard applied at 125 mils minimum DFT. (Coating may be applied in multiple coats to meet minimum DFT.)

B. Bonding Agent

1. Sika Armatec-110 EpoCem, as manufactured by Sika USA
2. Approved Equal

C. Epoxy Grouting Adhesive

1. Sidadur-35 Hi-Mod LV, as manufactured by Sika USA
2. Approved Equal

D. Repair Mortar/Cementitious Underlayment

1. A.W. Cook Cemtec Thin Patch or TPM-TP
2. A.W. Cook Cemtec MSM (Microsilica Mortar)
3. A.W. Cook Rapid Grade Vertical
4. Kerneos, Inc. – SeperCoat 2000 HS
5. Sherwin-Williams – Dura-Plate 2300
6. SikaTop-122, as manufactured by Sika USA (for horizontal surfaces)
7. SikaTop-123 Plus, as manufactured by Sika USA (for vertical surfaces)
8. Strong-Seal MS-2C, as manufactured by The Strong Company, Inc.
9. Quadex – Aluminaliner
10. Quadex – GeoKrete Geopolymer
11. Approved Equal

E. Manhole Invert/Surface Defects Rehabilitation

1. Quadex – Hyperform
2. Quadex - Structure Guard RS
3. Approved Equal

F. Inflow and Infiltration Control Products

1. Quadex – I&I Guard

2. Quadex – Quad-Plug

3. Approved Equal

2.02 MATERIALS

A. General

1. All components of the coating system must have a flash point above 203˚F.

2. The resurfacer, primer and topcoat composite must contain no chemicals classified by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), or the Occupational Safety and Health Administration (OSHA) as carcinogenic, nor suspected carcinogenic chemicals.

3. Raw materials of the resurfacer, primer and topcoat composite must not contain any non-reactive diluents or solvents.

4. To ensure correct mix ratios are achieved, the packaging of each component must be pre-measured to the correct mix ratio and in the quantities that will be mixed on the job site. Each discrete batch size must not exceed 1.25 cubic feet in volume.

5. The material must be suitable for overhead, vertical and horizontal surfaces, and capable of being spray applied, brushed or rolled at a specified thickness as recommended by the manufacturer.

3.00 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Protect the ground and adjacent areas from overspray, spills, etc. Contractor is responsible for mitigating any damages to property.

B. Any active flows must be dammed, plugged, or diverted as required to ensure all liquids are maintained below or away from the surfaces to be coated until final applications are cured as recommended by the manufacturer.

C. Contractor is responsible for eliminating sources of inflow/infiltration (I&I) as part of the work. Contractor is to utilize injection grouting materials as required to eliminate I&I and complete the rehabilitation.

D. Specified surfaces should be shielded to avoid exposure of direct sunlight, other intense heat source or, where cementitious products are employed, excessive ventilation. Where varying surface temperatures do exist, coating installation should be scheduled when the temperature is falling versus rising.

E. Prior to commencing surface preparation, Contractor must inspect all surfaces specified to receive the coating and notify Owner's Representative, in writing, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or, procedures as specified herein.

3.02 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer's written recommendations.

B. Thoroughly cure concrete surfaces prior to application of coatings. Allow a minimum of 30 days curing time, or as recommended by manufacturer, to elapse before coatings are applied.

C. Remove all oils, grease, wax, fatty acids and other contaminants. Surfaces are to be cleaned using a detergent de-greaser or emulsifying alkaline water-base cleaner and washed with low-pressure water cleaning (less than 5,000 PSI), steam cleaning, or chemical cleaning as required to produce an acceptable surface for the application of repair mortars and coatings.

D. Remove and replace non-durable concrete prior to installation of coating system. Remove localized or weak concrete and replace with cementitious or polymer concrete repair mortar per the manufacturer's direction. Concrete surface imperfections such as bug holes, spalls, degraded mortar, exposed aggregate, etc. must be repaired using repair mortar or other means approved by the Engineer.

E. Spall Repair

1. Perimeter of spalled area must be saw cut to remove concrete to provide a ½" minimum repair depth. All unsound concrete must be removed.

2. Rebar must be cleaned of corrosion and contaminants using mechanical means. If any rebar has more than half its cross section exposed, then remove concrete from around the bar to a minimum depth of ½".

3. Place bonding agent on sound concrete and reinforcement surfaces as recommended by manufacturer.

4. Install repair mortar in multiple lifts as required. Prepare, install, finish and cure as recommended by manufacturer.

5. Finished surface texture must match existing finish texture.

F. Static Crack Repair

1. Surface cracks must be v-grooved and fully vacuum cleaned prior to repairing.

2. Cracks in sound concrete must be pressure injected with high strength, low viscosity epoxy or other product as recommended by manufacturer and approved by the Engineer.

G. Expansion Joints/Active Cracks

1. Joints and active cracks must be prepared as recommended by the coating manufacturer and as approved the Engineer based on the coating system being applied and it's properties.

2. Preparation may include v-grooving, application of polysulfide or polyurethane joint sealants and installing bond breaker material and/or fiberglass reinforcement along the joint/crack. Contractor must submit repair details and methodology as a submittal, including approval letter from the coating manufacturer for the materials and process.

H. The final surface provided for repair mortar or coating application must achieve a surface pH > 9.0, as determined by ASTM D4262. If the cleaned surfaces are not greater than 9.0 pH or as required by the coating/repair mortar manufacturers, the Contractor is responsible for removing addition concrete from the surface until embedded contamination is removed and an acceptable surface pH can be obtained.

I. Surface profile, including that of repair mortars, will be established per SSPC-SP13/NACE #6 in conjunction with the surface profile details provided in ICRI Technical Guidance No. 310.2R and as expressed as a Concrete Surface Profile Number CSP 1 – 9. The method of achieving the acceptable surface profile is to be selected by the Contractor as recommended by the coating manufacturer and as approved by the Engineer. This is typically accomplished by acid etching, grinding, light dry/wet abrasive blasting, light shot blast, water jetting or other acceptable means.

J. For deteriorated concrete surfaces with fully or partially exposed aggregate of the concrete, concrete must be prepared and fully parge coated with a mortar repair material. The repair material must be selected based on the thickness of material required to return the surface to the approximate original plane. Deep repairs may require successive lifts. Coating manufacturer must provide written documentation that repair mortar is compatible with the coating being applied.

K. Prior to application of the coating, control/contraction joints, construction joints, and cracks must be filled with the appropriate repair material.

L. All mortar splatter, protrusions, ridges, penetrations, sharp projections or other surface imperfections must be ground smooth or otherwise made smooth.

M. Provide 45-degree Cant or 1" radii at all 90-degree wall to wall, floor to wall and pipe penetration transitions for all linings. Cove is to be created using repair mortars, epoxy fillers or other products as recommended by the coating manufacturer and per their recommended details.

N. At coating termination points, cut a keyway into the concrete substrate a minimum of ¼-inch wide by ¼" in depth.

O. After mechanical preparation, provide additional decontamination and cleaning prior to application of the coating as recommended by the coating manufacturer.

3.03 COATING APPLICATION

A. Application must be in accordance with manufacturer's written recommendations.

B. Surface to be coated can be damp, if allowed by Manufacturer. There must be no standing water. Refer to manufacturer's recommendation on maximum allowable moisture vapor transmission.

C. Product Quality:

1. Use only those thinners and solvents recommended by the Manufacturer, only in the amounts necessary to produce the manufacturer's recommended spreading rate, and in amounts not exceeding the maximum quantities stated in the manufacturer's literature.

2. The coating material must not show excessive settling in a freshly opened full can and must be easily re-dispersed with a paddle to a smooth, homogeneous state. It must show no curdling, thickening, becoming lumpy, caking, or color separation and must be free of lumps or skim surfaces.

D. All coating runs, sags, pinholes, bubbles, voids, and skips must be repaired in accordance with the coating manufacturer's written recommendations and retested. All disbonded coatings must be removed and replaced in accordance with the coating manufacturer's written recommendations and as approved by the Engineer.

3.04 FIELD QUALITY CONTROL / TESTING

A. Contractor is responsible for performing all testing as indicated within this specification and any additional testing as required to ensure a complete and quality product.

B. The Owner may conduct the tests and observations to verify the applied coating meets Coating Manufacturer's published performance data. If the coating test results fall below the requirements or visual observation, the Owner reserves the right to have the Contractor remove the existing coating and change coating materials and/or manufacturers to a coating that will meet all the stated requirements in this Specification.

C. All steps of the coating system will be subject to observation prior to progression to succeeding steps. Phases of observation include, but not be limited to:

1. Pre-cleaning (before surface preparation) survey of facilities to be resurfaced or primed.

2. During surface preparation and prior to coating application.

3. During resurfacing and repairs.

4. During and immediately after each coating application.

5. Final coating observation.

D. The Contractor must not move or remove scaffolding, ladders or other fixtures necessary to provide proper observation until such work has been observed and approved by the Owner's Representative. The Contractor is responsible for providing adequate lighting as required to facilitate observations.

E. Any work found to be deficient, damaged, or otherwise unacceptable must be repaired in accordance with the Coating Manufacturer's latest written repair recommendations at no additional cost to the Owner.

F. Owner and Owner's Representative will make every attempt to minimize damage to newly coated areas during observation activities, but any damage caused, regardless of by whom, must be repaired by the Contractor at no additional cost to the Owner.

G. Observation and/or acceptance of Contractor's work by Owner, or their Representatives in no way releases Contractor from any of the terms and conditions of the Contract Agreement.

3.05 TESTING AND OBSERVATION

A. Surfaces of all concrete must first be cleaned and observed by the Contractor to ensure that all grease, oil, and other foreign materials have been removed before coating. Any area found to be improperly cleaned, must be redone to the Owner's Representative's satisfaction. Final surface preparation must be as per the manufacturer's recommendation. Prior to observation of all surfaces by Owner's Representative, Contractor must observe and confirm readiness for inspection.

B. Contractor must perform pH testing of concrete surfaces per ASTM D4262 and provide documentation of the test results to the Engineer prior to proceeding with any resurfacing or recoating activities. pH of concrete must be in accordance with the manufacturer's written requirements for any products applied.

C. On days when coating is being performed, the Contractor must document test methods and procedures used, equipment used, air temperature, surface temperature, humidity, dew point, quantity of structure(s) lined (square footage covered), number of gallons of lining compound expended and materials used, and any additional data required by the Engineer.

   Air temperature, surface temperature, humidity and dew point must be measured and recorded by the Contractor prior to application of coating at least every three (3) hours. The Contractor must use a form approved by the Owner for recording this data. The completed forms must be kept on the job site at all times, from the time coating is first applied until the coating system is complete.

D. Contractor is responsible for testing for moisture vapor emission from the concrete in accordance with ASTM F1869.

E. Destructive Testing: Pull off adhesion tests may be requested on the existing substrate and any coating applied in compliance with ASTM D-4541. If test results do not meet the criteria of the Coating Manufacturer's written adhesion limits, additional tests will be performed as

deemed necessary by the Owner. Contractor must repair damaged coatings per manufacturer's recommendations, all test areas where coating has been damaged and repair all areas where adhesion of coating is below Coating Manufacturer's written adhesion limits. Repairs must be made by the Contractor at no additional cost to the Owner. Repair areas will be subject to re-testing and must continue to be re-tested until the adhesion of the repaired coating meets the stated minimum adhesion limit of the Coating Manufacturer. Retest costs, including actual labor and materials, will be borne by the Contractor and deducted from the Contract Value by Change Order.

F. Film Thickness Testing:

1. Make wet film tests during coating operations to assure proper thicknesses of coating is being applied.

2. Maximum and minimum DFT must be per the supplied coating manufacturer's printed requirements and as required by this Section. DFT will be measured per SSPC-PA 2, Level 2 with an allowable measurement of spot DFT of:

   a. Minimum DFT, as specified.

   b. 120 percent of maximum DFT specified.

3. The total thickness after the final coat has been applied must be 100 percent of the thickness specified, at a minimum. Apply additional coats per the Manufacturer's recommendations regarding preparation and application over existing conditions until the specified thickness is reached or exceeded.

4. Additional testing must be performed as required by field observation by the Owner's Representative. Testing location and results must be documented as indicated within this specification.

G. Holiday Testing: No pinholes, holidays, or other irregularities will be permitted in the final coated surface. Contractor must perform holiday testing on the entire coated surface using a high voltage holiday detector for coatings with a DFT greater than 20 mils in accordance with ASTM D4787. Mark and repair pinholes in accordance with the manufacturer's instructions, then retest repaired areas. Areas containing holidays must receive additional coats until tests indicate no holidays. Repairs must be squared off with painter's tape.

H. Documentation of Field Testing: The location and results of the thickness and adhesion tests must be documented during field testing. If a location fails a test, the failing result must be included in the documentation along with what actions were taken to repair the failing area and the results of the subsequent retest of the area. After successful completion of the coating installation, this documentation must be submitted to the Owner as record data.

3.06 CLEAN AND ADJUST

A. Promptly remove trash and debris resulting from coating operation from the site, including all coating containers and waste products.

B. Remove any tape and/or overspray from piping, electrical equipment, etc.

END OF SECTION

DIVISION 22

PLUMBING

22 05 19 METERS & GAUGES FOR PLUMBING PIPING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install pressure gauges and cocks. Dial gauges shall indicate pressure on a graduated dial by means of a pointer utilizing an elastic element (Bourdon tube or coil), and actuating linkage as necessary for indicating pressure.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMITTALS

Submittals must be in accordance with Section 01 33 00 “Document Management” and include:

A. Record Data – Manufacturer’s Product Data Sheets

B. O&M Documentation

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

A. PRESSURE GAUGES

1. The gauges shall be the Manufacturer's standard commercial product. The gauges shall be new and shall embody the design characteristics stated for the respective class, size, type, etc. scheduled herein. Gauges 4 inch and smaller shall be glycerin filled with bronze or brass cases. Gauge larger than 4 inch shall be glycerin filled with stainless steel cases. Inlet shall be 1/4" size with bottom or back connections as indicated.

2. Class 1 gauges shall be pressure-indicating. Class 2 gauges shall be vacuum gauge-designed for vacuum indications. Class 3 gauges, shall indicate pressure or vacuum.

3. Approved Manufacturers:

a. Marshalltown Instruments

b. Ashcroft (Dresser Industries)

c. Weksler

d. Trerice

e. Approved Equal

B. PULSATION DAMPENERS: At each pressure gauge, furnish and install a pulsation dampener, Mid-West Model 150, Vari-Damp Pulsation Dampener, or Weksler Type BW42.

C. GAUGE COCKS: Gauge cocks for isolating standard product gauges shall be heavy duty brass with tee handle and male and female ends for 1/4" bottom threaded connections. 200 psi minimum pressure rating. Gauge and sample cocks and nipples for gauges will be provided by Merit Brass or approved equal.

3.00 EXECUTION

3.01 INSTALLATION

A. Provide connecting piping to install the pressure gauges. Connection shall comprise of brass or bronze nipples, fittings, bronze gauge cock and pulsation dampener.

B. Install the gauge and protect the gauge until project acceptance by the Owner.

C. Gauges must only be connected to piping using welded on bosses or “thread-o-lets”. Direct tapping of piping or use of tapping saddles will not be accepted.

3.02 SCHEDULES

A. The pressure gauges to be furnished as part of the pumping system are listed below. The list does not include the gauges to be furnished as part of the mechanical or plumbing equipment.

B. The list has been prepared to facilitate takeoff and may or may not include all pressure gauges necessary, which is the responsibility of the Contractor.

GAUGE LOCATION	CLASS	DIA. SIZE	PRESSURE RANGE	NUMBER REQ'D
Lift Station No. 4 Discharge Piping (Submersible) (Altitude Gauge*)	1	6”	0-230 ft H_2O 0-100 psi	3
Lift Station No. 35 Discharge Piping (Submersible) (Altitude Gauge*)	1	6”	0-30 ft H_2O 0-15 psi	1
Lift Station Nos. 15, 17 Discharge Piping	Selected self-priming pump manufacturer to provide discharge piping pressure gauge. Reference Section 44 42 56.09.			
Lift Station Nos. 15, 17 Suction Piping	Selected self-priming pump manufacturer to provide suction piping vacuum gauge. Reference Section 44 42 56.09.			
*Altitude Range shall be in 2-foot and 1 psi maximum graduations.				

END OF SECTION

22 10 00.01 MISCELLANEOUS PIPING AND APPURTENANCES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidental necessary to install miscellaneous piping and appurtenances.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Record Data

    a. Manufacturer’s data sheets

    b. AIS Certification

2.00 PRODUCTS

2.01 MECHANICAL JOINT RESTRAINT

Refer to Section 33 05 01.09 “Polyvinyl Chloride (PVC) Pressure Pipe and Fittings”.

2.02 DUCKBILL CHECK VALVES

A. Duck bill check valves shall be of the flow-operated check type with a slip-on end connection. Inlet port areas shall be 100 percent of the mating pipe port size. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. Valves shall open in the proper direction under 2 inches or more of pressure, and shall withstand up to 10 feet of back pressure. Valves shall be designed to slip over the specified pipe outside diameter, and shall be attached to the pipe by means of 316 stainless steel clamps furnished by the valve manufacturer. Valves shall be of one-piece neoprene rubber construction with a fabric reinforcement, with a protective EPDM exterior wrapping for protection against ultraviolet radiation.

B. Approved Manufacturers:

1. Red Valve Tide Flex Check Valves
2. Approved Equal

2.03 RESTRAINED FLANGE COUPLING ADAPTERS

A. Restrained flange adapters shall be used as indicated in lieu of threaded or welded flanged spool pieces. Flanged adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10 (350#/Class). All connection hardware shall be stainless steel.

B. Restraint for flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to ensure proper initial set of gripping wedges. Adaptors shall be epoxy coated and lined.

C. The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6 inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

D. Approved Manufacturers:

1. Series 1100 and 2100 MEGAFLANGE® Restrained Flange Adapter as produced by EBAA Iron, Inc.

2. Approved Equal

2.04 WET WELL INSIDE DROP SYSTEM

A. Provide a plastic composite collection device that facilitates the controlled drop of effluent into the lift station. All pipe supports and hardware must be 316 stainless steel. Drop system is to consist of bowl collection system, force main hood, drop pipe and all appurtenances.

B. Installation must be per the manufacturer's recommendations for an existing fiberglass wet well.

C. Approved Manufacturers:

1. Reliner/Duran, Inc.

2. Approved Equal

2.05 REDUCED PRESSURE BACKFLOW PREVENTER (2 inches and smaller):

A. ANSI/ASSE 1013; complete unit of two independently acting check valves together with an automatically operating pressure relief valve, two ball valves, strainer, and four test cocks, bronze or iron body with bronze internal parts, 150 psi working pressure, and shall comply with AWWA Standard C506.

B. Acceptable Manufacturers and Models:

1. Cla-Val Co.: RP-2
2. Watts: 009QT
3. Hersey: FRP-II
4. Febco: 825Y
5. Wilkins: 975XL

2.06 ALUMINUM BACKFLOW PREVENTER ENCLOSURE:

A. Minimum 18-gauge aluminum with stainless steel hasps for padlock, handle and hardware.

B. Box must be insulated, minimum R-value of 8, and designed to protect to -30-degrees F. Insulation must be non-wicking type.

C. Adjustable anchors must be on the inside of the box and enclosure must be removable.

D. Finish to be mill aluminum or as selected by the Owner.

E. Acceptable Manufacturers:

1. Safe-T-Cover
2. Watts
3. Hot Box
4. Approved Equal

F. Grates shall incorporate a pull opening arm, designed so the grate can be pulled open.

G. Opening arms shall include a hasp to allow the hatches to be locked with a pad lock in the closed position.

H. Safety grate shall be rated for 300 lbs/sq. ft.

I. Safety grate shall have permanent hinging system and be lockable in the 90-degree open position.

J. Aluminum safety grate shall be coated with a safety orange color. Coating shall be a thermosetting, powder coat finish, 2-4 mils., minimum.

K. Materials

1. Grate material shall be 6061 aluminum for bars, angles and extrusions. 1/4” diamond plating shall be 5086 aluminum.

2. All hardware and hinges shall be constructed of 316 stainless steel.

L. Approved Manufacturers:

1. Safe-Hatch

2. Approved Equal

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and install valves and appurtenances in a manner that prevents damage to any part of the unit.

B. Install items in accordance with the Manufacturer's instructions.

C. Verify size, type, location, pressure rating, and connections of all pipe and fittings with equipment suppliers, where applicable.

END OF SECTION

DIVISION 26

ELECTRICAL

26 00 00 GENERAL ELECTRICAL PROVISIONS

1.00 GENERAL

Furnish and install complete Electrical and SCADA system for the Lift Station Nos. 4, 15, 17 and 35 Rehabilitation Project. The scope of work shall include Furnishing and Installation of a complete Electrical system including all equipment and materials for a fully operational and functional system. Items shall include all conduit and wiring; conduit fittings; conduit support system; Pump Control Panel and Control system, along with supporting rack systems and all programming; Meter Loop, Electrical SWGR, Low Voltage equipment, Lighting etc., including the required equipment for a complete and working system as detailed in these plans and specifications for the LMWD Liftstations Improvement Project.

1.01 GENERAL

The General Conditions and Requirements, Special Provisions, if applicable are hereby made a part of this section.

A. The Electrical Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the Owner's office and shall be examined by all bidders. Failure to examine all documents shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

B. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents. The Contractor shall warranty all Parts and Labor for 18 months from the date of Substantial Completion

C. The Contractor is responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly. Failure to examine all site conditions shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

D. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

E. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

F. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

    1. Underwriters Laboratories

2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

G. The use of the word “furnish” or “Install” or “provide”, shall be taken to mean that the item or facility is to be both furnished and installed under this section unless specifically stated to the contrary that the item or facility is to be furnished under another section and installed under this section; furnished under this section and installed under another section; or furnished and installed under another section.

H. The use of the term “as or where Indicated”; “as or where shown”; “as or where specified”; or “as or where scheduled” shall be taken to mean that the reference is made to the contract documents either under the drawings and/or the specifications.

1.02 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. It is the responsibility of the contractor to investigate and identify all required permits, licenses and inspections required and investigate and identify any AHJ. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

D. Determine the exact requirements for ALL utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform ALL work as required by those utilities.

1.03 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. All materials and equipment shall be or the highest quality in order to provide the most reliable end product possible. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)

B. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturer’s Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code
6. National Fire Protection Association

C. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

D. All products shall bear UL labels where standards have been set for listing.

1.04 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings shall be taken to mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

C. Submit for review in sextuplet within fifteen (15) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and submittals are not received in fifty (15) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne by the contractor.

D. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.

E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's representative and such procedures will not be cause for delay. After final review, supply up to six (3) copies, if requested.

G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each Submittal and/or shop drawing.

H. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.

I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent.

J. Materials to be submitted as required are as follows:

1. Control Panel
2. Motor Protection
3. Wire & Wiring Devices
4. Conduit and Fittings
5. J-Boxes
6. Electrical Enclosures
7. Electrical Equipment and Materials
8. Pump Controller

K. Each submittal shall be accompanied with a written statement certifying that the submitted equipment and/or material meet the plans and specifications.

1.05 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within fifteen (15) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, the contractor shall assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

E. Energy Efficiency of each item of power consuming equipment shall be considered one of the standards for evaluation.

1.06 EXCAVATION AND BACKFILLING (AS REQUIRED)

A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.

C. All backfilling shall be made with Concrete Backfill.

D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

G. Any construction involving the opening of trenches and or Sidewalks and Concrete Drives is to be done in an efficient manner so as to reduce the impact of to surrounding areas. Trenches are shall not be left open during periods of rain so as to reduce the impact of the weather to surrounding areas/structures.

1.07 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

F. No cutting of structural elements shall be done without permission of the Engineer.

1.08 WATERPROOFING

A. Interiors of raceways that are likely to have water ingress such as runs to and from J-Boxes, Control Boxes shall have water-stops/sealing hubs etc. installed to prevent water from entering into installations.

1.09 CONSTRUCTION REQUIREMENTS

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the engineer in advance of construction. Confirmed locations shall be made for the following:

1. Poles
2. Receptacles
3. Rough-ins and connections for equipment furnished under other sections
4. Lighting Fixtures
5. Outlets
6. J-Boxes, Control Panels, and, Switchgear, Electrical Panels, Control Panels etc.

B. All work shall be done in the best and most workmanlike manner by qualified careful electricians who are skilled in their trade. The standards of work required throughout shall be of the first class only and electricians whose work is unsatisfactory to the Engineer shall be instantly dismissed from the work upon written notice from the Engineer at no additional cost to the Owner. All work must meet the approval of the Engineer.

C. Unless shown in detail, the drawings are diagrammatic and do not give exact details as to the elevations and routing of conduits, nor do they show all offsets and fittings. Nevertheless, the installation must be made to fit and conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are shown, confirm locations and routing prior to installation with Engineer.

D. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole-punch. Cutting openings with a torch or other device that produces a jagged edge, rough cut will not be acceptable.

E. Raceway entry into equipment shall be carefully planned. Cutting of enclosure framework to accommodate poorly planned raceway placement will not be acceptable. No hole-punch penetrations shall be made on top of any equipment, panel, or Junction box. All hole-punch penetrations shall be properly sealed so as to prevent moisture and gasses from entering the equipment, panel, or Junction Box etc.

F. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be acceptable.

G. Equipment, inclusive of supporting devices, shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid tight fitting manner.

1.10 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

E. Interiors of Switchgear, Motor Control Centers, Control Panels, shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200 watt Lamp located the bottom of each section, or panel. Energizing integral condensation heaters shall be acceptable in place of lamps.

1.11 COOPERATION WITH WORK UNDER OTHER SECTIONS

A. Cooperate with all other trades so as to facilitate the general progress of the work. Allow other trades every reasonable opportunity for then installation of their work and the storage of their materials.

B. The work under this section shall follow the general construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before any concrete is placed or masonry is installed.

C. Work with other trades in determining exact locations of outlets, conduits, fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime as required to accomplish these requirements if directed to do so.

1.12 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.13 TESTING AND ENGINEERING STUDIES

A. All cables shall have an insulation test performed using a 1000 Volt Megger tester. Testing shall include the entire length of cable from the source terminal to the load terminal. Testing shall be performed prior to final landing of power cables to equipment. Reports are to be made during the time of the testing and submitted to the Engineer for review. Reports must include time and date, weather conditions, printed names and signatures of tester and at least one witness. Testing must be performed in the presence of the Engineer/Owner Representative. Insulation values of each cable shall be equivalent to or greater than 500,000 ohms. In the event a cable's test value is not equivalent or greater than 500,000 ohms, that cable shall be removed and replaced. Upon reinstallation, ALL cables are to be retested. Retesting must result in the same resistance value equal to or greater than 500,000 ohms. Retested and/or replaced cables are required to achieve the proper resistance rating. See additional requirements in SECTION 16600.

B. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner.

1.14 RECORD DRAWINGS

A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.

B. Show conduit routing and wiring runs as constructed and identify each.

C. Record all deviations from the Contract Documents.

D. Submit set of marked-up drawings for review.

1.15 OPERATIONS AND MAINTENANCE MANUALS

A. Prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.

B. Submit six (6) copies for review.

2.00 PRODUCTS

2.01 RACEWAYS

A. Above ground rigid metallic conduit shall be schedule 40 Aluminum conduit, Rigid Conduit, or PVC coated plastibond conduit with like fittings as indicated on plans sheets. Conduit couplings shall be threaded Aluminum, Rigid, or PVC coated plastibond as indicated on plansheets. Such conduit shall be Cantex, JM Eagle, Republic, Triangle, Wheatland, or Engineer approved equivalent. Please provide full submittal for review and acceptance by Engineer. Conduits in wet areas shall be PVC Coated Conduits with PVC Coated couplings and condulets.

B. Rigid non-metallic conduit shall be Schedule 40 PVC plastic. Couplings shall be PVC solvent weld type. Such conduit shall be Carlon, or equivalent.

C. 90 degree transitions from underground to above shall be PVC Coated Rigid Aluminum Conduit. Couplings shall be PVC Coated Plastibond Couplings with PVC solvent weld type Adapter in ductbank. Above Ground use PVC Coated Couplings for transition to Aluminum Conduit above ground. The transition shall be 12” minimum above ground with PVC Coated conduit transition and nipples. The Contractor shall use long sweep 90 degree bends as required. All above ground nipples shall be cut uniformly including threading to provide a uniform near and workman like appearance.

2.02 CONDUIT FITTINGS

A. Rigid metallic conduit locknuts shall be, Aluminum, or PVC coated Aluminum - plastibond as indicated on the plan sheets. Sealing locknuts shall also have an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4. These lock nuts shall have a integral grounding terminal for proper grounding. These fittings and shall be MYERS "SCRU-TITE", or equal.

B. Chase nipples, reducers, enlargers, “Ericksons”, capped els, short els, long els, split couplings and fittings shall be Aluminum that is oxidizing resistant and intended for use with rigid Aluminum conduit. All such fittings shall be PVC coated where as required.

C. Rigid metallic conduit locknuts shall be compatible be Aluminum that is oxidizing resistant and intended for use with rigid Aluminum conduit. Sealing locknuts shall have in addition to that specified above, an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4.

D. Rigid metallic conduit insulating bushings shall be molded canvas bakelite type suitable for operation in 100ºC rise over 40ºC ambient. Polyproplyne bushings will not be acceptable.

E. Rigid Metallic Conduit Grounding type bushings shall be Aluminum that is oxidizing resistant and intended for use with rigid Aluminum conduit. with threaded steel body insulated throat, and ground lug. Insulated throat shall meet specifications under article D above.

F. Rigid metallic conduit expansion/deflection fittings shall be water-tight with flexible plastic sleeve that allows ¾” movements in all directions. Hubs shall be threaded, hot dipped galvanized (HDG) malleable iron. Clamping bands shall be stainless steel. There shall be on equipment ground bonding jumper, Expansion deflection fittings shall be Crouse-Hinds, OZ, or equivalent.

G. Rigid metallic conduit hubs shall be Aluminum liquid-tight type with threaded body, with sealing ring on conduit side and threaded make tapered steel body with hardened steel locknut on box side. Plastic jacketed hubs shall have 40 mils PVC coating. Such fittings shall be OCAL “Blue” or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote “Supreme” shall be acceptable.

H. Cadmium and electro-galvanized plated devices and hardware shall not be acceptable.

2.03 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.

B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal.

C. Rigid metallic conduit bodies shall be Aluminum type with threaded hubs, gasketed metal covers, with stailnless steel screws. Plastic jacketed type shall have 40 mils minimum coating of PVC. Such conduit shall be OCAL “Blue” or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote “Supreme” shall be acceptable.

D. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.

E. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws.

F. Rigid metallic conduit boxes shall be HDG cast iron, with threaded integrally-cast

G. hubs, cast metal cover, and stainless steel cover screws. Such boxes shall be Crouse Hinds, Appelton, or equivalent. Plastic jacketed type shall have 40 mils minimum coating of PVC.

2.04 WIRE AND CABLE

A. Contractor shall refer to Section 16123. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.

B. All 480V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75ºC. Furnish okonite "Okolon", Rockbestos "Firewall", or equal.

C. All 120/240V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75ºC. Furnish okonite "Okolon", General Cable, South Wire, Encore, or Engineer approved equal.

D. Factory pigmented insulation color for sizes #6 and smaller for power wiring shall be as follows:

1. 150V to Ground, or less:

PHASE	COLOR
A	Black
B	Red
C	Blue
Grounding Conductor	Green
Grounded Conductor	White

2. Greater than 150V to ground:

PHASE	COLOR
A	Brown
B	Orange
C	Yellow
Grounding Conductor	Green
Grounded Conductor	Gray

E. Bare conductors for grounding purposes shall be hard-drawn stranded copper.

2.05 CONNECTORS

A. Mechanical connectors shall be copper alloy bolted pressure type with bronze hardware.

B. Insulated spring-wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 105º C continuous. Furnished 3M "Hyflex", T&B "PT" or equal.

C. Insulated set-screw connectors shall consist of copper body with flame-retardant 600V plastic insulated shield. Furnished Ideal, T&B, or equal.

D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrel and tin-plated copper ring-tongue style connector. Furnish T&B "Sta-kon", 3M "Scothlok", or equal.

E. Terminal strips shall be channel-mounted type with tin-plated solderless box lugs contained with barriered nylon-insulated separable barriers. Such devices shall be Square D, Cutler Hammer, Allen Bradley, or equivalent.

F. Terminal connectors for flat head terminal screws shall be locking spade type with vinyl insulated compression indent shaft, T&B, Ideal, Amp, or equivalent.

2.06 INSULATING PRODUCTS

A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, F.E., 3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, "slipknot Grey", 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be moisture-proof void filling tape shall be "plysafe", 3M Scotch 23, or equal.

D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be "Plysil #3445", 3M Scotch 70, or equal.

E. Insulation putty filler-tape shall be Plymouth #2074, 3M, or equal. Putty to be used as necessary to keep moisture and gasses from entering raceways.

2.07 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.

B. Numbered marking labels shall be colored vinyl markers, T&B, Brady, or equal.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.

D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking "BURIED CONDUIT", or similar language, along its length.

E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with white engraving. Attachment means shall be self-tapping stainless steel screws.

2.08 GROUNDING DEVICES

A. Exothermally welded joints shall be made with Enrico "cadweld", Burndy "Thermweld", or equal kits.

B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.

C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.

2.09 SUPPORTING DEVICES

A. Contractor shall refer to Section 16070 Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be good quality Aluminum; 1-5/8" wide x 3-1/4" deep unistrut. Clamp nuts and mounting hardware for use with slotted channels shall be grade 316 stainless steel.

C. Conduit straps for use with slotted channels shall be stainless steel with stainless steel hardware. HDG unistrut and straps shall be acceptable for this project. Please provide full submittal for Engineer review and acceptance.

D. Concrete and Masonry Anchors shall be stainless steel type. Furnish Hilti, or equal.

E. Poles for supporting outdoor control panels shall be Hot Dipped Galvanized, with footings encased in concrete. Tops of poles shall be covered with a Hot Dipped Galvanized conduit cap.

F. "U" bolts shall be stainless steel with Stainless Steel hex-head bolts.

G. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.10 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.

H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

3.00 INSTALLATION

3.01 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, will not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of structures. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.

E. Unless otherwise indicated, conduit runs installed below-grade in earth shall be schedule 40 PVC electrical conduit. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that tops of conduits are at least Thirty-Six (36") inches below finished grade. Support runs on plastic spacers and backfill to three (3") inches above and all around including topmost conduits with 3000 PSI Red Concrete. Complete backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped.

F. Below-grade to above-grade upturns in non-metallic runs shall be made with Schedule PVC Coated rigid conduit as in PART 2 PRODUCTS 2.01 RACEWAYS

G. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.

H. All conduit runs shall be watertight over their lengths of run except where drain fittings are indicated. In which cases, install specified breather-drain fittings.

I. Empty conduits shall have pull-tape installed. Identify each terminus as to location of other end. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Cap exposed ends of empty conduit with plastic caps.

J. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

K. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

L. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, fagged edges, and torn metal.

M. All raceways shall be swabbed clean after installation. There shall be no debris

N. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.

O. Surface mounted conduit and all fittings shall be schedule 40 Aluminum conduit and shall conform to Section, 2.01 RACEWAYS; A. Mounting hardware shall be Aluminum Deep Channel Unistrut with stainless steel hardware including nuts, bolts, anchor bolts and pipe clamps.

3.02 CONDUIT BODIES AND BOXES

A. Contractor shall refer to Section 26 05 33. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction. PVC coated fittings shall be used as required.

B. Covers for conduit bodies installed shall be gasketed cast metal type.

C. All conduit boxes installed shall be cast metal type Aluminum as required or indicated. Covers for all such boxes shall be gasketed stainless steel to match box construction.

3.03 RACEWAY SUPPORT

A. Contractor shall refer to Section 16070. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Below-grade conduits shall be supported with plastic saddles.

3.04 WIRING

A. Branch circuits may be spliced for receptacle, lighting and small appliances load inside appropriate junction boxes.

B. Except as otherwise specified, taps and splices with #10 AWG and smaller shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be further insulated with an envelope of stretched piece of EPR tape around each wire to fill

the interstices between the wires. Then, apply one-half lapped layer of electrical tape over all.

C. Taps, splices, and connection in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

D. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

E. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

F. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

G. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

H. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

I. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

J. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

3.05 WIRING DEVICES

A. Contractor shall refer to Section 26 27 26. Install wiring devices where indicated. Wiring devices shall be type as indicated.

B. Each wiring device shall be set with axis plumb and installed with yoke screw so as to adequately support device yokes to the box.

C. Device boxes shall be cast metal condulets or equal.

D. Use ganged boxes for ganged devices.

E. Each device box shall be equipped with specified cast metal cover.

3.06 GROUNDING

A. Refer to Section 26 05 26.

END OF SECTION

26 05 19 WIRING (600 VOLT OR LESS WIRES AND CABLES)

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. 600 volt class wire and cable.
2. Instrumentation class wire and cable.
3. Network cable.
4. Fire alarm wire and cable.
5. Telephone wire and cable.
6. 600 volt class tray cable.
7. 600 volt class armored cable.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
    a. Submittal Procedures.
    b. Section 26 00 00 – General Electrical Requirements
    c. Section 26 05 53 – Electrical Identification.
    d. Section 26 43 13 – Surge Protective Devices.
    e. Section 26 05 73 – Electrical System Studies.
    f. Other Pertinent Sections

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. ASTM International (ASTM):

1. B 3 – Standard Specification for Soft or Annealed Copper Wire.
2. B 8 – Standard Specification for Concentric-Lay–Stranded Copper

C. Conductors, Hard, Medium-Hard, or Soft. C. CSA International (CSA).

D. Insulated Cable Engineers Association (ICEA):

1. NEMA WC 70/ICEA S-95-658-1999 – Standard for Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
2. NEMA WC 57/ICEA S-73-532 – Standard for Control, Thermocouple Extension, and Instrumentation Cables.

E. National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA):

1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

G. National Fire Protection Association (NFPA):

1. 72 – National Fire Alarm and Signaling Code.
2. 101 – Life Safety Code.

H. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):

1. 568-C.2 – Balanced Twisted-Pair Telecommunication Cabling and Components Standard.

I. Underwriter's Laboratories Inc., (UL):

1. 44 – Thermoset-Insulated Wires and Cables.
2. 1424 – Standard for Cables for Power-Limited Fire-Alarm Circuits.
3. 1569 – Standard for Metal-Clad Cables.
4. 2196 – Standard for Tests for Fire Resistive Cables.
5. 2225 – Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

B. Definitions of terms and other electrical considerations as set forth in the:

1. ASTM.
2. ICEA.

C. NEMA:

1. Type 4 enclosure in accordance with NEMA 250.
2. Type 4X enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Furnish and install the complete wire and cable system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. Product data:

1. Manufacturer of wire and cable.
2. Insulation:
    a. Type.
    b. Voltage class.
3. American wire gauge (AWG) size.
4. Conductor material.
5. Pulling compounds.

C. Shop drawings:
    1. Show splice locations.

D. Test reports:
    1. Submit test reports for meg-ohm tests.

E. Calculations:
    1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
        a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
    2. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. All wires and cables shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.13 OWNER`S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal (XHHW-2):

1. 600 volt class wire and cable:
    a. General Cable.
    b. Okonite Company.
    c. Southwire Company.
    d. Encore.
2. Instrumentation class wire and cable:
    a. Alpha Wire Company.
    b. Belden CDT.
    c. General Cable BICC Brand.
    d. Okonite Company.
    e. Rockbestos Surprenant Cable Corporation.
3. Network cables:
    a. Belden CDT.
    b. Panduit.
    c. TE Connectivity.
4. Fire alarm wire and cable:
    a. West Penn Wire.
    b. Olympic Wire and Cable.
    c. Rockbestos Surprenant Cable Corporation.
    d. Draka Lifeline.
5. Telephone wire and cable:
    a. American Telephone and Telegraph.
    b. West Penn Wire.
    c. Olympic Wire and Cable.
    d. Superior Essex Inc.
    e. Draka Comteq.

f. General Cable.

6. Tray cables:
    a. General Cable, BICC Brand.
    b. Southwire Company.
    c. Okonite.
7. Armored cables.
    a. Okonite Company.
    b. Rockbestos Surprenant Cable Corporation.
    c. Southwire Company.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Conductors:
    1. Copper in accordance with ASTM B 3.

2.04 MANUFACTURED UNITS

A. General:
    1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
    2. Permanently mark each wire and cable with the following at 24-inch intervals:
        a. AWG size.
        b. Voltage rating.
        c. Insulation type.
        d. UL symbol.
        e. Month and year of manufacture.
        f. Manufacturer's name.
    3. Identify and mark wire and cable as specified:
        a. Use integral color insulation for Number 2 AWG and smaller wire.
        b. Wrap colored tape around cable larger than Number 2 AWG.

B. 600 volt class wire and cable:
    1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Feeder/Branch Circuit Schedules:
        a. When not indicated on the Drawings, size wire as follows:
            1). In accordance with the NEC:
                a). Use 75 degree Celsius ampacity ratings.

b). Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.

2). Provide Number 12 AWG minimum for power conductors.

3). Provide Number 14 AWG minimum for control conductors.

2. Provide Class B stranding in accordance with ASTM B 8:

a. Provide Class C stranding where extra flexibility is required.

3. Insulation:

a. XHHW-2.

b. 90 degrees Celsius rating.

4. Multi-conductor cables:

a. Number and size of conductors as indicated on the Drawings or in the Feeder/Branch Circuit Schedules.

b. Individual conductors with XHHW-2 insulation.

c. Overall PVC jacket.

d. Tray cable rated.

e. Color-coding for control wire in accordance with ICEA Method 1, E-2 in accordance with NEMA WC 57/ICEA S-73-532.

f. Ground conductor: Bare or Insulated, green:

1). Sized in accordance with NEC.

C. Instrumentation class cable:

1. Type TC.

2. Suitable for use in wet locations.

3. Voltage rating: 600 volts.

4. Temperature rating:

a. 90 degrees Celsius rating in dry locations.

b. 75 degrees Celsius rating in wet locations.

5. Conductors:

a. Insulation:

1). Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.

b. Number 16 AWG stranded and tinned.

c. Color code:

1). Pair: Black and white.

2). Triad: Black, white and red.

3). Multiple pairs or triads:

a). Color-coded and numbered.

6. Drain wire:

a. 18 AWG.

b. Stranded, tinned.

7. Jacket:

a. Flame retardant, moisture and sunlight resistant PVC.

b. Ripcord laid longitudinally under jacket to facilitate removal.

8. Shielding:

a. Individual pair/triad:

1). Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.

b. Multiple pair or triad shielding:

1). Group shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100-percent coverage.

2). Completely isolate group shields from each other.

3). Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100-percent coverage.

c. All shielding to be in contact with the drain wire.

D. Network cables:

1. Category 6E (Category 6 Enhanced):

a. General:

1). Provide all Cat 6E cables meeting the most recently published standards set by ANSI/TIA/EIA for installation and testing of communication cabling and connectors.

b. Conductors:

1). 23 AWG solid bare copper conductors.

c. Insulation:

1). Polyolefin.

2). 4 non-bonded twisted pair cables formed into a cable core.

d. Color code:

1). Pair 1: White/blue stripe and blue.

2). Pair 2: White/orange stripe and orange.

3). Pair 3: White/green stripe and green.

4). Pair 4: White/brown stripe and brown.

e. Outer jacket:

1). PVC with ripcord color Blue.

f. Electrical characteristics:

1). Frequency range: 0.772-550 MHz.

2). Attenuation: 32.1 dB/100 m.

3). Near-end crosstalk (NEXT): 39.3 dB.

4). Power sum NEXT: 37.3 dB.

5). Attenuation to crosstalk ratio (ACR): 7.2 dB.

6). Power sum attenuation to crosstalk ratio (PSACR): 5.3 dB/100 m.

7). Equal level far-end crosstalk (ELFEXT): 22.8 dB.

8). Power sum ELFEXT: 19.8 dB/100 m.

9). Return loss: 17.3 dB.

10). Propagation delay: 537 ns/100 m.

11). Delay skew: 45 ns/100 m.

12). Propagation delay (skew), max: 2.5 ns/100 m.

2. DeviceNet cable:

a. Provide DeviceNet cables in the following cable types as indicated on the Drawings and in the Specifications:

1). Thick.

2). Thin.

b. General:

1). NEC/UL Type TC or TC-ER.

2). Compliant with all ODVA specifications, and shall pass the ODVA established conformance test.

3). Approved to bear the ODVA Conformance Tested Service Mark.

c. Thick cable types shall consist of 2 shielded pairs for data and power:

1). Shielded data pair:

a). Tinned, copper conductors minimum with 19 by 30 stranding (minimum).

b). Flame retardant polypropylene insulated.

c). Aluminum foil-polyester tape.

d). One pair AWG #18 for signal (minimum).

e). Color: Blue and white.

2). Shielded DC power pair:

a). Tinned, copper conductors with 19 by 28 stranding (minimum).

b). Polyvinyl chloride insulated.

c). Aluminum foil-polyester tape.

d). One pair AWG #16 for power (minimum).

e). Color: Black and red.

3). 100-percent coverage each pair foil shielded with overall 65-percent coverage tinned copper braid.

4). Outer shield tinned copper drain wire.

5). Sunlight/oil resistant polyvinyl chloride outer jacket.

6). 600-volt insulation level.

7). Nominal OD 0.48 inch (minimum).

8). Use CPE insulated cable for direct burial.

d. Thin cable types shall consist of 2 shielded pairs for data and power:

1). Shielded data pair:

a). Tinned, copper conductors with 19 by 32 stranding (minimum).

b). Foam polyethylene (FPE).

c). Aluminum foil-polyester tape.

d). One pair AWG #20 for signal (minimum).

e). Color: Blue and white.

2). Shielded DC power pair:

a). Tinned, copper conductors with 19 by 30 stranding (minimum).

b). Polyvinyl chloride insulated.

c). Aluminum-foil polyester tape.

d). One pair AWG #18 for power.

e). Color: Black and red.

3). 100 percent coverage each pair foil shielded with overall 65-percent tinned copper braid.

4). Outer shield tinned copper drain wire.

5). Sunlight/oil resistant polyvinyl chloride outer jacket.

6). 300-volt insulation level.

7). Nominal OD 0.378 inch.

3. RS-485 cable:

a. Two-wire:

1). Shielded twisted pair.

2). Tinned, copper conductors minimum with 7 by 30 stranding.

3). AWG #22.

4). Insulation:

a). FHDPE: Foam high-density polyethylene.

b). 300-volt insulation level.

5). Outer shield:

a). 100-percent coverage.

b). Tape/braid.

c). Aluminum foil-polyester tape.

d). Tinned copper braid.

6). Outer shield drain wire:

a). Tinned, copper conductor minimum with 7 by 30 stranding.

b). AWG #22.

7). Outer jacket PVC:

a). Sunlight resistant.

8). UL/CSA flame tested.

9). Minimum bending radius 2.5 inches.

10). Nominal OD 0.284 inch.

E. Tray cable:

1. Provide minimum size Number 1/0 AWG for single wires:
    a. Listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with the NEC.
2. Provide multi-conductor cable listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with the NEC.
    a. Provide with an integral white insulated conductor where a neutral is required.
3. Ambient temperature adjustment in accordance with the NEC.

F. Fire alarm cable:

1. Number of pairs: As necessary for the application.
2. Voltage rating: 300 V minimum.
3. Two-hour fire rating in accordance with UL 2196.
4. Provide fire alarm cable in accordance with the requirements of UL 1424.
5. Provide Type FPLP (power-limited plenum rated) for all cabling within ducts, plenums, and all spaces used for air handling:
    a. Cable must meet NEC standards, and must have adequate fire-resistant and low smoke-producing characteristics.

6. Provide Type FPLR (power-limited riser rated) for all vertical runs that pass from floor to floor:
    a. FPLR cable must meet NEC standards, and must have fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.
7. FPL (power-limited general purpose) is only suitable for general-purpose fire alarm use and shall not be used for risers, ducts, plenums, and in air-handling spaces:
    a. FPL cable must meet NEC standards, and must be listed as resistant to the spread of fire.
8. Cable substitutions are not permitted unless approved by Engineer.
9. Meets code requirements of NFPA 72 and NFPA 101.
10. Conductor insulation:
    a. Low smoke PVC.
    b. Minimum 105 degrees Celsius rating.
11. Conductor jacket:
    a. Low smoke PVC.
    b. Ripcord and surface-printed with year of manufacture and cable description at maximum 24-inch intervals.
    c. Minimum 105 degrees Celsius rating.

G. Telephone cable:
1. Number of twisted pairs: As indicated on the Drawings.
2. Voltage rating: 300 volts.
3. Insulation: Thermoplastic, color coded in accordance with telephone industry standards.
4. Insulation:
    a. Non-plenum: High molecular weight polyethylene.
    b. Plenum-rated: FEP.
5. Jacket:
    a. Non-plenum: PVC.
    b. Plenum-rated: Low smoke PVC.
    c. Surface-printed with year of manufacture and cable description at maximum 24-inch intervals.
6. Shield: 8 mil aluminum or copper, overlapped to provide 100-percent coverage, covered totally on both sides with copolymer or equal coating able to provide an effective moisture barrier.
7. Conductors: ASTM B3, solid, soft, bare copper.
8. Use minimum Number 24 AWG conductors, unless otherwise indicated on the Drawings.

9. Twist insulated conductors into pairs with varying lengths of lay.
10. Apply non-hygroscopic core tape over cable core as a dielectric and heat barrier.
11. Provide plenum-rated cable for wiring within ducts, plenums, and all spaces used for air handling.

H. Armored cable:

1. Tight-fitting, continuously welded, corrugated impervious aluminum armor sheath applied over the cable core in accordance with UL 1569.
2. PVC outer jacket.
3. Comply with UL-2225 if within hazardous classification area.
4. For multi-conductor cable, include a separate ground conductor in the cable:
    a. An internal ground conductor shall meet NEC requirements for equipment ground conductor size.
    b. The cable armor is not acceptable as a ground conductor.
5. Rated for 90 degrees Celsius in wet or dry locations.
6. Color-coding for control wire in accordance with ICEA Method 1, E-2.
7. Color-coding for power cables as specified above.
8. Individual conductors in accordance with this Specification:
    a. Provide the number and size of conductors as indicated on the Drawings.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Wire ties:

1. One of the following or equal:
    a. T&B "Ty-Rap" cable ties.
    b. Panduit cable ties.

B. Wire markers:

1. As specified in Section 26 05 53.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.

B. Test Type XHHW-2 in accordance with the requirements of UL 44.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16000.

B. Color-coding:

1. Color-coding shall be consistent throughout the facility.
2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
    a. Phase A – Black.
    b. Phase B – Red.
    c. Phase C – Blue.
    d. Single phase system – Black for one hot leg, red for the other.
    e. Neutral – White.
    f. High phase or wild leg – Orange.
    g. Equipment ground – Green.
3. The following color code shall be followed for all 480/277 volt systems:
    a. Phase A – Brown.
    b. Phase B – Orange.
    c. Phase C – Yellow.
    d. Neutral – Gray.
    e. Equipment ground – Green.
4. The following color code shall be followed for all 120 VAC control wiring:
    a. Power – Red.
    b. Neutral – White.
5. The following color code shall be followed for all general purpose DC control circuits:
    a. Grounded conductors – White with blue stripe.
    b. Ungrounded conductors – Blue.
6. Switch legs shall be violet. Three-way switch runners shall be pink.
7. Wires in intrinsically safe circuits shall be light blue.
8. Wire colors shall be implemented in the following methods:

a. Wires manufactured of the desired color.

b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:

1). Colored tape shall be wrapped to overlap 1/2 of the width of the tape.

C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:

1. Install wires only in approved raceways.

2. Do not install wire:

a. In incomplete conduit runs.

b. Until after the concrete work and plastering is completed.

D. Properly coat wires and cables with pulling compound before pulling into conduits:

1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:

a. Ideal Products.

b. Polywater Products.

c. 3M Products.

d. Greenlee Products.

e. Or equal as recommended by cable manufacturer.

f. Do not use oil, grease, or similar substances.

E. E. Cable pulling:

1. Prevent mechanical damage to conductors during installation.

2. For cables Number 1 AWG and smaller, install cables by hand.

3. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.

4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the ENGINEER may, at his discretion, require replacement of the cable.

5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.

6. Make splices or add a junction box or pull box where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer's recommendation for the specified cable size:

a. Make splices in manholes or pull boxes only.

b. Leave sufficient slack to make proper connections.

F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

G. Install and terminate all wire in accordance with manufacturer's recommendations.

H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:

   1. Do not lace wires in gutter or panel channel.

   2. Install all wire ties with a flush cutting wire tie installation tool:

      a. Use a tool with an adjustable tension setting.

   3. Do not leave sharp edges on wire ties.

I. Terminate solid conductors at equipment terminal screws with the conductor tightly wound around the screw so that it does not protrude beyond the screw head:

   1. Wrap the conductor clockwise so that the wire loop is closed as the loop is tightened.

   2. Do not use crimp lugs on solid wire.

J. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:

   1. Use ring type lugs if box lugs are not available on the equipment.

K. Splices:

   1. Provide continuous circuits from origin to termination whenever possible:

      a. Obtain Engineer’s approval prior to making any splices.

   2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.

   3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:

      a. Splice box NEMA rating requirements as specified in Section 26 05 33.

      b. Make splices in labeled junction boxes for power conductors.

      c. Make splices for control and instrument conductors in terminal boxes:

         1). Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.

   4. Power and control conductors routed in common raceways may be spliced in common junction boxes.

   5. Clearly label junction and terminal boxes containing splices with the word "SPLICE."

   6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.

   7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:

      a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.

   8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:

a. A heat shrink insulating system listed for submersible applications.

b. Or an epoxy resin splicing kit.

L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

M. Instrumentation class cable:

1. Install instrumentation class cables in separate raceway systems from power cables:

a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.

b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.

2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.

3. Shield grounding requirements as specified.

N. Multi-conductor cable:

1. Where cable is not routed in conduit with a separate ground conductor, use one conductor in the cable as a ground conductor:

a. Use an internal ground conductor, if it is no smaller than as indicated on the Drawings and in accordance with NEC requirements for equipment ground conductor size.

b. Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.

O. Armored cable:

1. Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with 1 of the full-sized conductors serving as ground.

2. The cable armor is not acceptable as a ground conductor.

3. Where armored cable terminates at a device, switchboard, panel, etc., use armored cable connector.

4. Where armored cable run continues in conduit, strip jacket and armor for portions in conduit, and terminate cable and jacket with an armored cable connector threaded into a coupling or conduit box.

P. Telephone cable:

1. Install telephone cables in dedicated metallic raceways, including raceways in ductbanks, manholes, and pull boxes.

Q. Fire alarm cable:

1. Install fire alarm cable in dedicated metallic raceways as indicated on the Drawings.

R. Signal cable:

1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

S. Submersible cable in wet wells:

1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

T. Wiring allowances:

1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.

2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. Grounding:

1. As specified in Section 26 00 00

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 05 26 GROUNDING AND BONDING

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Grounding electrodes.
2. Grounding electrode conductors.
3. Equipment grounding conductors.
4. Main bonding jumper.
5. Ground connections.
6. General requirements for grounding.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
    a. Submittal Procedures.
    b. Section 26 00 00– General Electrical Provisions

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. ASTM International (ASTM):

1. B 3 – Standard Specification for Soft or Annealed Copper Wire.
2. B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. Institute of Electrical and Electronics Engineers (IEEE): 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

D. Underwriters Laboratories, Inc. (UL):

1. 467 – Ground and Bonding Equipment.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

1.04 SYSTEM DESCRIPTION

A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:

1. Grounding electrodes.

2. Bonding jumpers.

3. Ground connections.

C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 16950, shall be:

1. 5 ohms or less for industrial systems.

2. 1 ohm or less for electrical buildings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications

B. Product data:

1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00.

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Compression steel connectors: One of the following or equal:
   1. FCI Burndy.
   2. Thomas & Betts.

B. Exothermic connectors: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Burndy Weld.

C. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Conex.

D. Ground cable: One of the following or equal:
   1. Nehring.
   2. Harger.
   3. Southwire.

E. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Ground rod:
   1. Minimum: 3/4-inch diameter, 10 feet long.
   2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
      a. The copper-to-steel bond shall be corrosion resistant.
   3. In accordance with UL 467.
   4. Sectional type joined by threaded copper alloy couplings.

5. Fit the top of the rod with a threaded coupling and steel-driving stud.
6. Minimum of three rods spaced the length of the rod as indicated in the NEC.

B. Ground cable:
1. Requirements:
a. Soft drawn (annealed).
b. Concentric lay, coarse stranded in accordance with ASTM B 8.
c. Bare copper in accordance with ASTM B 3.
2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. Compression connectors:
1. Manufactured of high copper alloy specifically for the particular grounding application.
2. Suitable for direct burial in earth and concrete.
3. Identifying compression die number inscription to be impressed on compression fitting.

D. Exothermic welds:
1. Current carrying capacity equal to that of the conductor.
2. Permanent molecular bond that cannot loosen or corrode over time.
3. Will not deteriorate with age.

E. Equipment grounding conductors:
1. Conductors shall be the same type and insulation as the load circuit conductors:
a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
2. Minimum size in accordance with the NEC.

F. Grounding electrode conductors:
1. Minimum size in accordance with the NEC.

G. Main bonding jumpers and bonding jumpers:
1. Minimum size in accordance with the NEC.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Precast ground well boxes:
1. Minimum 10 inch interior diameter.
2. Traffic-rated cast iron cover.

3. Permanent “GROUND” marking on cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00.

B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:

1. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.

2. Provide a separate grounding conductor in each individual raceway for parallel feeders.

C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:

1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:

1. Individually bond these raceways to the ground bus in the equipment.

E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

H. Duct bank ground system:

1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as specified in the Specifications.

2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

I. Grounding at service (600 V or Less):

1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.

J. Ground connections:

1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors or exothermic welds as required, UL listed, and labeled for the application.

2. Make ground connections in accordance with the manufacturer's instructions.

3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings or specified in the Specifications.

K. Grounding electrode system:

1. Ground ring (Where indicated on the drawings):

a. Provide all trenching and materials necessary to install the ground ring around process facility and structures or indicated on the Drawings. Ground ring shall be required for all structures.

b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size per NEC.

c. Minimum burial depth 36 inches.

d. Re-compact disturbed soils to original density in 6 inch lifts.

2. Ground rods:

a. Locations at corners of structures, structural members or as indicated.

b. Length of rods forming an individual ground array shall be equal in length.

c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.

d. Prepare all ground rods for exothermic welds, as recommended by the manufacturer, before exothermic welding of connectors to ground rod.

3. Metal underground water pipe:

a. Bond metal underground domestic water pipe to grounding electrode system.

4. Metal frame of building or structure:

a. Bond metal frame of building or structure to grounding electrode system.

5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.

6. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

L. Shield grounding:

1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:

a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.

2. Terminate the shield drain wire on a dedicated terminal block.

3. Use manufacturer's terminal block jumpers to interconnect ground terminals.

4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

M. Telephone panel ground:

1. Install individual ground rod or ground system at telephone panels:

a. Install a dedicated grounding electrode conductor from the telephone panel to the grounding electrode system.

b. Do not connect any other grounds to the telephone panel grounding electrode conductor.

2. Install ground rod or ground system in accordance with telephone company requirements.

N. Where indicated on the Drawings, install ground rods in precast ground wells.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00.

B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

C. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

D. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at individual ground rods. Make tests at ground rods before any conductors are connected.

a). Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b). Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

    a). Grounding system will be considered defective if it does not pass tests and inspections.

    b). Prepare test and inspection reports.

    c). Report measured ground resistances that exceed the following values:

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances to the Engineer for acceptance.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.08 ADJUSTING

A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:

1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 05 29 CONDUIT SUPPORT

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Mounting and supporting electrical equipment and components.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Section 26 00 00 – General Electrical Specifications

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. ASTM International (ASTM):

1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. A 240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

1.04 SYSTEM DESCRIPTION

A. Design requirements:

1. Conform to the requirements of the Building Code as required.

2. Demonstrate the following using generally accepted engineering methods:

a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.

b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.

3. Design loading and anchoring requirements:
    a. As indicated in the Building Code unless otherwise specified.
    b. Seismic loading requirements:
        1). Freestanding or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 26 00 00.
    c. Wind loading requirements:
        1). All exterior freestanding equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 26 00 00.
    d. Minimum safety factor against overturning: 1.5.
    e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.

B. Performance requirements:
    1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

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

C. Shop drawings:
    1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
    2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
        a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.

3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

D. Installation instructions:

1. Furnish anchorage instructions and requirements based on the wind conditions of the Site:

a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00.

1.12 SYSTEM STARTUP

A. As specified in Section 26 00 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Thomas & Betts.

2. Power-Strut.

3. Unistrut.

4. Cooper B-Line.
5. Robroy.
6. Aickinstrut.
7. Champion.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Use materials appropriate for the area as specified in Section 26 00 00.

B. Stainless steel:

1. Supports:

a. In accordance with ASTM A 240.

b. ANSI Type 316 material.

2. Hardware:

a. ANSI Type 316 material.

C. PVC coated galvanized steel:

1. Supports:

a. Hot dip galvanized steel as specified in this Section.

b. PVC coating thickness of 10 to 20 mils.

2. Hardware:

a. ANSI Type 316 material.

D. Fiberglass:

1. Supports:

a. Vinyl ester.

2. Hardware:

a. Polypropylene.

b. Thermal plastic elastomer.

c. Fiberglass reinforced plastic.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Anchor bolts:

1. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Paint and finish all supporting structures as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.

1. Provide the necessary sway bracing to keep trapeze type structures from swaying.

C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:

1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.

D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:

1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.

2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.

3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.

4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.

5. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

E. Corrosion protection:

1. Isolate dissimilar metals, except where required for electrical continuity.

a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

F. Raceway:

1. Furnish all conduit racks and trapeze structures needed to support the raceway from the structure.

    a. Group conduits and position on racks to minimize crossovers.

    b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.

G. Anchoring methods:

1. Solid concrete: Anchor bolts, anchor rods, or post-installed anchors as specified in Section 05190.

2. Metal surfaces: Machine screws or bolts.

3. Hollow masonry units: Post-installed anchors as specified.

H. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

I. Re-coat all scratches, cuts, and drilled holes in galvanized surfaces with CRC "Zinc-It" or similar product.

J. Re-coat all drilled holes and cut surfaces on PVC-coated materials.

K. Seal all drilled holes and cut surfaces on fiberglass materials.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 05 33 BOXES

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Device boxes.
2. Raceway system boxes.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
    a. Submittal Procedures.
    b. Section 26 00 00 – General Electrical Specifications.

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. ASTM International (ASTM):

1. A 47 – Standard Specification for Ferritic Malleable Iron Castings.
2. D 149 – Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. D 495 – Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
4. D 570 – Standard Test Method for Water Absorption of Plastics.
5. D 648 – Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
6. D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
7. D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

C. Joint Industry Conference (JIC).

D. Underwriters Laboratories, Inc. (UL):

1. 94 – Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

B. Specific definitions:

1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.

2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SYSTEM DESCRIPTION

A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.

B. Provide boxes and conduit bodies as indicated on the Drawings or as needed to complete the raceway installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00.

B. Product data:

1. Manufacturer.

2. Materials.

3. Dimensions:

a. Height.

b. Width.

c. Depth.

d. Weight.

e. NEMA rating.

4. Conduit entry locations.

5. Catalog cut sheets.

6. Installation instructions.

C. Shop drawings:

1. Include identification and sizes of pull boxes.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. Regulatory requirements:

1. Outlet boxes shall comply with all applicable standards of:
    a. JIC.
    b. NEC.
    c. NEMA.
    d. UL.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00.

1.09 SEQUENCING

A. As specified in Section 26 00 00.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. Pressed steel boxes:
        a. Steel City.
        b. Appleton.
        c. Crouse – Hinds.
        d. Thomas & Betts.
    2. Plastic and/or fiberglass boxes:
        a. Hoffman.
        b. Carlon.

c. Stahlin.

3. Plastic coated steel boxes:
    a. Rob Roy.
    b. OCAL.
4. Cast device boxes:
    a. Appleton.
    b. Crouse – Hinds.
    c. OZ/Gedney.
5. (NOT USED)
6. (NOT USED)
7. Formed steel enclosures:
    a. Hoffman.
    b. Thomas and Betts.
    c. Stahlin.
    d. Rittal.
8. Stainless steel enclosures:
    a. Hoffman.
    b. Stahlin.
    c. Rittal.
9. Pressed steel boxes and concrete boxes:
    a. Appleton.
    b. Steel City.
    c. Cooper/Crouse Hinds.
    d. OZ Gedney.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. (NOT USED)

B. Concrete boxes:
    1. For outlets and pull boxes in concrete construction.
    2. Pressed steel or cast construction, concrete tight.
    3. Knockout sizes range from 1/2 inch to 1 inch.
    4. Depth as needed.

5. Types:
    a. Four inch octagon.
    b. Four inch octagon ceiling boxes with hanging bars.
    c. Gangable masonry boxes:
        1). 3-1/2 inch deep, 3-3/4 inch high, length as required:
            a). 2-1/2 inch deep boxes may be used where wall thickness precludes the use of the deeper boxes.
        2). With partitions as needed.

C. Threaded-hub boxes:
    1. Construction:
        a. With internal green ground screw.
        b. Furnished with a suitable gasketed cover.
        c. With integral cast mounting lugs when surface mounted.
        d. Conduit sizes range from 3/4 inch to 1 inch.
        e. Tapered threaded hubs with integral bushing.
    2. Aluminum (copper free) boxes:
        a. High strength copper free 4/10 of 1 percent maximum alloy for use with aluminum rigid conduit.
    3. Malleable iron boxes:
        a. Conforming to ASTM A 47 Grade 32510.

D. Plastic coated threaded-hub boxes:
    1. Construction:
        a. With internal green ground screw.
        b. Furnished with a suitable gasketed cover.
        c. With integral cast mounting lugs when surface mounted.
        d. Conduit sizes range from 3/4 inch to 1 inch.
        e. Double coated with a nominal 0.002 inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
        f. With a minimum 0.040 inch (40 mil) PVC coating bonded to exterior.
        g. With pressure sealing sleeve to protect the connection with conduit.

E. Class I Division 1 areas:
    1. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
        a. The approval ratings must be permanently marked on each item.

F. Class I, Division 2 areas:

1. For boxes not containing arcing parts:
    a. As specified in Section 26 00 00.
    b. Pressed metal boxes are not allowed.
2. For boxes containing arching parts provide:
    a. Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
        1). The approval ratings must be permanently marked on each item.
3. Cast iron box and cover.
4. Precision machined flame path between box and cover with neoprene O-ring.
5. Bolt-on stainless steel slotted mounting feet for horizontal or vertical mounting.
6. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
7. External flange.
8. Provisions for mounting pan.
9. Ground lug.

G. (NOT USED)

H. Formed steel enclosures:
1. Steel (NOT USED):
2. Stainless steel:
    a. NEMA Type 4X:
        1). Boxes in locations subject to flooding or temporary submersion:
            a). NEMA Type 6.
    b. Fabricated from 14-gauge Type 316 stainless steel.
    c. All seams continuously welded.
    d. Door:
        1). Rolled lip around 3 sides.
        2). 2Attached to enclosure by means of a continuous stainless steel hinge and pin.
    e. Neoprene door gasket to provide a watertight seal:
        1). Attached with an adhesive.
        2). Retained by a retaining strip.
    f. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
        1). With a hasp and staple for padlocking.
    g. Provide large enclosures with door and body stiffeners for extra rigidity.

h. No holes or knockouts.

i. Finish:

1). Brushed.

j. Stainless steel external mounting brackets when surface mounted.

I. Cast iron junction boxes:

1. NEMA Type 4
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors:
   a. Can be surface mounted using mounting lugs.
5. Construction:
   a. Cast iron box.
   b. Covers:
      1). Checkered plate covers suitable for foot traffic.
      2). When used in areas subject to vehicular traffic H-20 loading.
   c. Hot dip galvanized.
   d. Neoprene gasket.
   e. Stainless steel screw covers.

J. Floor outlet boxes:

1. Watertight cast iron, semi adjustable.
2. Telephone outlets shall be fitted with 6 inch brushed nipples.
3. Provide a pedestal housing for floor outlets in open areas.
4. Suitable for receptacles, communications, and data outlets as specified and indicated on the Drawings, complete with gaskets and cover plates:
   a. Dual-gang, heavy-duty cast iron, suitable for wiring devices to be installed to make a complete and operable system and installation.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Fasteners:

1. Stainless Steel in boxes with wiring devices.
2. Screws, nuts, bolts, and other threaded fasteners:
   a. Stainless steel.

B. Provide breather and drain fittings where appropriate.

C. Internal panels:

1. Provide internal panels where required for mounting of terminal strips or other equipment.
2. With plated steel shoulder studs.
3. Steel with white polyester powder finish.

D. Floor stand kit when shown:

1. Fabricated from 12-gauge steel.
2. Bottom plate 11 gauge.
3. Heights:
    a. 12 inches.
4. Do not provide external mounting brackets, when a floor stand kit is used.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00.

B. General:

1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 26 00 00.
2. Provide outlet box materials to match the conduit system:
    a. (NOT USED)
    b. GRC – Cast ferrous boxes.
    c. RAC – Aluminum (copper free) boxes.
    d. PCS – PVC coated cast ferrous boxes.
    e. PVC – PVC boxes.
    f. PCA – PVC coated aluminum boxes.
3. Solid type gang boxes:

a. For more than 2 devices.

b. For barriered outlets.

4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8 inch free air space between the back of the enclosure and the wall:

   a. Use machined spacers to maintain air space; built-up washers are not acceptable.

   b. Use stainless steel or nylon materials for spacers.

5. Use cast malleable iron boxes when box must support other devices.

6. Boxes serving luminaires or devices:

   a. Use as pull boxes wherever possible.

7. In finished areas:

   a. Provide specific pull or junction boxes only as indicated on the Drawings or as directed.

8. Fit all cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.

9. In terminal boxes, furnish terminals as indicated on the Drawings, with a minimum of 50 percent spare terminals:

   a. Furnish wireways for discrete and analog/DC wiring.

   b. Separate analog wiring from 120 V discrete or power wiring.

10. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.

11. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

C. Outlet boxes:

1. Locate outlet boxes as indicated on the Drawings:

   a. Adjust locations so as not to conflict with structural requirements or other trades.

2. Use Aluminum boxes:

   a. In hazardous areas.

   b. Where exposed to the weather.

   c. In unheated areas.

   d. Where subject to mechanical damage:

      1). Defined as exposed boxes less than 10 feet above the floor.

   e. To act as a pull box for conductors in a conduit system.

   f. Accommodate wiring devices.

3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.

4. Outlet boxes may be used as junction boxes wherever possible.

D. Pull boxes and junction boxes:

1. Size pull boxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
2. Install pull boxes such that access to them is not restricted.

E. For boxes not indicated:

1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations:
    a. Plastibond Aluminum.
3. (NOT USED)
4. Outlet, switch, and junction boxes where surface mounted in exposed locations:
    a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
5. Outlet, control station, and junction boxes for installation in corrosive locations:
    a. Stainless Steel, or plastibond Aluminum to match the conduit system.
    b. Furnished with mounting lugs.
6. Boxes for concealed conduit system:
    a. Non-fire rated construction:
        1). Depth: To suit job conditions and comply with the NEC.
        2). For luminaries: Use outlet boxes designed for the purpose:
            a). 50 pounds or less: Box marked “For Fixture Support.”
            b). More than 50 pounds: Box listed and marked with the weight of the fixture to be supported (or support luminaire independent of the box.)
        3). For junction and pull boxes: Use galvanized steel boxes with flush covers.
        4). For switches, receptacles, etc.:
            a). Plaster or cast-in-place concrete walls: Use 4 inch or 4-11/16 inch Aluminum boxes with device covers.
            b). Walls other than plaster or cast-in-place concrete: Use type of Aluminum box which will allow wall plate to cover the opening made for the installation of the box.
7. Recessed boxes in fire rated (2 hours maximum) bearing and nonbearing wood or steel stud walls (gypsum wallboard facings):
    a. Use listed single and double gang metallic outlet and switch boxes.
        1). The surface area of individual outlet or switch boxes shall not exceed 16 square inches.

b. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet of wall surface.

c. Securely fasten boxes to the studs.

1). Verify that the opening in the wallboard facing is cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.

d. Separate boxes located on opposite sides of walls or partitions by a minimum horizontal distance of 24 inches.

1). This minimum separation distance may be reduced when wall opening protective materials are installed according to the requirements of their classification.

e. Use wall opening protective material in conjunction with boxes installed on opposite sides of walls or partitions of staggered stud construction in accordance with the classification requirements for the protective material.

8. Other fire rated construction: Use materials and methods to comply with the listing requirements for the classified construction.

F. (NOT USED)

G. Hazardous locations:

1. All metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.

2. All threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.

3. Conduits entering and exiting metallic boxes in Class I Division 2 areas shall utilize approved grounding bushings to bond the conduits together.

4. Provide the following types of conduit bodies and boxes:

a. Malleable iron bodies and boxes with GRC or IMC conduit systems.

b. PVC coated conduit bodies and boxes with PCS conduit systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 26 00 00.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 05 53 ELECTRICAL IDENTIFICATION

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Identifying electrical, instrumentation, and process equipment and components.
2. Material, manufacturing, and installation requirements for identification devices.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
    a. Submittal Procedures.
    b. Section 26 00 00 – General Electrical Specifications

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

1.04 SYSTEM DESCRIPTION

A. Nameplates:

1. Provide a nameplate for each piece of mechanical equipment, process equipment, valve, pump, mixer, feeder, fan, air-handling unit, motor, switch, receptacle, controller, instrument transducer, instrument power supply, solenoid, motor control center, starter, panelboard, switchboard, individually mounted or plug-in type circuit protector or motor controller, disconnect switch, bus duct tap switch, time switch, relay and for any other control device or major item of electrical equipment, either located in the field or within panels.
2. Provide all nameplates of identical style, color, and material throughout the facility.
3. Device nameplates information:

a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.

b. Device tag and loop number ID (#) (e.g. EDV-#).

c. Circuit ID (e.g. LPA-11).

d. Area served (e.g. Lighting Chemical Building).

B. Wire numbers:

1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:

a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.

b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.

c. Internal panel wires on a common terminal shall have the same wire number.

d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:

1). Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in Section 16130.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Product data:

1. Nameplates:

a. Color.

b. Size:

1). Outside dimensions.

2). Lettering.

c. Material.

d. Mounting means.

2. Nameplate schedule:

a. Show exact wording for each nameplate.

b. Include nameplate and letter sizes.

3. Wire numbers:

a. Manufacturer’s catalog data for wire labels and label printer.

C. Record documents:

1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

1.08 PROJECT SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00.

1.12 SYSTEM STARTUP

A. As specified in Section 26 00 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Nameplates and signs:
   1. One of the following or equal:
      a. Brady.
      b. Seton.

B. Conductor and cable markers:
   1. Heat-shrinkable tubing:
      a. One of the following or equal:
         1). Raychem.
         2). Brady.
         3). Thomas & Betts.
         4). Kroy.

C. Conduit and raceway markers:
   1. One of the following or equal:

a. Almetek: Mini Tags.

b. Lapp Group: Maxi System.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Nameplates:

1. Fabricated from white-center and Black face laminated plastic engraving stock:

a. 3/32 inch thick material.

b. Two-ply.

c. With chamfered edges.

d. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:

1). No characters smaller than 1/8 inch in height.

B. Signs:

1. Automatic equipment and high voltage signs:

a. Suitable for exterior use.

b. In accordance with OSHA regulations.

C. Conductor and cable markers:

1. Machine printed black characters on white tubing.

2. Ten point type or larger.

D. Conduit and raceway markers:

1. Non-metallic:

a. UV resistant holder and letters.

b. Black letters on yellow background.

c. Minimum letter height: 1/2 inch.

d. Adhesive labels are not acceptable.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)+

2.11 SOURCE QUALITY CONTROL

A. Nameplates:

1. Provide all nameplates for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):

a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00.

B. Nameplates:

1. Attach nameplates to equipment with rivets, bolts, or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.

2. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy- based cement to attach nameplates.

3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:

a. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the Engineer.

C. Conductor and cable markers:

1. Apply all conductor and cable markers before termination.

2. Heat-shrinkable tubing:

a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.

b. Tubing shall be tight on the wire after it has been heated.

c. Characters shall face the open panel and shall read from left to right or top to bottom.

d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

D. Conduit markers:

1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:

a. Conduit markings shall match the conduit schedule; as indicated on the Drawings.

2. Mark conduits at the following locations:
    a. Each end of conduits that are greater than 10 feet in length.
    b. Where the conduit penetrates a wall or structure.
    c. Where the conduit emerges from the ground, slab, etc.
    d. The middle of conduits that are 10 feet or less in length.
3. Mark conduits after the conduits have been fully painted.
4. Position conduit markers so that they are easily read from the floor.
5. Attach non-metallic conduit markers with nylon cable ties:
    a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
6. Mark conduits before construction review by Engineer for punch list purposes.
7. Label intrinsically safe conduits in accordance with the requirements of the NEC.

E. Medium voltage raceway labels:
1. Apply at 50 foot intervals stating the voltage level contained within the raceway.

F. Signs and labeling:
1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
    a. Fasten warning signs with round head stainless steel screws or bolts.
    b. Locate and mount in a manner to be clearly legible to operations personnel.
2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power.
    a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
    a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers, or raceway labels that in

the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 05 73 ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

1.00 GENERAL

1.01 ENGINEERING STUDIES

A. The coordination report shall include all portions of the electrical distribution system from the normal power source or sources down to and including each low voltage secondary main breaker. All plant electrical facilities, both new and future, shall be included in the report as indicated on the Overall One Line Diagrams and other pertinent Electrical drawings. Normal system connections and those, which result in maximum and minimum fault conditions, shall be adequately covered in the report. Additional information if necessary may be obtained from the local Utility.

B. The coordination report shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The firm performing the work shall be currently involved in high- and low-voltage power system evaluation. The work shall be performed, stamped and signed by a professional engineer currently licensed in the State of Texas. Credentials of the individual(s) performing the work and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of ten (10) years' experience in power system analysis is required for the individual in charge of the project.

D. The firm performing the work shall demonstrate capability and experience to provide assistance during start up as required.

1.02 DATA COLLECTION

A. Any data which is necessary for completion of the studies shall be obtained by the Contractor

B. The Contractor shall expedite completion of the work and submission of the report as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

2.00 PRODUCTS

2.01 SHORT-CIRCUIT AND COORDINATION REPORT

A. The short-circuit and coordination effort shall be performed using SKM PowerTools , ETAP, or Engineer approved computer software. Contractors shall use latest version of any software proposed. Methods shall be in accordance with the latest applicable IEEE and ANSI standards.

B. In the short-circuit report, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities

and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each switchgear bus, transformer primary and secondary terminals, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA and symmetrical and asymmetrical fault currents.

C. In the protective device coordination report, provide time-current curves (TCC) graphically indicating the coordination proposed for the system, centered on conventional, log-log forms 11 inch x 17 inch minimum size. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Use manufacturers application software for microprocessor based relays. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings for all devices in a Microsoft Excel spreadsheet.

D. Include on the TCC curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics of other system load protective devices. In addition, include all devices down to each low voltage secondary main breaker. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

E. Select each primary protective device required for a wye-wye connected transformer so that it's characteristic or operating band is within the transformer characteristics; including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to- ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from downstream device curves by at least a 0.4-second time margin over relays and 0.2 seconds over fuses.

F. Include complete fault calculations as specified herein based on design documents and field survey data.

G. Submit qualifications of engineer(s) who will perform the work for approval prior to commencement of work. Provide reports in conjunction with equipment submittals to verify equipment ratings required. Submit a preliminary report to the Engineer for review and approval prior to delivery of final report. Make all additions or changes as required by the reviewer.

H. Notify the Engineer in writing of any circuit protective devices found to be not properly rated for fault conditions.

I. As part of this report the Contractors shall provide a Harmonic analysis of the entire electrical system is required as a part of this project. This report is intended to show the effects of the VFD's and other Harmonic generating equipment on the electrical system and to verify system conformance with IEEE Std. 519. The point of Common Coupling shall be taken at the interconnection between the Pad Mount transformer and the Main Incoming breaker. The full load amps for the system shall include all motors running (using NEC tables for motor ampacity) with an additional 100A assumed as the MCC load. The testing company should contact the local utility for any additional information required regarding available fault current of the utility system/transformer.

1. Short-Circuit Analysis shall consist, but not be limited to the following

    a. Calculation of the maximum RMS symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

    b. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

    c. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.

    d. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

    e. Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

    f. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

    g. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

    h. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.

2. Protective Device Time-Current Coordination Analysis

    a. The time-current coordination analysis shall be performed with the aid of computer software intended for this purpose, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.

b. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection considered more important than service continuity.

c. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.

d. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

e. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

f. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

g. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

h. Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

i. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the time-current analysis to be completed prior to final installation.

3. Load Flow and Voltage Drop Analysis

a. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and include calculations of power flow in all three-phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.

b. The analysis shall provide the calculated maximum values of kVA, kW, kVAr, power factor, and amperes for each power circuit.

c. The calculated power losses in each branch and total system losses shall be provided.

d. A computer printout listing all cables, transformers, loads, and other circuit data shall be included.

e. Provide tabular bus-to-bus computer printouts listing the calculated values.

f. The analysis shall include a computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.

g. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.

Significant deficiencies in loading or voltage levels shall be called to attention of the engineer (architect) and recommendations made for improvements at soon as they are identified.

2.02 FINAL REPORT

A. The results of the power system study shall be summarized in a final report. Four (4) bound copies of the final report shall be submitted.

B. The report shall include the following sections:

1. Descriptions, purpose, basis, and scope of the analysis.
2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
5. SKM electronic files including project, library and report files.
6. Excel electronic files on tabulated protective device settings.

2.03 ARC Flash Study

A. Section includes short circuit protective device coordination study and arc flash hazard analysis encompassing portions of electrical distribution system from normal power source or sources up to and including breakers in service entrance switchboard, fuses in service entrance switchboard, main breaker in sub-distribution panels, fuses in sub-distribution panels and main breaker in each panelboard and any Switchgear provided electrical equipment as part of this scope of work.

B. Report Preparation:

1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
2. Perform study with aid of computer software program as listed herein
3. Obtain actual settings for equipment incorporated in this scope of work
4. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following as applicable:
   a. Utility supply bus.
   b. Medium voltage air interrupter switchgear.

c. Medium voltage circuit breaker switchgear.
d. Secondary unit substations.
e. Automatic transfer switch.
f. Manual transfer switch.
g. Engine generator.
h. Medium voltage motor controllers.
i. Low-voltage switchgear.
j. Switchboards.
k. Motor control centers.
l. Distribution panelboards.
m. Branch circuit panelboards.
n. Busway.
o. Each other significant equipment location throughout system.

C. Report Contents:
1. Include the following:
    a. Calculation methods and assumptions.
    b. Base per unit value selected.
    c. One-line diagram.
    d. Source impedance data including power company system available power and characteristics.
    e. Typical calculations.
        1) Fault impedance.
        2) X to R ratios.
        3) Asymmetry factors.
        4) Motor fault contribution.
        5) Short circuit kVA.
        6) Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
        7) Tabulations of calculation quantities and results.
    f. One-line diagram revised by adding actual instantaneous short circuits available.
    g. State conclusions and recommendations.

2. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
3. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
4. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
5. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following as required:
    a. Power Company relay characteristics.
    b. Power Company fuse characteristics.
    c. Medium voltage equipment protective relay characteristics.
    d. Medium voltage equipment protective fuse characteristics.
    e. Low voltage equipment circuit breaker trip device characteristics.
    f. Low voltage equipment fuse characteristics.

g. Cable damage point characteristics.
h. Pertinent transformer characteristics including:
    1.) Transformer full load current.
    2.) Transformer magnetizing inrush.
    3.) ANSI transformer withstand parameters.
    4.) Significant symmetrical fault current.
i. Pertinent motor characteristics.
j. Generator characteristics including:
    1.) Phase and ground coordination of generator protective devices.
    2.) Decrement curve and damage curve.
    3.) Operating characteristic of protective devices.
    4.) Actual impedance value.
    5.) Time constants.
    6.) Current boost data.
    7.) Do not use typical values for generator.
k. Transfer switch characteristics.
l. Other system load protective device characteristics.

D. Obtain and verify all data needed to perform the arc flash hazard analysis. The arc flash hazard analysis shall include the following IEEE Standard 1584 nine step analysis process:
    1.) Collect system and installation data.
    2.) Determine modes of operation.
    3.) Determine bolted fault current.
    4.) Determine arc fault current.
    5.) Determine protective device characteristic and arc fault duration.
    6.) Document system voltages and equipment class.
    7.) Select working distances.
    8.) Calculate incident energy.
    9.) Calculate the arc flash protection boundary

E. ARC FLASH SIGNAGE

1. Study Preparer shall fabricate signs or labels with the arc flash hazard study results in accordance with NFPA 70E that includes the Arc Flash Protection Boundary, Limited Approach Boundary, Prohibited Approach Boundary, Restricted Approach Boundary, Calculated Incident Energy, and the required level of personnel protective equipment (PPE).
2. The Study Preparer shall work with the Contractor for implementing the Arc Flash Hazard sign or label installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.
3. The signs or labels shall be rated for outdoor use.

2.04 FINAL REPORT

A. The results of the power system study shall be summarized in a final report. Four (4) bound copies of the final report shall be submitted.

B. The report shall include the following sections:

1. Descriptions, purpose, basis, and scope of the analysis.

2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
5. SKM electronic files including project, library and report files.
6. Excel electronic files on tabulated protective device settings.
7. Recommendations for Calorie Suite requirements for the equipment being installed in this scope or work
8. Sample ARC Flash Decals
9. Results of ARC Flash Study analysis

2.03

3.00 EXECUTION

3.01 FIELD SETTINGS

A. Field setting and calibration of protective devices shall be performed in accordance with Section 26 08 00.

B. Necessary adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination report shall be carried out by the Contractor at no additional cost to the District.

END OF SECTION

26 08 00 ELECTRICAL ACCEPTANCE TESTING

1.00 GENERAL

1.01 SCOPE:

A. Perform acceptance testing of electrical apparatus and circuits described herein to determine suitability for energization and operation. It is the intent of these specifications to assure that the completed electrical installation is installed in accordance with the design drawings and specifications and is operational with industry and manufacturer's tolerance.

B. Provide all material, equipment, labor and technical supervision to perform tests and inspections as described herein.

1.02 REFERENCES:

A. All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.

1. American National Standards Institute- ANSI
2. American Society for Testing and Materials- ASTM
    a. ASTM 877. Test Method for Dielectric Breakdown Voltage of Insulating Liquids using Disk Electrodes.
    b. ASTM D 923. Test Method for Sampling Electrical Insulating Liquids.
    c. ASTM D 971. Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
    d. ASTM D 974. Test Method for Acid and Base Number by Co/or-Indicator Titration.
    e. ASTM D 1500. Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
    f. ASTM D 1524. Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
    g. ASTM D 1533. Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method).
    h. ASTM D 1816. Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
3. Institute of Electrical and Electronic Engineers- IEEE ANSI/IEEE C2, National Electrical Safety Code
    a. ANSI/IEEE C37, Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses.
    b. ANSI/IEEE C57, Distribution, Power and Regulating Transformers.
    c. ANSI/IEEE C62, Surge Protection

d. ANSI/IEEE Std. 43. IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

e. ANSI/IEEE Std. 48. IEEE Standard Test Procedures and Requirements for High-Voltage AC Cable Terminations

f. ANSI/IEEE Std. 81. IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

g. ANSI/IEEE Std. 95. IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.

h. ANSI/IEEE Std. 141. IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (IEEE Red Book).

i. ANSI/IEEE Std. 142. IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).

j. ANSI/IEEE Std. 241. IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).

k. ANSI/IEEE Std. 242. IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).

l. ANSI/IEEE Std. 399. IEEE Recommended Practice for Power Systems Analysis (Brown Book).

m. ANSI/IEEE Std. 400. IEEE Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

n. ANSI/IEEE Std. 421B. IEEE Standard for High-Potential-Test Requirements for Excitation Systems for Synchronous Machines.

o. ANSI/IEEE Std. 446. IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book).

p. ANSI/IEEE Std. 450. IEEE Recommended Practice for Maintenance, Testing, and replacement of Large Lead Storage Batteries for Generating Stations and Substations.

q. ANSI/IEEE Std. 493. IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book).

r. ANSI/IEEE Std. 602. IEEE Recommended Practice for Electric Systems in Health Care Facilities (White Book).

s. ANSI/IEEE Std. 637. IEEE Guide for the Reclamation of Insulating Oil and Criteria for its use.

t. ANSI/IEEE Std. 739. IEEE Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities (Orange Book).

u. ANSI/IEEE Std. 1100. IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).

v. ANSI/IEEE Std. 1106. IEEE Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations.

4. Insulated Cable Engineers Association - ICEA
5. InterNational Electrical Testing Association- NETA
    a. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Electrical Manufacturer's Association- NEMA
    a. NEMA Standard for Publication No. AB4: Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications.
    b. NEMA Publication MG1: Motors and Generators
7. National Fire Protection Association- NFPA ANSI/NFPA 70: National Electrical Code.ANSI/NFPA 708: Recommended Practice for Electric Equipment Maintenance. ANSI/NFPA 70E: Electrical Safety Requirements for Employee Workplaces. ANSI/NFPA 780: Lightning Protection Code.
8. Occupational Safety and Health Administration- OSHA
9. State and local codes and ordinances
10. Underwriters Laboratory- UL

1.03 QUALIFICATIONS OF TESTING FIRM:

A. The testing firm shall be a independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person shall be currently certified by the International Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.

D. The testing firm shall utilize technicians who are regularly employed by the firm for testing services.

E. The testing firm shall submit proof of the above qualifications in accordance with Par.1.06.

1.04 TEST EQUIPMENT:

A. Suitability of Test Equipment
    1. All test equipment shall be in good mechanical and electrical condition.
    2. Split-core current transformers and clamp-on or tong-type ammeters require careful consideration of the following in regard to accuracy:
        a. Position of the conductor within the core.
        b. Clean, tight fit of the core pole faces.
        c. Presence of external fields.

d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.

3. Selection of metering equipment should be based on a knowledge of the waveform of the variable being measured. Digital multimeters may be average or RMS sensing and may include or exclude the de component. When the variable contains harmonics or de offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.

4. Field test metering used to check power system meter calibration must have an accuracy higher than that of the instrument being checked.

5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.

6. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment

B. Test Instrument Calibration

1. The testing form shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology. (NIST)

3. Instruments shall be calibrated in accordance with the following frequency schedule:

a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum

b. Laboratory instruments: 12 months

c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.

d. Dated calibration labels shall be visible on all test equipment.

e. Records, which show date and results of instruments calibrated or tested, must be up-to-date and shall be submitted in accordance with Par. 1.06.

f. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.

g. Calibrating standard shall be of higher accuracy than that of the instrument tested.

1.05 DIVISION OF RESPONSIBILITY:

A. The independent testing contractor shall perform all tests as listed in this Section.

B. The installation contractor may perform tests which are described in other specification sections. These include insulation resistance and continuity tests on low voltage equipment and circuits and high potential testing of medium voltage cable.

1.06 SUBMITTALS- FOR APPROVAL:

A. Qualifications Statement:

1. Experience record on proposed testing firm to include client contact names and telephone numbers.
2. Experience record on technicians who will perform testing work.

B. Test Equipment

1. Schedule of test equipment to be used for project.
2. Calibration records for each item of test equipment.

1.07 SUBMITTALS- FOR CLOSE OUT

A. Field Test Reports- Submit the following data bound and indexed in a 3 ring loose leaf binder.

1. Summary of project.
2. Description of equipment tested and nameplate data.
3. Description of tests.
4. Test results.
5. List of deficiencies observed and corrective action taken, if any.
6. Analysis and recommendations.

2.00 PRODUCTS- NOT USED

3.00 EXECUTION

3.01 FIELD TESTS

A. Perform field tests and listed herein. Test procedures shall be in accordance with NETA Acceptance Testing Specifications. Dielectri c test voltages applied to circuits and to equipment shall not exceed values or duration recommended by the equipment manufacturer.

B. Low Voltage Motor Starters:

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.

d. Motor-Running Protection

1). Compare overload element rating with motor full-load current rating to verify correct sizing.

2). If power-factor correction capacitors are connected on the load side of the overload protection, include the effect of the capacitive reactance in determining appropriate overload element size.

3). If motor-running protection is provided by fuses, verify correct rating considering motor characteristics and power-factor correction capacitors.

e. Inspect all bolted electrical connections for high resistance using one of the following methods:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3). Perform thermographic survey.

2. Electrical Tests

a. Insulation Tests

1). Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2). Measure insulation resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Refer to manufacturer's instructions for devices with solid-state components.

3). Measure insulation resistance of each control circuit-to-ground.

4). Perform an insulation resistance test at 1000 volts de on all control wiring. For units with solid-state components, follow manufacturer's recommendations.

b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

NOTE: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to ANSI/NEMA ICS 2, Part 4.)

c. Test circuit breakers, including motor circuit protectors, in accordance with Section 7.6.1.1.

d. Perform operational tests by initiating control devices.

3. Test Values

a. Compare bolted connection resistance to values of similar connections.

b. Bolt-torque levels should be in accordance with values specified by manufacturer.

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

d. Insulation-resistance values shall be in accordance with accepted values.

e. Control wiring insulation test resistance should be a minimum of 500 megohms.

f. Overload trip times shall be in accordance with manufacturer's published data.

C. Cables - Low-Voltage, 600 Volt Maximum

1. Visual and Mechanical Inspection

a. Compare cable data with drawings and specifications.

b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.

c. Inspect all bolted electrical connections for high resistance using one of the following methods:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

d. Perform thermographic survey.

e. Inspect compression-applied connectors for correct cable match and indentation.

f. Verify cable color coding with applicable specifications and the National Electrical Code.

2. Electrical Tests

a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts de for 300 volt rated cable and 1000 volts de for 600 volt rated cable. Test duration shall be one minute.

b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

c. Perform continuity test to insure correct cable connection.

3. Test Values

a. Compare bolted connection resistance to values of similar connections.

b. Bolt-torque levels should be in accordance with values specified by the manufacturer.

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

d. Minimum insulation-resistance values should not be less than 500 megohms.

e. Investigate deviations between adjacent phases.

D. Switchgear and Switchboard Assemblies

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment

d. Inspect all doors, panels, and sections for corrosion, dents, scratches, fit, and missing hardware.

e. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.

f. Inspect all bolted electrical connections for high resistance using one of the following methods:

   1). Use of low-resistance ohmmeter.

   2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

   3). Perform thermographic survey.

g. Verify that current and potential transformer ratios correspond to drawings.

h. Compare equipment nameplate data with latest one-line diagram when available.

i. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

   1). Attempt closure on locked-open devices. Attempt to open locked-closed devices.

   2). Make key exchange with devices operated in off-normal positions.

j. Thoroughly clean switchgear prior to testing.

k. Lubrication

   1). Verify appropriate contact lubricant on moving current-carrying parts.

   2). Verify appropriate lubrication on moving and sliding surfaces.

l. Inspect insulators for evidence of physical damage or contaminated surfaces.

m. Verify correct barrier and shutter installation and operation.

n. Exercise all active components.

o. Inspect all mechanical indicating devices for correct operation.

p. Verify that filters are in place and/or vents are clear.

q. Perform visual and mechanical inspection on all instrument transformers.

r. Inspect control power transformers.

   1). Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2). Verify that primary and secondary fuse ratings or circuit breakers match drawings.

3). Verify correct functioning of drawout disconnecting and grounding contacts and interlocks

2. Electrical Tests

a. Perform tests on all instrument transformers.

b. Perform ground-resistance tests.

c. Perform resistance tests through all bus joints with a low-resistance ohmmeter, if applicable.

d. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute.

e. Perform an overpotential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. The test voltage shall be applied for one minute.

f. Perform insulation-resistance tests at 1000 volts de on all control wiring. For units with solid-state components, follow manufacturer's recommendations.

g. Perform control wiring performance test.

h. Perform current injection tests on the entire current circuit in each section of switchgear.

1). Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.

2). Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.

3). Test current at each device.

i. Determine accuracy of all meters and calibrate watthour meters. Verify multipliers.

j. Perform phasing check on double-ended switchgear to insure correc tbus phasing from each source.

k. Control Power Transformers

1). Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.

2). Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.

3). Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

4). Verify correct function of control transfer relays located in switchgear with multiple power sources.

l. Voltage Transformers

1). Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.

2). Perform secondary wiring integrity test. Confirm correct potential at all devices.

3). Verify secondary voltages.

m. Verify operation of switchgear/switchboard heaters.

3. Test Values

a. Compare bus connection resistances to values of similar connections.

b. Bolt-torque levels shall be in accordance those specified by manufacturer.

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar bus by more than 50 percent of the lowest value.

d. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. Values of insulation resistance less than manufacturer's minimum shall be investigated. Overpotential tests should not proceed until insulation- resistance levels are raised above minimum values.

e. The insulation shall withstand the overpotential test voltage applied.

E. Circuit Breakers - Low-Voltage - Insulated Case/Molded Case

1. Visual and Mechanical Inspection

a. Compare nameplate data with drawings and specifications.

b. Inspect circuit breaker for correct mounting.

c. Operate circuit breaker to insure smooth operation.

d. Inspect case for cracks or other defects.

e. Inspect all bolted electrical connections for high resistance using one of the following methods:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3). Perform thermographic survey.

f. Inspect mechanism contacts and arc chutes in unsealed units.

2. Electrical Tests

a. Perform a contact-resistance test.

b. Perform an insulation-resistance test at 1000 volts de from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase

c. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

d. Perform insulation resistance tests at 1000 volts de on all control wiring. Do not perform the test on wiring connected to solid state components.

e. Perform adjustments for final settings in accordance with coordination study supplied by owner.

f. Perform long-time delay time-current characteristic tests by passing 300 percent rated primary current through each pole separately unless series testing is required to defeat ground fault functions.

g. Determine short-time pickup and delay by primary current injection.

h. Determine ground-fault pickup and time delay by primary current injection.

i. Determine instantaneous pickup current by primary injection using run-up or pulse method.

j. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

k. Verify the calibration of all functions of the trip unit by means of secondary injection.

3. Test Values

a. Compare bolted connection resistance to values of similar connections.

b. Bolt-torque levels should be in accordance those specified by manufacturer

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

d. Circuit breaker insulation resistance should be in accordance manufacturer's published data.

e. Control wiring insulation resistance should be a minimum of 500 megohms.

f. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. Circuit breakers exceeding specified trip time at 300 percent of pickup shall be tagged defective.

g. Instantaneous pickup values of molded-case circuit breakers shall be within tolerances.

F. AC Motors

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Confirm correct application of manufacturer's recommended lubricants.

d. Inspect anchorage, and grounding.

e. Inspect all bolted electrical connections for high resistance using one ofthe following methods:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3). Perform thermographic survey.

f. When applicable, perform special tests such as air gap spacing and pedestal alignment.

g. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

2. Electrical Tests- Induction Motors

a. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

b. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.

1). Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.

2). Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.

c. Perform de overpotential tests on motors in accordance with ANSI/IEEE Standard 95.

d. Perform insulation power-factor or dissipation-factor tests.

e. Perform surge comparison tests.

f. Perform insulation-resistance test on pedestal in accordance with manufacturer's published data.

g. Test surge protection devices.

h. Test motor starter.

i. Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.

j. Verify that the motor space heater is functional.

k. Perform a rotation test to insure correct shaft direction.

l. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

3. Electrical Tests- Synchronous Motors

a. Perform all tests as indicated above for induction motors.

b. Perform a voltage-drop test on all salient poles.

c. Perform insulation-resistance tests on the main rotating field winding, the exciter-field winding, and the exciter-armature winding in accordance with ANSI/IEEE Standard 43.

d. Perform a high-potential test on the excitation system in accordance with ANSI/IEEE Standard 421B.

e. Measure and record resistance of motor field winding, exciter-stator winding, exciter-rotor windings, and field discharge resistors.

f. Perform front-to-back resistance tests on diodes and gating tests of silicon controlled rectifiers for field application semiconductors.

g. Prior to initial start, apply voltage to the exciter supply and adjust exciter-field current to nameplate value.

h. Verify that the field application timer and the enable timer for the power- factor relay have been tested and set to the motor drive manufacturer's recommended values.

i. Record stator current, stator voltage, and field current by strip chart recorder for the complete acceleration period including stabilization time for a normally loaded starting condition. From the recording determine the following information:

1). Bus voltage prior to start.

2). Voltage drop at start.

3). Bus voltage at motor full-load.

4). Locked-rotor current.

5). Current after synchronization but before loading.

6). Current at maximum loading.

7). Acceleration time to near synchronous speed.

8). RPM just prior to synchronization.

9). Field application time.

10). Time to reach stable synchronous operation.

j. Plot a V-curve of stator current versus excitation current at approximately 50 percent load to check correct exciter operation.

k. If the range of exciter adjustment and motor loading permit reduce excitation to cause power factor to fall below the trip value of the power- factor relay. Verify relay operation.

4. Test Values

a. Compare bolted connection resistance to values of similar connections.

b. Bolt-torque levels should be in accordance with values specified by manufacturer.

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data

is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

d. Insulation-resistance test results shall be in accordance with manufacturer's published data. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B insulation and Class F insulation. NOTE: Overpotential, and surge comparison tests shall not be made on motors having values lower than those indicated above.

e. Stator winding de overpotential test voltage shall be in accordance with NEMA publication MG 1, paragraph 3.01. Test results are dependent on ambient conditions, and evaluation is on a withstand basis. If phase windings can be separately tested, values of leakage current may be compared for similar windings.

f. Vibration amplitudes shall not exceed values shown in manufacturer's published data.

g. Salient pole voltage drop shall be equal for each pole

NOTE: For de tests each pole (or pair of poles) shall not vary more than two percent from the average. An ac test is more sensitive than a de test in determining shorted turns. A pole with shorted turns will have a substantially lower voltage than sound coils. Coils adjacent to coils with shorted turns will exhibit slightly lower voltage.

h. The measured resistance values of motor-field windings, exciter-stator windings, exciter-rotor windings, and field-discharge resistors shall be compared to manufacturer's recommended values.

G. Adjustable Speed Drive Systems

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Ensure vent path openings are free from debris and that heat transfer surfaces are not fouled by oil, dust, or dirt.

d. Motor Running Protection

1). Compare drive overcurrent setpoints with motor full-load current rating to verify correct settings.

2). If drive is used to operate multiple motors, compare individual overload element ratings with motor full-load current ratings.

3). Apply minimum and maximum speed setpoints. Confirm setpoints are within limitations of the load coupled to the motor.

e. Inspect all bolted electrical connections for high resistance using one of the following methods:

1). Use of low-resistance ohmmeter.

2). Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3). Perform thermographic survey.

2. Electrical Tests

a. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element. NOTE: Test times for thermal trip units will, in general, be longer than the manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison (Refer to ANSI/NEMA ICS 2, Part 4.)

c. Perform startup of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

d. Perform operational tests by initiating control devices.

1). Check motor rotation operating on the drive and on the bypass.

2). Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual vibration. If excessive vibration occurs enter these critical frequencies into the drive's programmed step-over frequencies so operation at these speeds will not occur.

3). Verify operation of drive from remote start/stop and speed control signals.

4). Measure and record total harmonic distortion of current and voltage in accordance with IEEE 1159-1995.

e. Test input circuit breaker by primary injection

f. Test for the following parameters in accordance with relay calibration procedures for protective relays:

1). Input phase loss protection.

2). Input overvoltage protection.

3). Output phase rotation.

4). Overtemperature protection.

5). DC overvoltage protection.

6). Overfrequency protection.

7). Drive overload protection.

8). Fault alarm outputs.

3. Test Values

a. Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer's published time-current curve.

b. Harmonic values at the point of common coupling shall be in accordance with ANSI/IEEE 519.

c. When critical test points are specified, the relay shall be calibrated to specified critical points even though other test points may be out of tolerance.

d. Bolt-torque levels shall be in accordance with Table 10.12 unless otherwise specified by the manufacturer.

H. Grounding Systems

1. Visual and Mechanical Inspection

a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

a. The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference: ANSI/IEEE Standard 142.)

b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. Fiber-Optic Cables

1. Visual and Mechanical Inspection

a. Compare cable, connector, and splice data with drawings and specifications.

b. Inspect cable and connections for physical and mechanical damage.

c. Verify that all connectors and splices are correctly installed.

2. Electrical Tests

a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.

b. Perform connector and splice integrity test using an optical time domain reflectometer.

c. Perform cable attenuation loss measurement with an optical power loss test set.

d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set.

3. Test Values

a. The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.

b. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available

END OF SECTION

26 22 13 DRY TYPE TRANSFORMERS

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Enclosed dry-type transformers:

a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.

b. Primary voltage 600 volts and below.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Section 26 00 00

1.02 REFERENCES

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. American National Standards Institute (ANSI):

1. C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type.

2. 389 – IEEE Recommended Practice for Testing Electronics Transformers and Inductors.

C. Institute of Electrical and Electronics Engineers (IEEE):

1. C57.12.01 – Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings.

2. C57.12.91 – Standard Test Code for Dry-Type Distribution and Power Transformers.

D. National Electrical Manufacturers Association (NEMA):

1. TP-1 – 2002 – Guide for Determining Energy Efficiency for Distribution Transformers.

2. TP-2 – Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.

E. Underwriters Laboratory (UL):

1. 1561 – Standard for Dry-Type General Purpose and Power Transformers.

1.03 DEFINITIONS

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.04 SYSTEM DESCRIPTIONS

A. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:

1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 26 00 00 after all derating factors have been applied.

2. Suitable for continuous operation at full rating with normal life expectancy in accordance with ANSI C57.96.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. Product data:

1. Catalog cut sheets.

2. Nameplate data.

3. Dimensions:

a. Height.

b. Width.

c. Depth.

4. Inrush current.

5. Insulation system and temperature constraints.

6. Number and rating of taps.

7. Sound levels.

8. Connection diagrams:

a. Primary.

b. Secondary.

9. BIL rating.

10. Required clearances.

11. Percent impedance.

12. Efficiency.

13. Certification of low temperature rise design.

14. Certification of full capacity capability at the Project elevation and ambient conditions.

15. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26 00 00:

a. Manufacturer’s statement of seismic qualification with substantiating test data.

b. Manufacturer’s special seismic certification with substantiating test data.

C. Installation instructions:

1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category A or B:
    a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. General Electric.
    2. Schneider Electric/Square D.

3. Eaton/Cutler-Hammer.
4. ABB.
5. Siemens.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with ANSI 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (db)
1-9	40
10-50	45
51-150	50
151-300	55
301-500	60
501-700	62
701-1000	64

   3. Taps:
      a. 15 kilovolt-amperes and less:

1). Two 5 percent full capacity primary taps below rated voltage.

b. 25 kilovolt-amperes and larger:

1). Four 2.5 percent full capacity primary taps below rated voltage.

2). Two 2.5 percent full capacity primary taps above rated voltage.

c. Operated by a tap changer handle or tap jumpers accessible through a panel.

4. Terminals:

a. UL listed for either copper or aluminum conductors.

b. Rated for 75 degrees Celsius.

5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with ANSI C57.96.

B. Transformers less than 15 kilovolt-amperes:

1. Insulation class: 185 degrees Celsius.

2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:

1. Insulation class: 220 degrees Celsius.

2. Temperature rise: 115 degrees Celsius, except as noted below:

a. 150-degree Celsius rise for dry-type transformers located in motor control centers.

3. Efficiency:

a. In accordance with NEMA TP-1.

b. Measured in accordance with NEMA TP-2.

D. Low temperature rise transformers 15 kilovolt-amperes and larger:

1. Insulation class: 220 degrees Celsius.

2. Temperature rise: 115 degrees Celsius.

3. Efficiency:

a. Minimum of 96 percent for 115 degree rise.

E. K-factor transformers:

1. Provide K-factor transformers with ratings as indicated on the Drawings.

2. Insulation class: 220 degrees Celsius.

3. Temperature rise: 115 degrees Celsius.

4. Neutral bus sized for 200 percent of rated current.

5. Electrostatic shielding between the primary and secondary windings.

F. Enclosures:

1. Heavy gauge steel:

a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.

b. Indoor: NEMA Type 1.

2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.

3. Built-in vibration dampeners to isolate the core and coils from the enclosure:

a. Neoprene vibration pads and sleeves.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Nameplates:

1. Non-corrosive metal or UL listed non-metallic:

a. Stamped, engraved or printed with the following information:

1). Phases.

2). Frequency.

3). Kilovolt-ampere rating.

4). Voltage ratings.

5). Temperature rise.

6). Impedance.

7). Insulation class.

8). BIL rating.

9). Connection diagram.

10). Weight.

11). Manufacturer.

12). The identification “transformer.”

13). Classes of cooling.

14). Tap voltage(s).

15). Vector diagram.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

2.11 SOURCE QUALITY CONTROL

A. Factory tests:

1. Applied voltage test to each winding and from each winding to the core:

a. 600-volt class winding 4.5 kilovolt.

2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.

3. Voltage ratio and polarity.

4. Sound level, performed in a test room with ambient sound level not exceeding

5. 24 db.

6. Perform all tests in accordance with UL 1561.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:

1. Floor, wall, platform, motor control center, packaged power supply, or roof mounted, as indicated on the Drawings.

2. Locate where not in direct contact with building structure.

3. Install on double-deflection mounts selected for maximum isolation manufactured by Korfund or equal.

4. Make any necessary connections to the enclosure with liquid tight, flexible conduit having neoprene gaskets and insulated ground bushings.

5. Ground the enclosure:

a. To an equipment ground conductor in the conduit.

b. To the facility grounding electrode system.

6. Floor mounted transformers:

a. Install transformers on 3-1/2-inch housekeeping pads.

b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer’s recommendations.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

3.08 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

3.09 CLEANING

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 24 13 GROUP-MOUNTED CIRCUIT BREAKER SWITCHBOARDS

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Free standing, front access only, dead-front type metal-enclosed distribution, low voltage switchboards, utilizing group mounted circuit protective devices.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor’s Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Section 26 00 00 – General Electrical Requirements

c. Section 26 05 53 – Electrical Identification.

d. Section 26 43 13 – Surge Protective Devices.

e. Section 26 05 73 – Electrical System Studies.

f. Other Pertinent Sections

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Institute of Electrical and Electronic Engineers (IEEE).

C. National Electrical Manufacturers' Association (NEMA):

1. PB-2 – Dead-front Distribution Switchboards.

D. Underwriters' Laboratories, Inc. (UL):

1. 50 – Standard for Enclosures for Electrical Equipment.

2. 891 – Switchboards.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

1.04 SYSTEM DESCRIPTION

A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including but not limited to, circuit breakers, bus, and enclosure with accessories and features specified in this Section and indicated on the Drawings.

B. Description of sections:

1. Space for future devices:

a. Where indicated on the Drawings, space for future devices shall include:

1). All necessary bus.

2). Device supports.

3). Device mounting equipment.

4). Device connections to bus work.

5). Wire troughs or raceway space.

6). Unused device space shall be covered with blank code gauge steel covers or doors.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Product data:

1. Manufacturer of switchboard.

2. Manufacturer of all component parts of switchboard.

3. Weight of switchboard.

4. Dimensions:

a. Height.

b. Length.

c. Width.

5. Nameplate schedule.

6. Bill of material.

7. Ratings:

a. Voltage.

b. Phase.

c. Current.

d. Interrupting rating (circuit breakers and fuses).

e. Momentary current rating.

8. List of recommended spare parts.

9. Name and telephone number of manufacturer's authorized parts and repair provider. Furnish circuit breaker submittals

C. Shop drawings:

1. Layout drawings:

a. Complete, detailed, and scaled switchboard layout:

1). Front panel.

2). Sub-panels.

3). Interior panels.

4). Top and bottom conduit windows.

2. Verify lugs

a. Point-to-point connections.

b. Feeder tags and label breakers.

D. Installation instructions:

1. The written instructions must detail the complete installation of the switchboard including rigging, moving, and setting into place.

2. Provide anchorage instructions and requirements for the switchboard based on the seismic requirements at the project site as indicated in Section 260000:

a. Stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operating and maintenance manuals:

1. Submit operating instructions and a maintenance manual for the switchboard(s) furnished and/or installed under this Contract.

2. Operating instructions:

3. Maintenance manual:

a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.

b. Manuals to include but are not limited to the following:

1). Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.

2). Report listing the installed setting of all adjustable parameters, set per coordination study.

F. Test reports:

1. Manufacturer to furnish a certified report after the shop tests.

2. Manufacturer to furnish a certified report after the startup:

a. Report must state that the installation is complete and satisfactory, or list items requiring additional and a proposal for the corrective actions.

G. Certification letters:

1. Provide a letter from the switchboard manufacturer that lists every paragraph, subparagraph etc. of this Section and states compliance or non-compliance with said paragraph. If non-compliance is indicated, provide an explanation for the deviation and alternative method to address the non-compliance.

H. Calculations:

1. Detailed calculations or details of the actual physical testing performed on the switchboard to prove the switchboard is suitable for the seismic requirements at the Project site.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. Where indicated on the Drawings as service entrance equipment, the switchboard shall be UL labeled and listed “Suitable for Service Entrance.”

C. Sections and devices shall be UL listed and labeled.

D. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.07 DELIVERY STORAGE AND HANDLING

A. As specified in Section 26 00 00.

B. Ship the switchboard to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment:

1. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

2. Energize space heaters in NEMA 3R switchboards.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified and submit results for Engineer’s review.

B. After successful review of the initial fault current study, submit complete equipment submittal as specified in the Submittals article of this Section for Engineer’s review.

C. Conduct internal factory test to ensure that systems and equipment are functional and submit certified test results for Engineer’s review.

D. Assemble equipment in the field.

E. Conduct field acceptance test and submit results for Engineer’s review.

F. Submit Manufacturer’s certification that equipment has been properly installed and is fully functional for Engineer’s review.

G. Conduct Owner’s training sessions.

H. Formally energize, start-up and commission equipment:

1. Startup and commissioning shall be performed by the manufacturer’s authorized representative.

1.10 SCHEDULING

A. As specified in Section 26 00 00.

1.11 WARRANTY

A. A. As specified in Section 26 00 00.

B. Extended warranty:

1. 1 year.

1.12 SYSTEM START UP

A. As specified in Section 26 00 00.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Eaton/Cutler-Hammer, "Pow-R-Line C.”
2. Schneider Electric/Square D. “Power-Style QED.”
3. Allen-Bradley.

B. Circuit breakers: Same Manufacturer as the switchboard.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Switchboard:

1. Furnish low voltage Class 1 or Class 2 switchboards as required or as specified indicated on the Drawings.
2. Provide complete and functional switchboards with required controls.
3. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.
4. Furnish main circuit breaker with line entry on top of breaker. Do not invert breaker.

B. Voltage ratings:
1. Voltage level and configuration: As indicated on the Drawings.
2. Frequency: 60 hertz.
3. Solidly grounded system insulation level:
a. Twice the rated voltage plus 1,000 volts.

C. Bus:
1. General:
a. Silver-plated copper.
b. Bus cross-section per UL heat rise requirements.
c. Current density of 1,000 amperes per square inch.
d. Mounted on supports of high-impact, non-tracking insulators.
e. Phase A-B-C bus arrangement: Top-to-bottom, left-to-right, front-to-back throughout the switchboard.
f. Symmetrical short circuit current bracing of as indicated on the Drawings.
g. Continuous current rating as indicated on the Drawings.
2. Horizontal bus:
a. Provisions for future connections to additional switchboard sections.
3. Ground bus:
a. Sized per UL 891 or Rated at 25 percent of incoming capacity.
4. Neutral bus:
a. Sized for 100 percent of power bus rating.

D. Enclosure:
1. General:
a. Self-supporting structures bolted together to form the required line-up.
b. All sections rear aligned.
c. Dead-front.
d. Conduit entry:
1). Open-bottom.

2). Removable top cover.

2. Frame:
   a. Die-formed 12 gauge steel.
3. Covers:
   a. Bolt-on.
   b. Code gauge steel.
   c. Removable front covers.
      1). Held in place by captive screws.
4. Rating:
   a. NEMA 4X.

2.06 COMPONENTS

A. Circuit breakers:
   1. General:
      a. Molded case circuit breakers as specified in other pertinent sections of this specification.
      b. Breakers, 1200-amp rated or higher, shall contain an arc flash reduction maintenance mode switch.
   2. Main circuit breaker:
      a. Frame, trip, and short circuit ratings as indicated on the Drawings.
      b. 100 percent rated.
      c. Fixed mounted insulated case. Fixed mounted power breaker.
   3. Feeder breakers:
      a. Frame, trip, and short circuit ratings as indicated on the Drawings.

B. Wiring:
   1. Provide all necessary internal wiring, fuse blocks, and terminal blocks as required.
   2. Number all wires at each end and indicate wire numbers on shop drawings.
   3. Type SIS switchboard wire with at least 26 strands.
   4. Minimum wire size:
      a. No. 14 for control circuits.
      b. No. 12 for potential and current transformer circuits.
   5. Numbered and labeled in accordance with other pertinent sections of this specification.

2.07 ACCESSORIES

A. Metering system:

1. Include metering as indicated on the Drawings and specification section 16290.
2. Provide microprocessor based power meters as specified in Section 16290.

B. Surge protective devices:
1. Provide surge protective devices as indicated on the Drawings and as specified in other pertinent sections of this specification.

C. Nameplates:
1. Provide engraved plastic nameplates to identify:
a. Switchgear units.
b. Door mounted components.
c. Interior mounted devices.
2. As specified in Section 26 05 53.
3. Engraved with the circuit number and circuit name as indicated on the Drawings.
4. Manufacturers labels:
a. Each vertical section shall have a label identifying:
1). Serial number.
2). Shop order number.
3). Bus rating.
4). Vertical section reference number.
5). Date of manufacture.

D. Warning signs:
1. Voltage:
a. Provide a minimum of 2 warning signs on the front of the switchgear lineup and 2 on the back.
b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
c. Signs shall read:
1). "WARNING-HIGH VOLTAGE-KEEP OUT."
2. Arc flash:
a. Provide one warning sign for each switchboard compartment.
b. Signs shall have read a minimum of:
1). “DANGER ELECTRIC ARC FLASH HAZARD.”
2). Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.

E. Electrical switch board shall be selectively coordinated, fully rated, with ground fault protection.

F. Space heaters:

1. Fused, thermostatically controlled, strip-type, operated at half voltage for long life:
    a. 500 volt or 250 volt rated heaters at 240 volt or 120 volt, respectively.
2. A powered [from the switchboard control power transformer.
3. Each space heater shall be powered through its own dedicated circuit breaker.

G. Lugs:

1. For all external connections of No. 6 AWG or larger.
2. UL listed for copper or aluminum conductors.
3. Rated for 75-degree Celsius conductors.
4. Lugs shall be of the compression type in design requiring a hydraulic press and die for installation.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Chemically clean all steel surfaces before painting.

B. Exterior color Manufacturer's standard over phosphate-type rust inhibitor.

2.11 SOURCE QUALITY CONTROL

A. Completely assemble, wire and test switchboard at the factory:

1. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in other pertinent sections of this specification.

B. Install the switchboard per the Manufacturer's guidelines and submitted installation instructions to meet the seismic requirements at the Project site.

C. General:

1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the switchboard.
2. Assemble and install the switchboard in the location and layout indicated on the Drawings.
3. Perform work in accordance with manufacturer's instructions and shop drawings.

4. Furnish components and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install the switchboard on a 3-1/2-inch raised concrete housekeeping pad:
    a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
    b. Weld and/or bolt the switchboard frame to be to the leveling channels.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in other pertinent sections of this specification.

B. Manufacturer's services:

1. Furnish the services of a factory certified technician during the startup and adjustment period to ensure that all items furnished are in proper operating condition:
    a. Technician must be completely knowledgeable in the operation, maintenance, and startup of the electrical system.
2. Before startup, furnish written certification that the entire installation all electrical connections have been inspected and are proper and consistent the Contract Documents.
3. Furnish a written report after startup, signed by the technician:
    a. Report must state that the installation is complete and meets all of the manufacturer's requirements.
    b. List any items requiring additional attention.

3.08 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.09 CLEANING

A. As specified in Section 26 00 00.

3.10 DEMONSTRATION AND TRAINING

A. As specified in other pertinent sections of this specification.

B. Demonstrate the operation to the Engineer's and Owner's satisfaction.

C. Training:

1. Manufacturer shall instruct the Owner's personnel regarding the operation and maintenance of all items supplied:

    a. Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.

    b. Training shall consist of one 8-hour session at the Owner’s facility.

    c. Video record the training session in DVD format and deliver to the Owner within 2 weeks of the training session.

    d. Supply complete training documents for 8 individuals:

        1). Training documents to be supplied a minimum of 4 weeks before the training session, and to be used by the Owner as reference documents during the training period.

3.11 PROTECTION

A. As specified in other pertinent sections of this specification.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 24 16 PANELBOARDS

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Panelboards serving facility feeder circuits, branch circuits or other utilization equipment at the voltage levels and configurations indicated on the Drawings.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor’s Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Section 26 00 00 – General Electrical Requirements

c. Section 26 05 53 – Electrical Identification.

d. Section 26 43 13 – Surge Protective Devices.

e. Section 26 05 73 – Electrical System Studies.

f. Other Pertinent Sections

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Underwriter's Laboratories, Inc. (UL):

1. 67 – Standard for Panelboards.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

1.04 SYSTEM DESCRIPTION

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:

1. Service voltage and configuration as indicated on the panel schedules.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Product data:

1. Manufacturer of panelboard.
2. Bill of material.
3. Assembly ratings including:
    a. Voltage.
    b. Phase.
    c. Continuous current.
    d. Short circuit interrupting rating.
4. NEMA enclosure type.
5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
6. Furnish circuit breaker submittals.
7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26 00 00:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:

1. Drawings to contain:
    a. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
        1). Height.
        2). Length.
        3). Width.
    b. Weight.
    c. Anchoring locations.
    d. Breaker layout drawing with dimensions:
        1). Location of the main, branches, solid neutral, and ground.
    e. Conduit entry/exit locations.
        1). Identify all conduit entry/exit locations and restrictions.
    f. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Installation instructions:

1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category A or B:
    a. Provide Manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 26 00 00.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operations and maintenance manual:
1. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
    a. Including but not limited to:
        1). Instruction narratives and bulletins.
        2). Renewal parts lists.
        3). Time-current curves for all devices.

F. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project site.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Where indicated as service entrance equipment, panelboards shall be UL labeled and listed "Suitable for Service Entrance."

C. Panelboards shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton/Cutler-Hammer.
   2. General Electric Company.
   3. Schneider Electric/Square D Company.
   4. Siemens.

B. Circuit breakers:
   1. Same Manufacturer as the panelboard.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.

B. Short circuit rating:
   1. Provide panelboards with short-circuit ratings as indicated on the Drawings:
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.

4. Panelboards shall be fully rated.

2.06 COMPONENTS

A. Enclosure:

1. NEMA enclosure type as indicated on the Drawings.
    a. Where not indicated on the Drawings, as specified in Section 16000 for the installed location.
2. Minimum width: 20 inches.
3. Gutter space in accordance with the NEC:
    a. Minimum of 4 inches of gutter space.
4. Dead-front, no live parts when the panelboard is in service.
5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
6. 4-piece front to provide ease of wiring access.
7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull.
    a. Minimum 2 keys per panelboard.
    b. Key all panelboard locks alike.
8. Circuit directory frame and card on the inside of the door.
9. Door-in-door construction consists of a one-piece front with 2 doors:
    a. The smaller door provides access to all device handles and rating labels and shall be lockable.
    b. The larger/Outer door provides access to all conductors and wiring terminals. Provide with cylinder tumbler lock mechanism.
10. Exterior enclosures: Outdoor exterior enclosures shall be furnished and installed with keyed lockable 3-point latch or multiple key handle operated latches. Screwed attached covers or doors are not acceptable.
11. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.

B. Bus:

1. General:
    a. Tin-plated copper.
2. Phase bus:
    a. Full size and height without reduction.
    b. Sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees Celsius:
        1). Limit current density to less than 1,000 amps per square inch.

c. Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.

3. Ground bus:

a. Copper, solidly bonded.

4. Neutral bus:

a. Provide where indicated on the Drawings.

b. 100 percent rated.

c. Provide lugs for each outgoing feeder requiring a neutral connection.

5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:

1. UL listed for copper and aluminum wire:

a. Provide lugs rated for 75-degree Celsius terminations.

b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified and as indicated on the Drawings:

1. Provide all circuit breakers with bolt-on connections:

a. Plug-in circuit breakers are not allowed.

2.07 ACCESSORIES

A. Surge protective devices:

1. Furnish panelboards with surge protective devices as indicated on the Drawings and as specified.

B. Nameplates:

1. As specified.

2. Install on outside of door.

3. Indicating:

a. Panel designation.

b. Voltage.

c. Number of phases and configuration.

C. Circuit identification labels:

1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.

2. Type all information on the cards using designations in the panel schedules.

3. Laminated on both sides.

D. Pad locking mechanism:

1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.

2. At a minimum, provide 1 mechanism per panelboard:

a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with Manufacturer's standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.11 SOURCE QUALITY CONTROL

A. Perform standard factory tests on the panelboards:

1. Test in accordance with the latest version of NEMA and UL standards.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:

1. Surface, flush or MCC mounted as indicated on the Drawings.

2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.

3. Perform Work in accordance with the Manufacturer's instructions and shop drawings.

4. Provide all brackets, hangers, supports, and hardware for mounting as required.

5. In all NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:

a. Use only stainless steel mounting hardware.

6. Mount panelboard so that top operating handle is not more than 6 feet 7 inches above the operating floor.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 260000 and other pertinent sections of the Plans and Specifications.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications.

3.12 SCHEDULES

A. Circuiting within the panelboard shall match the panel schedules as indicated on the Drawings.

B. Provide typewritten schedule in each panelboard.

END OF SECTION

26 25 50 GENERATOR DOCKING STATION

1.00 GENERAL

1.01 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.02 GUARANTEE/WARRANTY

A. The equipment installed under this contract shall be left in proper working order.

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

2.00 PRODUCTS

2.01 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. TRYSTAR: Generator Docking Station
2. TRYSTAR Model No.: SBDS-045W-LM-IK2S
3. TRYSTAR, https://www.trystar.com/contact/ **and/or** info@trystar.com

2.02 GENERAL REQUIREMENTS

A. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Generator.

B. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

C. Enclosures:

1. NEMA 4X – 316 Stainless Steel
    a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall be maintained with access plate open for cable entry.
    b. Front and side through a front access panel shall be accessible for maintenance.
    c. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.
2. Finishes:
    a. Stainless Steel – 316

D. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated Copper

2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.

E. Temporary generator connectors shall be Camlok style mounted on gland plate.
1. Camlok shall be color coded according to system voltage
a. A phase – Brown
b. B phase – Orange
c. C phase – Yellow
d. N Neutral – White
e. G Ground – Green

F. Temporary connectors shall include protective flip lids to prevent accidental contact.

G. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.

H. Short Circuit & Withstand Rating
1. Shall be minimum 65KAIC unless otherwise indicated on drawings.

I. Voltage & Amperage:
1. Amperage (as indicated on the drawings for each site), 277/480 Volt, 3 Phase

J. Phase Rotation Monitor Device:
1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.

K. [Optional Breaker Disconnects as Indicated on Project Drawings and Manufacturer Submittal Drawings:]
1. Must be UL 489 Listed Breaker

L. Additional accessories shall be included in submittal drawings as follows:

3.00 EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

3.02 INSTALLATION

A. Surface, Flush or Base Mounted: Determined by Application
1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.03 FIELD QUALITY CONTROL

A. Third Party Tests and Inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

26 27 26 WIRING DEVICES

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Switches.
2. Receptacles.
3. Plates.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
    a. Submittal Procedures.
    b. Section 26 00 00 – General Electrical Specifications

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Federal Specifications (FS):

1. W-C 596 – Connector, Electrical, Power, General Specification for.
2. W-S 896/2 – Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. National Electrical Manufacturers Association (NEMA):

1. WD1 – General Color Requirements for Wiring Devices.
2. ICS 5 – Industrial Control and Systems, Control Circuit and Pilot Devices.
3. OS1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. WD6 – Wiring Devices Dimensional Specifications.

D. National Fire Protection Association (NFPA):

1. 70 – National Electric Code (NEC).

E. Underwriters Laboratories Inc. (UL):

1. 20 – General Use Snap Switches.
2. 498 – Standard for Attachment Plugs and Receptacles.

3. 514D – Cover Plates for Flush-Mounted Wiring Devices.
4. 943 – Ground-Fault Circuit-Interrupters.
5. 1472 – Solid State Dimming Controls.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

B. Specific definitions:

1. GFCI: Ground fault circuit interrupter.
2. P-S: Pass and Seymour.
3. Cooper: Cooper Wiring Devices, a division of Cooper Industries.
4. T&B: Thomas and Betts.

1.04 SYSTEM DESCRIPTION

A. Switches, receptacles, and plates as indicated on the Drawings wired and operable to form a complete system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of the Plans and Specifications

B. Product data:

1. Catalog cut sheets.

C. Shop drawings:

1. Engraving schedule:

a. Furnish complete engraving schedule for engraved nameplates.

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00.

B. Wiring devices shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 00 00.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Switches:

1. General purpose switches: One of the following or equal:
    a. Hubbell.
    b. Leviton.
    c. Cooper.
2. Switches for office areas: One of the following or equal:
    a. Hubbell.
    b. Leviton.
    c. Cooper.
3. Switches for photocells: One of the following or equal:
    a. Hubbell.
    b. Cooper.
4. Switches for hazardous areas: One of the following or equal:
    a. Appleton.
    b. Crouse-Hinds.
5. Occupancy Sensor Switches: The following or equal:
    a. WattStopper.
    b. Cooper.
6. Dimmer switches: The following or equal:
    a. Lutron.

b. Cooper.

B. Receptacles:

1. General purpose receptacles: One of the following or equal:
   a. Hubbell.
   b. Leviton.
   c. Cooper.
2. Receptacles for hazardous areas: One of the following or equal:
   a. Crouse-Hinds.
   b. Appleton.
3. 250 VAC receptacles: One of the following or equal:
   a. Hubbell.
   b. Cooper.
4. 480-Volt, 3-phase receptacles: One of the following or equal:
   a. Crouse-Hinds.
   b. Hubbell.
   c. Russellstol™.

C. Plates:

1. General location: The following or equal:
   a. P-S.
   b. Cooper.
2. Wet or corrosive areas: One of the following or equal:
   a. Hubbell.
   b. Cooper.
   c. T&B.
   d. P-S.
3. In-use covers: One of the following or equal:
   a. TayMac.
   b. Cooper.
   c. P-S.
   d. T&B.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Switches:

1. General:
    a. 120-277 VAC.
    b. 20 ampere.
    c. Listed in accordance with UL 20.
    d. Designed and constructed in accordance with FS W-S-896/2.
    e. Back and side wired unless otherwise indicated.
    f. Integral grounding terminal.
    g. Totally enclosed:
        1). Color-coded body with color corresponding to ampere rating.
    h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
    i. Color:
        1). Ivory in finished areas.
        2). Brown in all other areas.
2. General purpose switches:
    a. Toggle type.
3. Switches for office areas:
    a. Rocker type.
    b. Rectangular.
4. Switches for use with photocell:
    a. Maintained contact.
    b. Two circuit.
    c. Three position:
        1). Center off.
5. Switches for hazardous areas:
    a. Suitable for use in Class I Division 1 and Class I Division 2 locations.
    b. Factory sealed.
    c. Through-feed or dead-end as required.
6. Occupancy sensor switches:

a. Wall switch with dual-technology passive infrared and ultrasonic sensor.

1). Configured such that lights turn on only when both infrared and ultrasonic sensors detect activity, but do not turn off as long as either sensor detects activity.

b. Selectable “automatic-on” mode activated by sensors or “manual-on” mode activated by pushbutton.

c. Adjustable 5-30 minute time delay.

d. Selectable audible alert as a warning before lights turn off.

e. Rated for fluorescent lighting loads of up to 800W.

f. True multi-way switching allowing identical controls at any location for multi-way switching applications.

7. Dimmer switches:

a. Shall be rectangular design with LED light level indicators.

b. Suitable for use with type of lamp switched.

B. Receptacles:

1. General purpose receptacles:

a. Single or duplex as indicated on the Drawings.

b. 125 VAC.

c. 20 ampere or as indicated on the Drawings.

d. NEMA Type 5-20R configuration for 20 ampere receptacles.

e. Other NEMA configurations as indicated on the Drawings.

f. Listed in accordance with UL 498.

g. Designed and constructed in accordance with FS W-C-596.

h. Back and side wired.

i. One-piece, rivet-less mounting strap.

j. Color:

1). Ivory in finished areas.

2). Brown in all other areas.

3). Orange when powered by a UPS.

2. Ground fault interrupter receptacles (GFCI):

a. 125 VAC.

b. 20 ampere.

c. Trip level 4-6 milliampere.

d. Individual and feed through protection.

e. UL 943 and UL 498 listed.

f. NEMA Type 5-20R configuration.

g. For damp or wet locations:

1). Weather resistant, in accordance with UL 498.

3. Isolated:

a. Duplex as indicated on drawings.

b. 125 VAC.

c. 20 ampere.

d. Isolated and insulated from box.

4. Receptacles for hazardous areas (As per NFPA 820):

a. 125 VAC.

b. 20 ampere.

c. Factory sealed.

d. Single receptacle.

e. 2-wire, 3-pole.

f. Grounded through extra pole and shell.

g. Dead-front construction.

h. Interlocked to prevent plug from being withdrawn until circuit has been broken.

5. 125 VAC receptacles:

a. 2-pole, 3-wire grounding for 240 VAC circuits.

b. 3-pole, 4-wire grounding for 208 VAC 3-phase circuits.

c. Ampere rating as indicated on the Drawings.

d. Provide NEMA configuration as required by the equipment connected to the outlet.

6. 480 VAC receptacles:

a. 3-pole, 4-wire grounding.

b. Ampere rating as indicated on the Drawings.

c. Spring door on receptacle.

d. Furnish one matching plug for each 480-volt power receptacle.

7. All outdoor receptacles not in hazardous areas shall be weather proof GFI type (5-20R).

8. Receptacles in Classified locations shall be Explosion Proof, Hazardous Location Rated, 20 amp, 125 VAC/250 VAC, 5-20R. Receptacle shall be ANSI/UL943, 1203 listed.

C. Plates:

1. General location:

a. Type 302 or 304 stainless steel.

b. Brushed satin finish.

c. Minimum thickness: 0.032 inches.

d. Rectangular or square shape.

e. Engraving:

1). Engrave each plate with the following information:

a). Area served.

b). Circuit number.

2). Treat engraving to improve visibility and, except for stainless steel plates, to prevent corrosion.

3). Characters shall be block letter pantograph engraved with a minimum character height of 1/8-inch.

f. Coordinate the number of gangs, number and type of openings with the specific location.

2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:

a. General:

1). UL listed for wet locations.

2). Gasketed.

3). Die cast metal:

a). Match material to box material.

b. Switches:

1). Lever operated:

a). Provide toggle switch.

c. Receptacles:

1). Weather proof in-use cover:

a). Die cast metal construction with electrostatic powder coating for corrosion resistance.

b). Gasketed.

c). Lockable.

d). UL listed and in accordance with NEC.

3. Corrosive areas:

a. Neoprene.

b. Gasketed.

c. Weatherproof.

D. Data and communications jacks:

1. Process network jacks – panel/enclosure mounted:

a. Network jacks located in process areas shall have a NEMA Type 4 rating (with closure cap).

b. Mounting of network jacks in control panels shall be accomplished using bulkhead connectors and environmental enclosure caps, which are permanently attached to the bulkhead fitting.

c. Network jacks shall have RJ-45 connections on both sides of connector (bulkhead pass through) allowing for direct connection to the network switch and computer with standard patch cords. No punch down PC board connections shall be allowed.

d. Manufactured by Woodhead Connectivity RJLNXX.

2. Process network jacks – conduit body mounted:

a. Network jacks located in process areas shall have a NEMA Type 4 rating (with closure cap).

b. Mounting of network jacks in conduit bodies adapter (with Minifast connector) shall be accomplished using conduit body insert and environmental enclosure caps.

c. PC board connections are not to be allowed.

d. Furnish 10 RJ-45 to minifast connector patch cable 3 feet in length.

e. Manufactured by InterlinkBT RSS series.

3. Network/phone jacks:

a. Network jacks located in computer rooms shall be installed per the installation details indicated on the Drawings.

b. Standard Decora wall plates shall be used with QuickPort modules and inserts.

c. Plugs shall be color coded as indicated in the installation details indicated on the Drawings.

d. Manufactured by Leviton Quickport series.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00.

B. Mounting heights:

1. Process and production areas:

a. Switches and receptacles 48 inches from finished floor to top of plate.

2. Offices and finished areas:

a. Switches: 48 inches from finished floor to top of plate.

b. Receptacles: 18 inches from finished floor to center of plate.

C. Switches:

1. Over 300 Volts:

a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

D. Receptacles:

1. Provide GFCI receptacles as indicated on the Drawings.

a. Provide weather resistant GFCI receptacles in all wet or damp areas.

1). As specified.

2. Mount non-weatherproof receptacles vertically:

a. Ground slot down.

3. Mount weatherproof receptacles horizontally:

a. Neutral slot up.

4. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.

E. Ensure all plates make a firm seal with wall for recessed mounted devices:

1. Outside edges of plates parallel with building lines.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 26 00 00.

B. Demonstrate the following to the Engineer and Owner:

1. Switching is as indicated on the Drawings.

2. All circuits conform to the panel schedules.

3. All ground fault receptacles operate at levels below or equal to OSHA maximum allowable fault levels.

3.11 PROTECTION

A. As specified in Section 26 00 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 28 11.13 LOW VOLTAGE POWER CIRCUIT BREAKERS

1.00 GENERAL

1.01 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for low voltage power circuit breakers (also identified as LVPCB, CB) as required for the complete performance of the work, as shown on the Drawings, as specified herein, and as specified elsewhere for the assemblies or systems comprised of the components specified herein.

B. Related Sections: Related sections include, but shall not be limited to, the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.

3. Refer to the following equipment specification sections in which low voltage power circuit breakers may be provided within for additional requirements.

a. Section 26 00 00 General Electrical Provisions

b. Section 26 24 13 Switchboards

c. Section 26 24 16 Panelboards

1.02 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. American National Standards Institute (ANSI)

a. ANSI C37.13, “Low-Voltage AC Power Circuit Breakers Used in Enclosures”

b. ANSI C37.50, “Low-Voltage AC Power Circuit Breakers Used in Enclosures Test Procedures”

2. Canadian Standards Association (CSA)

a. C22.1, “Canadian Electrical Code, Part I” (CEC)

b. C22.2 No.268-16, “Power circuit breakers up to 1000 Vac/1500 Vdc”

3. International Electrical and Electronics Engineers (IEEE):

a. IEEE C37.13, “IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures”

b. IEEE C37.14, “IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures”

4. International Electrotechnical Commission (IEC):

a. IEC 60068-2, “Environmental Testing”

b. IEC 60721, “Classification of Environmental Conditions”

c. IEC 60947-2, “Low-Voltage Switchgear and Control gear - Part 2: Circuit-Breakers”

d. IEC 61557-12, “Electrical Safety in Low Voltage Distribution Systems up to 1000 VAC and 1500 VDC”

5. International Organization for Standardization (ISO)

a. ISO 9001, “Quality Management Systems - Requirements”

b. ISO 14001, “Environmental Management Systems -- Requirements with Guidance for Use”

6. National Fire Protection Agency (NFPA)

a. NFPA 70, “National Electrical Code (NEC)”

7. Underwriters Laboratories, Inc. (UL)

a. UL 1066, “Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures"

1.03 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. BLE: Bluetooth Low Energy

2. DPWS: Device Profile Web Service

3. HMI: Human Machine Interface

4. IDMTL: Inverse Definite Minimum Time Lag

5. IMU: Intelligent Modular Unit

6. LVPCB: Low Voltage Power Circuit Breaker

7. LSIG = Long-time + Short-time + Instantaneous + Equipment Ground-fault Protection or a combination of these letters and types for the available adjustable protection on certain trip units.

8. L: Long Time (overload protection, analogous to the inverse-time thermal trip of a thermal/magnetic breaker)

9. S: Short Time (short circuit protection of low level faults)

10. I: Instantaneous (short current protection of high level faults, analogous to the instantaneous magnetic trip of a thermal/magnetic breaker)

11. G: Ground Fault (equipment ground fault protection)

12. NFC: Near Field Communication

13. OIT: Operator Interface Terminal is a locally mounted HMI device providing remote monitoring and functions of the connected equipment.

14. Smart Mobile Device, Phone or Tablet: Smart phone or tablet compatible with iOS or Android OS capable of running apps used for specified functionality.
15. ULP: Universal Logic Plug
16. USB-OTG: Universal Serial Bus – On the Go
17. ZSI: Zone Selective Interlocking

1.04 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of General Conditions and any Sections pertaining to Submittals and Section 26 00 00 General Electrical Requirements, in addition to those specified herein.
   1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
   2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.

B. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in General Conditions Section referring to Operation and Maintenance Data, Section 26 00 00 Electrical Requirements and additional requirements specified herein.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of specified products of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of ten years.
   1. The manufacturer shall have a valid ISO 9001 certification and an applicable quality assurance system that is regularly reviewed and audited by a third-party registrar. Manufacturing, inspection, and testing procedures shall be developed and controlled under the guidelines of the quality assurance system.
   2. The manufacturer shall have the ISO 14001 Environment Certification and shall supply the Product Environmental Profile (P.E.P.) upon request of the Engineer.
   3. The manufacturer or their representative shall have service, repair, and technical support services available 24 hours 7 days a week basis.

B. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Process controllers, assemblies, materials, and equipment shall be listed and labeled by Underwriter's Laboratories or by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

B. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

C. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.07 WARRANTY

A. General: Refer to Section 26 00 00

1.08 SPECIAL TOOLS AND SPARE PARTS

A. The Contractor shall provide a recommended spare parts list with the following information provided as a minimum:

1. Contact information for the closest parts stocking location to the Owner.

2. Critical spare parts shall be identified as those parts being associated with long lead times and/or those being critical to the unit's operation.

3. Maintenance spares shall be identified as being those parts required to regularly perform scheduled maintenance on the furnished equipment. These spares shall include, but shall not be limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

B. Spare parts shall be provided for each type and size of unit installed. At a minimum, the following shall be provided:

1. Provide the minimum spare parts recommended by the manufacturer, including but not limited to: trip coils, switches and spring charging motors.

C. Any manufacturer specific special tool, not normally found in an electrician's toolbox, required to remove and install recommended or furnished spare parts shall be furnished. At a minimum the following shall be provided:

D. Spare parts shall be properly marked and packaged for long term storage. Printed circuit boards shall be provided in separate anti-static containers.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Products: Circuit Breakers specified herein shall be the product of a single manufacturer. Products and manufacturers specified are to establish a standard of quality for design, function, materials, and appearance. Products shall be modified as necessary by the manufacturer for compliance with requirements. Provide the following specified product and manufacturer without exception, unless approved as a substitute by addendum to the Contract Documents prior to the bid date:

1. Schneider Electric
2. Eaton
3. Siemens
4. Engineer Approved Equal

2.02 GENERAL REQUIREMENTS

A. LVPCBs shall be a sealed low voltage power circuit breaker manually operated with integrally mounted electronic trip units.

B. LVPCBs shall be fixed mounted.

C. LVPCBs shall be 100% rated. The LVPCB interrupting rating shall exceed the available fault current. The LVPCB close-and-latch rating and 30 cycle withstand rating shall meet the application requirements. Circuit breakers shall have close and latch ratings up to 150 kA peak current.

D. Circuit breakers shall have a maximum 5-cycle closing time. The closing time shall be less than or equal to 50 milliseconds for ratings <800A; 70 milliseconds for ratings <4000A; 80 milliseconds for ratings >4000A.

E. LVPCBs shall provide long service life. The 3200 A circuit breaker frame and those of lower ratings must be certified to perform a minimum of 10,000 operations without maintenance. The circuit breaker frames greater than 3200 A must be certified to 5,000 operations without maintenance. Circuit breaker shall be equipped with a visual contact wear indicator.

F. Operation

1. All circuit breaker operating mechanisms shall be two-step, fully-stored energy devices for quick-make, quick-break operation. Open-close-open (O-C-O) cycle shall be possible without recharging. Motor operator shall automatically charge when circuit breaker is closed. Actuation of the operating handle or an operation cycle of the circuit breaker motor is to charge the closing springs (step one) and operation of a local CLOSE button is to close the circuit breaker contacts (step two). Closing the circuit breaker contacts shall automatically charge the opening springs.

2. Circuit breaker shall be equipped with anti-pumping function: If opening and closing commands occur simultaneously, the circuit breaker shall remain in the open position. After fault tripping or intentional opening using the manual or electrical controls, the closing order must first be discontinued, then reactivated to close the circuit breaker.

3. The front face of the circuit breaker shall have OPEN and CLOSE buttons with breaker contact and close spring status indicators. The indicator shall show "charged-not OK to

close" if closing springs are charged but the circuit breaker is not ready to close. A lockable clear cover shall be provided over the OPEN and CLOSE buttons as required.

4. The circuit breaker shall be equipped with a safety interlock which keeps the circuit breaker open if the trip unit is not installed.

5. Shunt trip and shunt close coils shall be continuous-duty rated.

G. Construction

1. The case of the circuit breaker shall be a polyester thermoset material providing high dielectric strength. Current-carrying components shall be completely isolated from the accessory mounting area and double insulated from the operator with an accessory cover in place. Each phase inside the circuit breaker shall be completely isolated from other phases and from ground.

2. Circuit breakers shall be equipped with metal filters to reduce effects of an interruption on surfaces surrounding the circuit breaker.

3. Secondary wiring shall be front accessible and available in cage clamp or ring terminal connections. The circuit breaker shall be provided with a removable secondary wiring barrier to prevent access even when circuit breaker enclosure doors are open.

4. Circuit breaker shall be compliant with REACH (Registration Evaluation and Authorization and Restriction of Chemicals) and RoHS (Restriction of Hazardous Substances).

2.03 TRIP UNITS – ADVANCED CUSTOMIZABLE OR SELECTABLE FIXED FUNCTIONALITY

A. Advanced trip units shall be imbedded within the hardware of the circuit breaker. Trip unit functionality shall be upgradable through the uploading of digital modules without the need to replace or modify trip unit hardware. Trip unit protection functions shall be electronically managed independently of measurement functions by a dedicated ASIC (application specific integrated circuit). Digital modules shall be added to the trip unit without removing power from the circuit breaker, unless hardware is required to be added in conjunction with the digital module.

B. Trip units shall provide local and remote trip indication and reason for trip (e.g. overload, short circuit or ground fault).

C. Trip units shall visually indicate the operating status of the circuit breaker: normal, warnings, alarms, ERMS, through the color changing backlit display.

D. All trip units shall be capable of setting the breaker locally, if enabled, via a smart mobile device, or remotely through communications.

E. It shall be possible to get trip cause data out of trip unit or adjust protection settings with any portable power supply connected through the USB port, without a 24Vdc power supply or when the main circuit breaker is OFF, including the battery pack, smart mobile device (USB OTG), or laptop pc.

F. Trip units shall incorporate “True RMS Sensing” through the 40th harmonic, and have LED long-time pickup indications.

G. Coils shall provide status, self-diagnosis (functionality and number of coil operations) and wiring diagnostics. Standard coils shall be acceptable provided that alternate coil monitoring and alarming is communicated to the remote monitoring system.

H. Protection Functions

1. Provide the appropriate trip unit functionality for the required system performance.

2. Trip unit protection functions shall consist of

a. adjustable long-time pickup and delay ANSI 49RMS/51

b. short-time pickup and delay ANSI 50TD/51

c. instantaneous pickup ANSI 50

d. ground-fault pickup and delay ANSI 50N-TD/51N

3. Long-time pickup (Ir) and delay shall be adjustable. Long-time pickup (Ir) shall be adjustable from 0.4 to 1 times In, adjustable in 1 ampere increments. Long-time delay settings shall be adjustable from 0.5 to 24 seconds at six times Ir in 0.5 second increments. If you can't adjust to 1 ampere increments, manufacturer shall supply one complete set of rating plugs per breaker to maximize future flexibility.

4. Short-time pickup shall be adjustable from 1.5 to 10 times Ir in increments of 1%. Short-time delay shall be adjustable from 0.1–0.4 I2t ON and 0–0.4 I2t OFF in increments of 0.1 seconds.

5. Instantaneous settings on the trip units with LSI protection shall be adjustable from 1.5 to 15 times In. The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided. Instantaneous settings shall have 2 selectable breaking times; "standard" when selective coordination is required and "Fast" when limiting let-thru energy is required. "Fast" is defined as 25 to 30 mS breaking time.

6. Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential.

a. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be adjustable from 0.2 to 1.0 times In in 0.1 In increments. The ground-fault settings for circuit breakers above 1200 A shall be adjustable from 500 to 1200 A.

7. An independent ground fault alarm shall provide ground fault and earth-leakage protections, having their own settings.

I. Trip unit shall provide dual trip curve settings for respective protection functions (LSIG), providing separate settings for various sources; utility, generator set or grid. User may switch from one set of settings to the other to comply with conditions of operation. Trip curve selection shall be selected by one of the following means: digital input through the IO module, Ethernet, or from the local display.

J. Trip unit shall provide a separate trip curve for arc energy-reducing maintenance setting (ERMS). The ERMS trip curve shall be selected through physical selector switch or a smart mobile device. Trip unit remote indicator light shall indicate when trip unit is operating in ERMS mode.

1. Trip unit shall operate in Fast Instantaneous trip mode, 25 to 30 mS, when ERMS trip curve is active.
2. Engaging/disengaging the ERMS mode or making settings changes to the ERMS settings shall be restricted to authorized personnel by limiting access to such features by padlocks or passwords to ensure safety of the personnel working with the equipment.

K. To deter unwanted changes to the protection settings, a sealable door feature blocks the use of the local display to make adjustments of the protection settings.

L. Measurement and Analysis Functions

1. Trip units shall have embedded measurement to provide real time metering. Metering accuracy by function shall be within 0.5% for current and voltage, and 1% for power and energy measurements. Metering accuracies shall be total measurement system, including CT and meter and shall be full scale over the range 10% to 120% of Ir. If not available at the circuit breaker, an external meter shall be provided for specified measurement and analysis functions.
2. Metering functions, at the point of measurement, shall calculate and display the imported and exported energy on each phase of the power system network. It shall calculate and display active, reactive and apparent energy per phase, as well as the total active, reactive and apparent energy.
3. Trip units shall be capable of harmonic analysis and waveform capture. Individual harmonics of voltages and currents, up to the 40th, shall be calculated every 200 ms in accordance with IEC 61000-4-30.
4. Measurements shall be capable of being shown on the breaker display, a smart mobile device via Bluetooth, a connected remote OIT or a remote monitoring system via Modbus TCP/IP.
5. Event management shall provide user notification of alarms and traceability. Event history to include: trips, protection setting changes, diagnostics, metering, configuration, and operation.
    a. The date and time the entry was made and the user ID associated with the change.
    b. User shall be able to activate alarms based on measurement (I, V, F, P, Q, S, THD, CosPhi, FP, Idemand, Pdemand,) or counters
    c. All events shall be available by communication, Bluetooth and Modbus TCP/IP, or Engineering tool.
6. Provide circuit breaker internal monitored functions for maintenance purposes: Coils electrical continuity checks, Circuit breaker closing time, Gear motor charging time, Circuit breaker closing & opening counter, Circuit breaker time stamp closing & opening history log.
7. Provide trip unit internal monitored functions for maintenance purposes: Internal Sensors (CTs) continuity, External Sensors disconnection (ENCT, ground fault sensor and I/O modules), Internal failure discrimination (ASIC, sensor plugs, internal battery, trip solenoid), Wireless communication failure (Bluetooth Low Energy [BLE] and Ethernet).
8. Trip unit shall communicate trip cause information to a smart mobile device without requiring power to the trip unit. A smart mobile device app shall be available to provide

virtual assistance in reclosing a breaker after trip event, utilizing information extracted from breaker, including wave form capture on trip event. This function shall assist the user to restore power by displaying circuit breaker event information, potential causes, a list of additional investigations needed to determine if power can be restored and recommendations for power restoration.

9. Provide Auto-test function for monitoring and communicating the following functions: trip unit state, battery state, contact state, circuit breaker remaining life estimate (algorithm based), spring charging function, and opening/closing function, indicated by Health State LED, embedded HMI display and smart mobile device app.
10. Trip unit shall allow for remote open / close operation of the circuit breaker either through wired communications or with a smart mobile device that provides assistance for the reclosing or opening the circuit breaker, by delivering instructions such as reset (if applicable) or charge spring (if applicable). The smart mobile device shall be capable of displaying circuit breaker status: ready-to-close, coil status or spring charging status.

M. Communications (as required)

1. Trip units shall have a communication/test port for checks on electronic and trip mechanism operation in compliance with market standards (USB and PC) avoiding requiring a specific Manufacturer's hardware tool.
2. Trip units shall have wireless communication interface for protection settings and health checks using Near Field Communications (NFC) and BLE protocols.
3. Circuit breakers shall be provided with a communication interface with two Modbus TCP/IP 10/100 Mbps ports (dual-port, single network) for connection to a Ethernet network for real-time access to the circuit breaker device data and settings. Ethernet network accessible circuit breakers shall provide embedded web page interface using a standard PC and web browser without the need for additional hardware and software. Ethernet communication interfaces shall be compliant to Device Profile Web Service (DPWS) for auto-discovery on the local area network (LAN).
4. Ethernet interface device used on drawout circuit breakers shall be capable of reporting cradle position, viewable in the embedded Web page and over a data connection to external monitoring software.

2.04 CIRCUIT BREAKER OPERATOR INTERFACE TERMINAL [- NOT USED]

A. Circuit breakers shall be provided with a locally mounted Operator Interface Terminal(s) (OIT) remote from the circuit breaker itself for each group of circuit breakersr connected via an Ethernet network: The OIT shall provide the following functions as a minimum:

1. Real time display monitored of devices
2. Simple control of devices and load
3. Display of the following circuit breaker functions:
    a. Energy consumption
    b. Electrical network data

c. Alarms and events

d. Energy quality

e. Device status (open, close, tripped); indication of fault types (LT, ST, instantaneous, ground fault); faulty phases; interrupted current.

f. Predictive maintenance monitoring contact wear rate, load profile, and the circuit breaker counter values

2.05 ELECTRICAL POWER MANAGEMENT SYSTEM -NOT USED

A. The equipment specified herein shall provide the necessary communications connectivity and functionality required to support the functionality of an Electrical Power Management System (EPMS). This shall include, but not be limited, to the following:

1. Communications connectivity using the specified Ethernet network and protocols of the EPMS and related EPMS connected equipment necessary to provide functionality. Equipment may be connected through a communications gateway as shown or specified; otherwise Ethernet and protocol connectivity shall be provided within the equipment.

2. Compliance with Cyber security requirements.

3. Remote EPMS application functionality for equipment configuration and operational control; electrical power monitoring; power quality monitoring, compliance and correction; and alarm monitoring with event log.

4. Refer to the Electrical Power Management System specification section for additional requirements.

B. Native EPMS software compatibility shall be fully factory-tested, and shall include the following characteristics.

1. Capability for pre-engineered, interactive graphical display screens to view and analyze real-time device data.

2. Pre-mapping of registers to standard measurement names without the need for additional configuration or internal device registers.

3. Automatic collection and logging of device data by EPMS software without additional configuration.

4. Refer to the individual circuit breaker device requirements for EPMS monitoring of measured and calculated values, alarms, events, parameters and additional data as available from the device, as specified herein and within the Electrical Power Management System specification.

3.00 EXECUTION

3.01 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 26 00 00 and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.

F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.02 TESTING

A. Methods for testing the circuit breakers shall be provided, test sets designed for verifying proper product configuration and function (specific to each manufacturer's products) shall be provided, if required for testing, but are not preferred. Testing procedures, in accordance with the National Electric Code regulations and accepted industry practice, shall be available for commissioning.

B. A test report shall be submitted that includes the list of all the devices connected to each channel as well as a diagram describing the configuration of the system with indication of the associated Modbus addresses.

END OF SECTION

26 28 16 DISCONNECT SWITCHES

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Fusible and non-fusible disconnect switches.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Commissioning and Process Start-up.

c. Section 26 00 00 - Common Work Results for Electrical.

d. Section 26 05 53 - Identification for Electrical Systems.

e. Section 26 05 73 - Electrical System Studies.

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Underwriters Laboratories Inc. (UL):

1. 20 - General-Use Snap Switches.

2. 98 - Enclosed and Dead-Front Switches.

3. 508 - Standard for Industrial Control Equipment.

C. National Electric Manufacturer's Association (NEMA):

1. 250 - Enclosures for Electrical Equipment.

2. KS 1-2001- Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

B. Specific definitions:

1. Safety switches and disconnect switches are to be considered synonymous.

1.04 SYSTEM DESCRIPTION

A. Provide heavy-duty type disconnect switches as indicated on the Drawings and specified in the Contract Documents.

B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

B. Product data:

1. Manufacturer.
2. Manufacturer's specifications and description.
3. Ratings:
    a. Voltage.
    b. Current.
    c. Horsepower.
    d. Short circuit rating.
4. Fused or non-fused.
5. NEMA enclosure type.
6. Dimensions:
    a. Height.
    b. Width.
    c. Depth.
7. Weight.
8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop drawings:

1. Manufacturer's installation instructions:
    a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
    b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
2. Identify motor or equipment served by each switch; indicate nameplate inscription.

D. Installation instructions:

1. Provide anchorage instructions and requirement based on the seismic requirements at the Project Site as specified in Section 26 00 00 and calculations:

a. Stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

B. Regulatory requirements:

1. NEMA KS1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).

2. UL 98 - Enclosed and Dead-Front Switches.

C. Disconnect switches shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16305 and submit results for Engineer’s review.

B. After successful review of the initial fault current study, submit complete equipment submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

1.12 SYSTEM START-UP

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or Engineer Approved Equal:

1. Schneider Electric/Square D Company.
2. Eaton/Cutler-Hammer.
3. General Electric.
4. Siemens.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Switch mechanism:
   1. Quick-make, quick-break heavy-duty operating mechanisms:
      a. Provisions for padlocking the switch in the Off position.
      b. A minimum of 90-degree handle travel position between Off and On positions:
         1). Provide handle position indicators to identify the handle position.
      c. Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
         1). With an externally operated override.

B. Switch interior:
   1. Switch blades visible when the switch is Off and the cover is open.
   2. Lugs:
      a. Front accessible.
      b. Removable.
      c. UL listed for 60/75-degree Celsius copper conductors.
   3. Current carrying parts completely plated to resist corrosion.
   4. Removable arc suppressors to facilitate easy access to line side lugs.
   5. Furnish equipment ground kits for every switch.

C. Fused switches:
   1. Furnish with fuses as indicated on the Drawings:
      a. Provide fuses as required by NEC and equipment manufactuerers.
   2. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
      a. Ratings 100 amperes through 600 amperes at 240 volts.
      b. Ratings 30 amperes through 600 amperes at 600 volts.
      c. Provide spring reinforced and plated fuse clips.

D. Ratings:

1. UL horsepower rated for AC or DC with the rating not less than the load served.
2. Current:
    a. 30 to 1,200 amperes.
3. Voltage:
    a. 250 volts AC, DC.
    b. 600 volts (30 A to 200 A, 600 volts DC).
4. Poles:
    a. 2, 3, 4, and 6 poles.
5. UL listed short circuit ratings:
    a. 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes).
    b. 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 amperes employing appropriate fuse rejection).
    c. 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1,200 amperes).
6. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 26 00 00 for the installed location.

E. Size, fusing and number poles as indicated on the Drawings or as required:

1. Provide solid neutral where indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and 9 enclosures furnished with drain and breather kit when used in outdoor applications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:

1. Use Myers hubs or bolt-on hubs for all conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.

2. Provide all mounting brackets, stands, supports and hardware as required:

a. Match finish and materials for all brackets, stands, and hardware with the switch installed.

b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.

3. When possible, mount switches rigidly to exposed building structure or equipment structural members:

a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.

b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.

4. Provide a nameplate for each disconnect switch:

a. Provide per requirements specified in Section 26 05 53.

b. Identify voltage, circuit, fuse size, and equipment served on the nameplate.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. As specified in pertinent Sections

3.08 FIELD QUALITY CONTROL

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

3.11 PROTECTION

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 29 13 MOTOR STARTERS

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Motor starters and contactors.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor’s Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Commissioning and Start-up.

c. Section 26 00 00 – Common Work Results for Electrical.

d. Section 26 05 53 – Electrical Identification.

e. Section 40 61 16 – Control Panels

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. International Electrotechnical Commission (IEC):

1. 801-1 – Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment – Part 1: General Information.

C. National Electrical Manufacturer's Association (NEMA):

1. ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.

D. Underwriters Laboratories (UL):

1. 508 – Standard for Industrial Control Equipment.

2. 508A – Standard for Industrial Control Panels.

1.03 DEFINITIONS

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

B. Specific definitions and abbreviations:

1. FVNR: Full voltage non-reversing.
2. RVSS: Reduced voltage solid state.
3. Solid state smart protective device.

1.04 SYSTEM DESCRIPTION

A. General requirements:

1. Starters for motor control centers, individual enclosed starters, or control panels.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

1. Submit motor starter data with equipment submittal.

B. Product data:

1. Manufacturer.
2. Catalog cut sheets.
3. Technical information.
4. Complete nameplate schedule.
5. Complete bill of material.
6. List of recommended spare parts.
7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
8. Electrical ratings:
    a. Phase.
    b. Wire.
    c. Voltage.
    d. Ampacity.
    e. Horsepower.
9. Individually enclosed starters:
    a. Dimensions:
        1). Height.
        2). Width.
        3). Depth.
        4). Weight.
    b. Enclosure information:

1). NEMA rating.

2). Materials.

c. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26 00 00:

1). Manufacturer's statement of seismic qualification with substantiating test data.

2). Manufacturer's special seismic certification with substantiating test data.

10. Furnish circuit breaker submittals as specified in Section 26 28 11.

C. Shop drawings:

1. Elementary and schematic diagrams:

a. Provide 1 diagram for every starter and contactor.

b. Indicate wire numbers for all control wires on the diagrams:

1). Wire numbering as specified in Section 26 00 00.

c. Indicate interfaces with other equipment on the drawings.

2. Individually enclosed starters:

a. Layout drawings:

1). Complete dimensioned component and starter unit layout drawings.

2). Allowable top and bottom conduit windows.

D. Installation instructions:

1. Detail the complete installation of the individually enclosed starters including rigging, moving, and setting into place.

2. For equipment installed in structures designated as seismic design category A or B:

a. Provide Manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.

3. For equipment installed in structures designated as seismic design category C, D, E, or F:

a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 26 00 00.

b. Submit anchoring drawings with supporting calculations.

c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operation and maintenance manuals:

1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section. Including but not limited to:

a. Electrical ratings:

1). Phase.

2). Wire.

3). Voltage.

4). Ampacity.

b. Complete bill of material.

c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:

1). Protective devices (fuses, breakers, overload relays, heater elements, etc.).

2). Pilot devices.

d. Complete renewal parts list.

e. As-built drawings:

1). Furnish as-built drawings for each starter and contactor indicating final:

a). Wire numbers.

b). Interfaces with other equipment.

2). 11-inch by 17-inch format.

F. Certifications:

1. Provide manufacturer's certification that the reduced voltage solid state starter will reliably control the acceleration and deceleration of the driven load at the installed conditions:

a. Failure of the manufacturer to provide said certification will be interpreted to mean that the manufacturer has agreed that the reduced voltage solid- state starter is matched to the driven load at the installed conditions and will function without fault.

b. If the reduced voltage solid-state starter fails to perform as desired, replace or modify the reduced voltage solid-state starter in order to achieve the desired operational conditions, as directed by the Engineer.

2. Provide manufacturer's certification that all electronic circuits and printed circuit boards are conformally coated.

1.06 QUALITY ASSURANCE

A. As specified in Sections 26 00 00 and other pertinent sections of the plans and specifications.

B. Regulatory requirements:

1. All starters and components shall be UL listed and labeled:

a. UL 508 – Industrial Control Equipment.

b. UL 508A – Industrial Control Panels.

2. NEMA ICS 2 – Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.

3. Combination starters shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 260000.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 260000.

1.09 SCHEDULING

A. Reduced voltage solid-state starters:

1. Submit certification that the RVSS will reliably accelerate and decelerate the driven load at the installed conditions as part of the equipment submittal.

2. RVSS start-up and testing by Manufacturer after connection to equipment.

3. RVSS training by Manufacturer after start-up and testing, and before plant commissioning.

1.10 WARRANTY

A. As specified in Section 26 00 00.

1.11 SYSTEM START-UP

A. As specified in Section 26 00 00.

B. RVSS:

1. Provide the services of the manufacturer's technical representative for start-up, adjustment, and troubleshooting, a minimum of 2 hours per starter at the Owner's facility.

1.12 OWNER’S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE

A. Spare parts:

1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:

a. One spare fuse of each size and type per starter.

b. One of each type of circuit board used in the RVSS starters, including but not limited to:

1). Control board.

2). Power board.

3). Bridge rectifier.

4). Inverter module.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. NEMA starters and contactors:
    a. Allen-Bradley.
    b. Schneider Electric/Square D.
    c. General Electric.
    d. Eaton/Cutler-Hammer.
    e. Siemens.
2. Reduced voltage solid state starters:
    a. Allen-Bradley.
    b. Eaton/Cutler-Hammer.
    c. General Electric.
    d. Benshaw.
    e. Schneider Electric/Square D.
    f. Siemens.
3. Manual motor starters:
    a. Schneider Electric/Square D.
    b. General Electric.
    c. Cutler-Hammer.
    d. Siemens.
4. Integral self-protected starters:
    a. Allen-Bradley.
    b. Schneider Electric/Square D.
    c. General Electric – Surion.
    d. Eaton/Cutler-Hammer.
    e. Siemens.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:

1. Provide combination type starters with motor thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
2. NEMA size, design, and rated:
    a. NEMA Size 1 minimum:
        1). With the exception of integral self-protected starters.
3. Coordinate thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor:
    a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.
6. Provide motor management devices.

B. Full voltage starters (FVNR):
1. Across-the-line full voltage magnetic starters.
2. Rated for 600 volts.
3. Electrical characteristics as indicated on the Drawings.
4. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.
5. Furnish starter with solid state smart electronic overload relays with SCADA interface. Provide monitored item as follows:
    a. Voltage.
    b. Current.
    c. Power.
    d. Status (on-off).
    e. I/O for control of motor management including load shedding capability.
    f. Phase failure protection.
6. Double-break silver alloy contacts.
7. Reversing starters provided with both mechanical and electrical interlocks to prevent line shorts and energizing both contactors simultaneously.

C. RVSS:
1. Manufactured and tested in accordance with the applicable requirements of IEEE, UL, and NEMA, including the following:
    a. Dielectric withstand per UL 508.
    b. Noise and RF immunity per NEMA ICS-2-230.
2. Furnish with a motor or thermal magnetic circuit breaker as indicated on the Drawings.

3. Provide protection against internal faults and high SCR temperature during operation of the motor including starting, running (except when bypassed), and stopping modes.
4. Capable of continuously delivering full rated current of the motor plus the motor service factor in ambient temperatures from 0 degrees Celsius to 40 degrees Celsius at the installed altitude.
5. Provide a magnetically operated bypass contactor in parallel with the solid- state starter:
    a. The bypass contactor to energize when the motor has reached full speed:
        1). The electronic overload protection circuits must be fully functional with the bypass contactor closed.
6. RVSS control module requirements:
    a. Microcomputer based, and contains the required circuitry to drive the power semiconductors in the power section of the starter.
    b. Integrally mounted on the power section and requires no additional panel space or wiring.
    c. Mounted for easy wiring, testing, service, and replacement.
    d. Provide 3-phase current sensing.
    e. Quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs, and SCR gate firing output circuits.
    f. Operates on power supplied from a control power transformer.
    g. Phase insensitive or with phase rotation protection.
    h. Control modes:
        1). Soft start with adjustable linear ramp time and a “kick start” or “boost” feature to provide a short time (typically 0.1 seconds) application of approximately full voltage.
        2). Soft start with adjustable linear ramp time, with a current limit:
            a). The current limit shall be adjustable over the range of 2 to 4 times normal full load current.
        3). Reverse voltage ramp (line voltage to zero voltage):
            a). Adjustable from 2 to 30 seconds to provide smooth stop.
            b). Automatic shutdown at end of voltage ramp.
    i. Protective functions:
        1). Single phase protection.
        2). Under voltage protection.
        3). Short circuit electronic trip overcurrent protection. Time not to exceed 3 cycles.
        4). Inverse time running overcurrent protection.
        5). Auxiliary trip circuitry.

6). Gate firing circuit lockout protection on trip.

7). Jam and stall detection.

8). Fault relay lockout protection.

9). 100 percent to 130 percent full load running current trip adjustment.

10). 100 percent to 450 percent of starting current limit adjustment.

11). Dwell time at current limit with ramp continuation after acceleration.

12). Individual light emitting diodes (LEDs) for trip and phase loss.

13). Minimum and maximum initial starting voltage adjustments.

14). Initial torque adjustment.

7. RVSS power section requirements:

   a. 3 sets of back-to-back phase controlled power semiconductors:

      1). Minimum repetitive peak inverse voltage of 1,500 volts at 480 VAC.

      2). Resistor/capacitor snubber networks to prevent false firing of the SCRs.

      3). Equipped with individual heat sink assemblies.

      4). Provide high-speed fuses for protection of the SCR stacks against short circuit conditions.

   b. Provide metal oxide varistors for surge protection on the line and load side power terminal connections:

      1). Rated for a minimum of 120 joules.

   c. Capable of supplying the following current levels:

      1). 600 percent of full load current for a minimum of 10 seconds.

      2). 450 percent of full load for a minimum of 30 seconds.

   d. Furnish ground lugs, one for incoming and one for outgoing ground connections.

   e. Furnish pressure type terminals for top or bottom entry power terminations.

8. Remote indicators:

   a. Provide Form C dry contacts for remote indication of:

      1). Internal fault error.

      2). Undervoltage.

      3). Overvoltage.

      4). Phase reversal.

      5). Phase loss.

      6). Overload.

      7). Frequency out of range.

      8). Excessive starts per hour.

9). Drive electronics over temperature.

10). Stall.

11). Jam.

12). System failure.

13). Starter failure.

14). Run status.

15). Full speed.

b. Provide SCADA Interface to indicate on-off status. Starter shall be furnished with native EtherNet/IP communication card.

9. Metering: Provide the following inputs to the SCADA system at each starter.

a. 3-phase motor current.

b. Power in kW.

c. Power factor.

d. Three-phase voltage.

e. Power usage in kWh.

10. Phase re-balance:

a. Continuously monitor the incoming 3-phase line voltage balance and adjust the output voltage to automatically balance the 3-phase currents supplied to the motor.

D. Manual motor starters:

1. General:

a. Provide with number of poles as indicated on the Drawings or as required by the connected load.

b. Provide handles that clearly indicate the ON and OFF (with lockout), positions.

c. Switch shall have positive, quick-make, quick-break mechanisms.

2. Thermal overload switches:

a. Provide thermal overloads in manual motor starters where integral overloads are not furnished with the motor.

b. Size heater elements for approximately 115 percent of the nameplate full- load current, for motors with a 1.15 service factor.

c. Thermal overload units in all phase legs.

d. Overload conditions interrupts all ungrounded conductors.

3. Enclosure:

a. Provide the NEMA enclosure type called for in the drawings and other pertinent sections of the specifications.

E. Integral self-protected starters (for actuated gates and valves):

1. IEC rated device consisting of:
    a. Circuit breaker.
    b. Contactor.
    c. Dual-function overload relay.
2. Designed to use the same contacts for contactor and breaker operation:
    a. Contactor and breaker operations shall be independent of each other.
3. Ratings:
    a. Voltage: 480 VAC.
    b. Current:
        1). 18 amps.
        2). 32 amps.
        3). 63 amps.
4. Furnish overload relay modules capable of independently adjustable thermal and magnetic trips:
    a. Provide one normally open and one normally closed contact associated with motor overload contact block per starter.
5. Provide surge protection devices across the coil of each magnetic starter.
6. Furnish local status indication.
7. Terminal wiring located behind recessed plastic housing.
8. DIN rail mounted.
9. With molded bus structure for line side power bussing.
10. Minimum life expectancy:
    a. 1.5 million operations.
    b. After interrupting 100 times rated current ten times, minimum expected life shall not be less than 0.5 million operations.
11. UL 508, Category E listed and labeled.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Molded case circuit breakers:
    1. Circuit breaker and ratings as indicated on the Drawings.
    2. Provide as specified in Section 26 28 11.
B. Contactors:
    1. NEMA size as indicated on the Drawings.

2. Electrically held:
    a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
3. Factory adjusted and chatter free.
4. Auxiliary contacts:
    a. Contact ratings as per NEMA A 600 rating:
        1). Auxiliary contacts rated 10 amps at 600 volts.
    b. Provide all contacts indicated on the Drawings, and any additional contacts required for proper operation.
    c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
5. Constructed in accordance with the following standards:
    a. UL 508.
    b. IEC 947-4.
        1). Type 1 coordination when protected by a circuit breaker.
        2). Type 2 coordination when protected by a suitable UL listed fuse. c. IEC 801-1 parts 2 through 6.

C. Overloads:
1. Solid state electronic with communications:
    a. Selectable Class 10.
    b. Ambient insensitive:
        1). Operating temperature: -20 to 70 degrees Celsius.
    c. Thermal memory.
    d. Protective functions:
        1). Motor overcurrent.
        2). Phase unbalance (adjustable).
        3). Phase loss.
        4). Ground fault:
            a). Provide zero sequence current transformer where indicated on the Drawings.
    e. 120 VAC powered.
    f. Provide current transformers for metering of motor current.
    g. Visible trip indicator.
    h. Push-to-trip test.
    i. Isolated normally open alarm contact.

j. Normally closed trip contact.

k. Automatic reset.

l. Communications:

1). Ethernet/IP.

D. Control power transformer:

1. Furnish integral control power transformer capacity to power:

a. All motor controls indicated on the Drawings.

b. Motor winding heaters, through a normally closed auxiliary contact on the starter.

c. Cabinet heater.

2. Primary and secondary fusing as indicated on the Drawings:

a. Fusing sized by the Manufacturer for the rating of the transformer furnished.

3. Control power transformer secondary voltage: as required.

a. 120 VAC.

E. Enclosures for individually enclosed starters:

1. NEMA type specified for the location as specified in Section 26 00 00:

a. Where not specified, provide NEMA Type 12 enclosure for indoor dry location, NEMA Type 4X enclosures for outdoor, wet, or corrosive areas.

2. Flange-mounted handle mechanism to operate disconnect switch or circuit breaker:

a. Door mounted operators or operator handles are not acceptable.

b. Handle mechanism features:

1). Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.

2). Lockable in the OFF position.

3). Mechanically interlocked so that the disconnect cannot be switched to the ON position with the door open:

a). Provide a means for qualified personnel to defeat this interlock during maintenance and testing.

4). Lockable in the ON position:

a). This feature shall not prevent the circuit breaker from operating during a fault condition.

3. Provide a thermostatically controlled space heater for equipment located outdoors or in unheated areas:

a. Powered from the starter or integral control power transformer.

2.07 ACCESSORIES

A. Lugs and terminals:

1. For all external connections of No. 6 AWG and larger.
2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:

1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:

1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.
2. As specified in Section 40 61 16.

D. Ethernet/IP input/output module:

1. Provide starters with Ethernet/IP input/output module.
2. Minimum input/output requirements:
    a. 2 outputs.
    b. 4 inputs.

E. Nameplates and wire markers:

1. As specified in Section 26 05 53.

F. Conformal coating:

1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H2S and chlorine.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. RVSS starters:

1. The Manufacturer of the respective RVSS starter shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards.
2. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.
3. The RVSS starter Manufacturer shall test for noise immunity on both input and output power connections and provide test results to the Engineer. Noise testing shall be performed in accordance with NEMA ICS 2-230.40.

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26 00 00.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. Starters in motor control centers:

1. Install as specified in Section 26 24 16.

D. Starters in control panels:

1. Install as specified in Section 40 61 16.

E. Individually enclosed starters:

1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, mounting structures and other accessories needed to completely install the starters.

2. Assemble and install the starters in the locations and with the layouts indicated on the Drawings.

3. Install floor-standing starters on a 3-1/2 inch raised concrete housekeeping pad:

a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.

b. Weld and/or bolt the starter frame to the leveling channels.

4. Install wall mounted starters as specified in Section 26 05 29.

5. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:

a. Mis-cut holes will require that the entire enclosure or removable panel be replaced. No hole closers or patches will be allowed.

6. Bundle circuits together and terminate in each unit:

a. Tie with nylon wire ties as specified in Section 26 05 19.

b. Label all wires at each end with wire numbers shown on the approved control drawings.

c. Make all connections to and from the motor starter via terminal blocks.

7. Furnish all mounting brackets, stands, etc. that may be required to physically mount the motor starter.

F. Manual motor starters:

1. Provide complete mounting brackets and hardware as necessary for complete support of manual motor starter at locations indicated on the Drawings.

2. Mount manual motor starter rigidly to exposed building or equipment structural members.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00.

3.08 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Set all overloads and motor circuit protectors based on the nameplate values of the installed motor.

3.09 CLEANING

A. As specified in Section 26 00 00.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 26 00 00.

B. Demonstrate operation of equipment as specified in Section 26 08 00:

1. Demonstrate the operation of every motor starter to the Engineer's and Owner's satisfaction.

C. Training:

1. Provide the services of the Manufacturer’s technical representative for training purposes:

a. RVSS starters: Minimum of 8 hours at the Owner’s facility.

3.11 PROTECTION

A. As specified in Section 26 00 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION

26 33 53 CONTROL SYSTEMS – UNINTERRUPTABLE POWER SUPPLIES 10KVA AND BELOW

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Single-phase double conversion uninterruptible power supplies rated 10 kilovolt-amperes and below.

B. Related sections:

1. Submittal Procedures.
2. Section 26 00 00 – General Electrical Requirements
3. Section 26 05 53 – Electrical Identification.
4. Section 26 43 13 – Surge Protective Devices.
5. Section 26 05 73 – Electrical System Studies.
6. Section 40 61 13 – Process Control System General Provisions
7. Section 40 61 16 – Control Panels
8. Other Pertinent Sections

1.02 REFERENCES

A. Federal Communications Commission (FCC):

1. FCC Part 15, Class A.
2. FCC Part 15, Class B.

B. Institute of Electrical and Electronic Engineers (IEEE):

1. 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
2. 1184 - IEEE Guide for Batteries for Uninterruptible Power Supply Systems.
3. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. Underwriters Laboratories, Inc. (UL):

1. UL 1778 - Standard for Uninterruptible Power Supply Systems and Equipment.

1.03 DEFINITIONS

A. Specific definitions:

1. Critical load: Load supplied by the UPS.
2. MOV: Metal oxide varistor.

1.04 SYSTEM DESCRIPTION

A. Provide complete, factory-assembled, wired, and tested, true on-line double conversion UPS equipment including, but not limited to, rectifier, DC bus, inverter, battery charger, batteries, automatic bypass, and ancillary components as specified herein and as indicated on the Drawings.

B. UPS loads as indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified.

B. Product data:

1. Manufacturer and model number.
2. Catalog data.
3. Dimensions:
    a. Height.
    b. Width.
    c. Depth.
    d. Weight.
4. Ratings:
    a. Input voltage.
    b. Output voltage.
    c. Input/output power factor.
    d. Efficiency.
    e. Harmonic distortion.
    f. Runtime.
5. Noise specifications.
6. Heat dissipation.
7. Warranties and maintenance contracts:
8. All communications requirements such as software, cards, etc.
9. Alarms and status available for remote monitoring and system health.

C. Shop drawings:

1. Power distribution block diagrams.
2. Front and rear views of equipment enclosures:
    a. Front elevation including all control and indicating devices.
3. Support points and weight of overall equipment.

4. Schematic and control wiring diagrams including, but not limited to:
    a. Line and load terminals.
    b. Alarm and status terminals.
    c. Manual maintenance bypass switch terminals.
    d. External wiring requirements for all communication signals.
5. Switching and overcurrent protective devices.

D. Calculations:
1. Include derating for temperature and elevation as necessary.
2. UPS sizing computation:
    a. Apply safety factors as specified in this Section.
    b. Provide itemized list of critical loads, including individual VA and watt ratings.
3. Battery time calculation based on specified runtime.
4. Total battery recharge time as a function of capacity utilized.

E. Design data:
1. Design mounting and anchorage for seismic design criteria specified:
    a. Provide seismic kits as required to meet design criteria.

F. Record documents:
1. Provide Record Drawings of installed unit(s) including layout and wiring.

G. Manufacturer’s field reports.

H. Operation and maintenance manuals:
1. System instruction manuals that describe troubleshooting, installation, operations, and safety procedures.
2. Recommendations for maintenance procedures and intervals.
3. Battery data/replacement information.
4. Parts list.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications:
1. A minimum of 10 years' experience in the design, manufacture, and testing of solid-state UPS systems.
2. ISO 9001 certified.

B. Regulatory requirements for complete UPS system:
1. UL listed per UL Standard 1778
2. IEEE C62.41, Categories A & B.

3. FCC 15:
    a. Greater than 2,000 VA - Class A.
    b. Less than 2,000 VA - Class B.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. Double-conversion true-online UPS manufacturers, one of the following or equal:
    1. Rack-mounted UPS, 700-3,000 VA:
        a. Emerson Network Power - Liebert GXT3 (700 - 3,000 VA).
        b. Eaton Corporation - Powerware 9130 RM (700 - 3,000 VA).

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Double conversion true on-line UPS system requirements:
    1. System characteristics:
        a. UPS as specified and as required by the installation and/or indicated on the Drawings.

b. The minimum VA rating of the UPS shall be greater than or equal to the safety factor (as indicated in the UPS schedule) times the connected load or 700 VA, whichever is greater.

c. Battery runtime at full load and site ambient temperature as indicated in the UPS schedule.

d. Efficiency greater than 85 percent AC-AC, all modes.

e. Acoustical noise:

1). Less than 55 dBA at 5 feet.

f. Output connections:

1). Receptacles:

a). 700-2,500 VA units:

(1). Provide a minimum of four NEMA Type 5-15R or Type 5-20R receptacles.

b). 3,000 VA units:

(1). Provide a minimum of four NEMA Type 5-20R receptacles.

(2). Provide at least one NEMA Type L5-30R receptacle.

c). Greater than 3,000 VA units:

(1). Provide a minimum of four NEMA Type 5-20R receptacles.

(2). Provide at least one NEMA Type L14-30R receptacle.

2). Provide hardwired connections as indicated on the Drawings.

g. Protection:

1). Undervoltage:

a). Operate on battery power if incoming source voltage goes below UPS system limits of operation.

2). Overvoltage:

a). Operate on battery power if incoming source voltage exceeds UPS system limits of operation.

3). Overcurrent:

a). Provide input and output current-limiting protection to ensure adequate overcurrent protection for UPS.

4). Surge protection:

a). MOV-based.

2. Electrical characteristics:

a. AC input:

1). Single phase.

2). Voltage as indicated in the UPS schedule.

a). Fully functional within +10 percent, -15 percent of nominal voltage at full load without depleting battery.

b). 120 V input:

(1). 2-wire plus ground.

c). 208/120 V or 240/120 input:

(1). 3-wire plus ground.

3). Current:

a). Reflected total harmonic distortion (THD) less than 25 percent at rated load.

4). Frequency range of operation:

a). 57-63 hertz.

5). Power factor:

a). Not less than 0.95 lagging at rated load.

b. AC output:

1). Single phase.

2). Voltage:

a). Regulation:

(1). ?3 percent for 3,000 VA rating and below.

(2). ?5 percent for greater than 3,000 VA rating - static load.

(3). ?10 percent for greater than 3,000 VA rating – dynamic load.

b). b) Total harmonic distortion (THD) when operating on incoming power:

(1). Not more than 3 percent for linear loads with a crest factor of 3:1.

(2). Not more than 5 percent for non-linear loads with a crest factor of 3:1.

c). Transient response:

(1). Within 7 percent for a 20-100 percent step load.

(2). Transient recovery time to nominal voltage within 166 milliseconds.

3). Load power factor:

a). UPS shall be capable of supporting the critical loads for all power factors experienced for their full range of operation.

4). Frequency regulation:

a). Within 3.5 hertz when on utility power.

b). Within 1.0 hertz when on UPS power.

3. Environmental requirements:

a. Operating ambient temperature:

1). UPS module: 50 degrees Fahrenheit to 104 degrees Fahrenheit (10 degrees Celsius to 40 degrees Celsius).

2). Battery: 68 degrees Fahrenheit to 86 degrees Fahrenheit (20 degrees Celsius to 30 degrees Celsius).

b. Operating altitude:

1). Project site conditions as specified in Sections 16050 and 17050

4. System components:

a. Surge protective devices:

1). MOV-supplied protection.

b. Inverter:

1). Pulse-width modulated AC output signal.

2). Overload withstand minimum time without transferring to bypass:

a). 101 to 110 percent for 2 minutes.

b). 111 to 125 percent for 10 seconds.

c). 126 to 150 percent for 1 second.

d). Greater than 150 percent for 96 milliseconds.

3). Transfer load to bypass when overload capacity is exceeded.

c. Battery rectifier/charger:

1). Recharge batteries to 90 percent in 6 hours or less.

d. Batteries:

1). VRLA (valve regulated lead acid), sealed, maintenance free.

2). Minimum 3-year float service life at 25 degrees Celsius.

3). Integral to UPS enclosure or housed in a matching enclosure.

4). Less than and including 6,000 VA: Hot-swappable.

5). Automatically perform routine battery health monitoring and provide visual, audible, and/or serial warnings if abnormal battery conditions exist.

e. Automatic bypass switch:

1). Integral to UPS system.

2). Sense UPS overload, inverter failure, or overtemperature, and automatically transfer loads to source power.

3). Maximum detect and transfer time of 4-6 milliseconds.

4). Automatic re-transfer without power interruption to critical load.

5). Input shall match output in phase, voltage, frequency, and grounding.

6). Rated to carry the full input current of the UPS.

7). Provide ability for manual operation.

f. Manual maintenance bypass switch:

1). Provides isolation of the UPS for maintenance purposes.

2). Make-before-break design so that UPS can be isolated from the critical loads by placing these loads on source power without interruption of operation.

3). Utility and UPS status indications.

4). Supply necessary input/output cords and receptacles for connections with power source and UPS.

5). Transfer time less than 6 milliseconds.

6). Rated to carry the full input current of the UPS.

7). Standalone UL-listed.

8). Input match output in phase, voltage, frequency, and grounding.

9). UPS input connection and UPS output plug:

a). 700 to 3,000 VA units: NEMA receptacle and plug to match UPS connections.

b). Above 3,000 VA units: NEMA receptacle and plug or hardwiring to match UPS connections.

10). Utility and load connections:

a). As indicated on the Drawings.

11). 700 to 3,000 VA units: One of the following or equal:

a). Liebert Micropod 2U.

b). Powerware Powerpass 9125.

12). Above 3,000 VA units: By manufacturer of UPS, with connections matched for operation with UPS.

g. UPS chassis:

1). Electrically isolate from AC output neutral.

2). Include an equipment ground terminal.

h. Cooling:

1). Forced air cooled.

i. Locally displayed system indicators:

1). Audible alarms during abnormal conditions:

a). UPS fault or overload condition.

b). Battery on.

c). Low battery.

d). Automatic bypass on/off.

e). Input power on.

f). Battery testing mode.

j. Controls:

1). Front-panel pushbuttons:

a). UPS start-up, shutdown, and manual bypass (for automatic bypass).

b). Testing.

c). Visual/audible alarms reset.

2). Applicable controls as specified in Communications Requirements.

k. Alarm contacts:

1). Provide relay interface card and required interposing relays for 120 VAC discrete input status signals:

a). Low battery.

b). UPS alarm.

c). On UPS power.

l. Communications requirements:

1). RS-232.

B. Rack-mount Standby UPS requirements:

1. Provide rack-mount UPS as specified and as indicated on the Drawings.

2. The minimum VA rating of the UPS shall be greater than or equal to the safety factor (as indicated in the UPS schedule) times the connected load or 700 VA, whichever is greater.

3. Battery runtime at full load and site ambient temperature as indicated in the UPS schedule.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Do not utilize extension cords, adapters, or other electrical connectors for UPS input.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. Perform inspections and test procedures before UPS startup:

1. Inspect equipment for signs of damage.
2. Verify installation as indicated on the Drawings and specified in the Specifications.
3. Inspect cabinets for foreign objects.
4. Verify neutral and ground conductors are properly sized and terminated.
5. Inspect battery cases.
6. Inspect batteries for proper polarity.
7. Check power and control wiring for tightness.
8. Check terminal connectors for tightness.
9. Assure connection and voltage of the battery string(s).

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified.

END OF SECTION

26 43 13 SURGE PROTECTION DEVICES

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. High-energy surge protective devices.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

a. Submittal Procedures.

b. Section 26 00 00 – Common Work Results for Electrical.

c. Section 26 05 53 – Electrical Identification.

d. Section 26 05 73 – Electrical System Studies.

e. Section 40 61 13 – Process Control System General Prvisions

f. Section 40 61 16 – Control Panels

g. Other Pertinent Sections

1.02 REFERENCES

A. As specified in Section 26 00 00.

B. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

2. C62.45 –Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.

3. C62.62- Standard Test Specifications for Surge Protective Devices for Low- Voltage AC Power Circuits.

C. Underwriters Laboratory:

1. 1449, 3rd Edition, Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 26 00 00.

B. Specific definitions:

1. SPD: Surge protective device.
2. SAD: Silicon avalanche diode.
3. MOV: Metal oxide varistor.
4. MCOV: Maximum continuous operating voltage.
5. In: Nominal discharge current.
6. VPR: Voltage protection rating.
7. SCCR: Short circuit current rating.

1.04 SYSTEM DESCRIPTION

A. Surge protective devices as an integral component of the electrical equipment.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26 00 00 and other pertinent sections of plans and specifications.

B. Product data:

1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
2. Manufacturer's catalog cut sheets indicating:
   a. Manufacturer and model numbers.
   b. Ratings of each SPD including but not limited to:
      1). Short circuit current rating.
      2). Nominal discharge current.
      3). Maximum continuous operating voltage.
      4). Voltage protection rating.
      5). System voltage.
      6). System frequency.
      7). Surge current capacity.
3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
   a. Overcurrent protection.
   b. UL 1449.

C. Shop drawings:

1. Provide electrical and mechanical drawings by the manufacturer that detail:
    a. Unit dimensions.
    b. Weights.
    c. Components.
    d. Field connection locations.
    e. Mounting provisions.
    f. Connection details.
    g. Wiring diagram.

D. Operation and maintenance manuals:
    1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

A. As specified in Section 260000 and other pertinent sections of plans and specifications.

B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
    1. Institute of Electrical and Electronics Engineers (IEEE C62.41, C62.45, C62.62).
    2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
    3. National Electrical Manufacturer Association.
    4. National Fire Protection Association (NFPA 20, 75 and 780).
    5. National Electric Code (NFPA 70).
    6. Underwriters Laboratories (UL 1449 3rd Edition and UL 1283).
    7. International Electrotechnical Commission (IEC 801).

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 260000 and other pertinent sections of plans and specifications.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00 and other pertinent sections of plans and specifications.

1.09 SEQUENCING

A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 00 00 and other pertinent sections of plans and specifications.

B. Extended warranty:

1. Furnish a manufacturer’s full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.

2. Warranty shall include:

a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.

b. A 24-hour toll-free 800-number for warranty support.

1.12 SYSTEM START-UP

A. As specified in Section 26 00 00 and other pertinent sections of plans and specifications.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Eaton Cutler Hammer
2. Schneider Electric/Square D
3. General Electric
4. Siemens

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Provide units as required for the locations indicated on the Drawings.

B. Electrical requirements:

1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.

2. MCOV:

a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.

3. Operating frequency:

a. 47 to 63 hertz.

4. SCCR:
   a. 100 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
   b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
5. Nominal discharge current In:
   a. 20 kA.
6. Maximum VPR:

Modes	240/120	208Y/120	480Y/277
L-N, L-G, N-G	900	900	1,500
L-L	1,800	1,200	2000

7. Peak surge current:
   a. Service entrance switchboard locations:
      1). 300 kA per phase minimum.
      2). 120 kA per mode minimum.
   b. Switchboards and IMCC (Intelligent Motor Control Centers)
      1). 200kA per phase minimum switchboard.
   c. Panel locations:
      1). 150 kA per phase, minimum.
      2). 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.
      d. Directly connected MOV(L-L), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 degrees to +50 degrees Celsius.
   2. Operating temperature:
      a. -0 degrees to +60 Celsius.
   3. Relative humidity:
      a. 5 percent to 95 percent.

4. Audible noise:
    a. Less than 45 dBa at 5 feet (1.5 m).
5. Operating altitude:
    a. Zero to 12,000 feet above sea level.

E. Provide surge protective devices that are suitable for application in IEEE C62.41. Entrance as tested to IEEE C62.45.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Enclosure:
1. Located in electrical equipment as indicated on the Drawings.
2. External mounting:
    a. NEMA Type 12 enclosure:
        1). No ventilation openings.
    b. Hinged cover requiring a tool for internal access.
    c. Internal drawing pocket.
    d. All monitoring indications must be visible without opening the door.

B. Internal connections:
1. Provide low impedance copper plates for intra-unit connections:
    a. Attach surge modules using bolted connections to the plates for low- impedance connections.
    b. Size all connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
1. MOV:
    a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
1. Individually fuse all components, including suppression, filtering, and monitoring components:
    a. Rated to allow maximum specified nominal discharge current capacity.
    b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.07 ACCESSORIES

A. Unit status indicators:

1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:

a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.

b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:

1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition.

1. Provide an alarm On/Off switch to silence the alarm.

2. A visible LED will confirm whether alarm is On or Disabled.

3. Locate both switches and the audible alarm on the unit's front cover.

D. Provide transient counter to count transient voltage surges:

1. LCD readout located on the unit's front cover.

2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.

3. If a dedicated breaker for the SPD is not provided in the switchboard, the service entrance SPD shall include an integral UL listed disconnect switch. A dedicated breaker shall serve as means of disconnecting for distribution SPDS.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

B. Perform Manufacturer's standard factory test.

1. Perform testing in accordance with UL 1449.

3.00 PART 3 EXECUTION

3.01 3.01 EXAMINATION (NOT USED)

3.02 3.02 PREPARATION (NOT USED)

3.03 3.03 INSTALLATION

A. As specified in Section 26 00 00 and other pertinent sections of the plans and specifications.

B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

C. Special techniques:

1. Install the SPD with as short and straight conductors including ground conductor as practically possible:

a. Twist the input conductors together to reduce input conductor inductance.

2. Interconnect the SPD to the power system using a Manufacturer-supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.

3. Do not subject SPD to insulation resistance testing.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified.

3.12 SCHEDULES (NOT USED)

END OF SECTION

DIVISION 31

EARTHWORK

31 05 23.13 SOIL CEMENT

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to place soil cement. Soil cement shall consist of sandy soil, Portland cement, fly ash, and water uniformly mixed, placed, compacted, finished, and cured in accordance with these specifications. The soil cement shall be constructed to the lines, grades and dimensions indicated or established by the Engineer.

1.02 QUALITY ASSURANCE

A. Owner Testing:

1. The Owner will prepare durability and other tests (using PCA-Soil Cement for Water Control: Laboratory Tests) to determine the amounts of soil, cement, fly ash, and water to be utilized. If a durable soil cement cannot be produced from the proposed soil with at most 12 percent cement content or a 10 percent cement and 3 percent fly ash content, even though material passed all other tests, the soil shall be rejected and the Contractor must find another source at no additional cost to the Owner. The cement and fly ash content is expressed as the percent of dry weight of sandy soil only, not of the total weight.

2. The Owner will perform density and moisture tests on the soil cement. Soil cement shall meet the requirements outlined in Paragraph 3.04.B. Any material not meeting the requirements shall be removed and replaced at no additional cost to the Owner.

B. Quality Control Program: The Contractor shall establish and maintain an effective quality control program for soil cement which is a means of ensuring compliance with contract requirements and of maintaining records of control. The program shall include, but not be limited to the following: sand source, gradations, moisture, batching requirements, and mix proportions at the batch plant or batch-type pugmill, ensuring adequate materials are on hand, and other tests and inspections required by these specifications.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Placement plan showing which areas of soil cement shall be placed in which sequence.

2. Certified test results for sand including sieve analysis and Atterburg limits.

3. Pugmill plant calibration tests.

4. Qualification of plant operator, soil cement placement foreman, and quality control testing supervisor.

5. Construction techniques shall be submitted by the Contractor before construction of any permanent soil cement section can be started. All mix designs and materials testing shall be completed prior to construction technique submittals.

6. Mix design test results from Independent Testing Laboratory. A minimum of six (6) combinations of cement/fly ash shall be tested.
7. Test results shall include compressive strength and wet-dry durability tests for each of the six mix design combinations.
8. Certified test results shall be submitted and the mix design shall be selected by the Engineer.

1.04 STANDARDS

A. The applicable provisions of the following standards shall apply as if written herein in their entirety:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C94	Specification for Ready-Mixed Concrete
ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150	Specification for Portland Cement
ASTM C618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM D558	Test Method for Moisture-Density Relations of Soil-Cement Mixtures
ASTM D559	Wetting and Drying Tests of Compacted Soil-Cement Mixtures
ASTM D560	Freezing and Thawing Tests of Compacted Soil-Cement Mixtures
ASTM D1632	Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
ASTM D1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D4318	Test Method for Liquid, Plastic Limit, and Plasticity Index of Soils

2. Portland Cement Association (PCA) Publication:

a. PCA - Soil Cement for Water Control: Laboratory Tests.

1.05 DELIVERY AND STORAGE

A. Do not stockpile soil until the soil cement materials are tested and accepted in accordance with Paragraph 1.02.

1.06 JOB CONDITIONS

A. Mixing Plant: Soil cement shall be central-plant mixed in an approved continuous-flow or batch-type pugmill. The plant shall be equipped with metering and feeding devices that add the soil, cement, fly ash, and water into the mixer in the specified quantities. The plant shall be equipped with sufficient scales and/or other measuring devices to verify that the specified amounts of soil, cement, fly ash, and water are utilized. Belt weigh scales shall be used for soil, cement, and fly ash. Before all measurement devices are used, they shall be calibrated by a qualified technician approved by the Engineer. The Engineer may order additional measuring devices if deemed necessary at no additional cost to the Owner. If the actual quantities of the mix vary more than 1 percent by weight of the specified quantities,

plant operations shall be modified to provide the required accuracy. The minimum capacity of the plant shall be 300 tons per hour.

B. Soil Cement:

1. Scales and metering devices shall be calibrated and certified on the site after batch plant is installed. Scales shall be certified at least twice per year. Metering devices shall be recalibrated as often as needed to verify accuracy.

2. Soil, cement, and fly ash shall be mixed sufficiently to prevent balls from forming when water is added. The mixing time shall be that which is required to secure an intimate, uniform mixture of the soil, cement, fly ash, and water. At the completion of moist mixing, the soil shall be so pulverized that 100 percent of the mixture passes a 2-inch sieve and at least 80 percent by dry weight passes a No. 4 sieve. The moisture in the soil cement material after mixing shall be such that the material shall have the specified moisture content during compaction. No additional soil, cement, fly ash, or water shall be added after mixing.

3. The mixing plant shall produce a mixture of soil, cement, and water which is uniform in color and at the required moisture and cement content.

4. Compressive Strength Requirements: 1,500 psi at 28 days as per ASTM D1633.

5. Wet-dry tests shall result in a loss of less than 10 percent in accordance with ASTM D559. For cold weather areas freeze-thaw tests shall result in a loss of less than 10 percent in accordance with ASTM D560.

C. Inspection of Plant:

1. The cement content shall be determined by the plant scales and metering devices and may be verified by the Owner by testing.

2. The Engineer shall have access at all times to all parts of the plant for checking the adequacy of the equipment in use, for inspecting operation of the plant and for verification of weights, or proportions or character of material. The Engineer shall be notified 5 days prior to the calibration of the plant or scales or recalibration.

D. Take the necessary precautions to avoid damage to completed soil cement by the equipment and to avoid the deposition of raw earth or foreign materials between layers of soil cement. Earth ramps crossing completed soil cement must have at least 2 feet compacted thickness. Any damage resulting to the soil cement shall be repaired at the expense of and by the Contractor at the direction of the Engineer.

2.00 PRODUCTS

2.01 MATERIALS

A. Cement: As specified in the Materials portion of Section 03 30 00 “Cast-In-Place Concrete.”

B. Water: Free from objectionable quantities of organic matter, alkali, salts, and other impurities deleterious to the hardening of soil cement. When tested in accordance with ASTM C94, water shall give 28-day strengths that are at least 90 percent of the strength of a companion control sample made with distilled water. The set time shall not be less than 1 hour or greater than 1-1/2 hours of the control sample.

C. Fly Ash: As specified in the Materials portion of Section 03 30 00 “Cast-In-Place Concrete.” Pozzolans, such as fly ash, if used, shall comply with the specifications for fly ash and other pozzolans (ASTM C618). The amounts of cement and pozzolan required shall be determined by tests made with the specific cement type, pozzolan, and soil to be used. If fly ash is specified, the amount and cement substitution rate shall be determined using PCA tests - Soil Cement for Water Control: Laboratory Tests.

D. Soil: Soil shall consist of approved select sandy materials. The soil shall not contain any material deleterious to its reaction with cement. The soil shall have a plasticity index of less than three when tested in accordance with ASTM D4318. The soil shall meet the following gradation limits when tested in accordance with ASTM C136:

Sieve Size	Percent Passing
2”	100
1-1/2”	98-100
No. 4	50-80
No. 40	40-70
No. 200	5-20

E. The distribution and gradation of materials in the soil cement shall be such that no lenses, pockets, streaks or layers of material differ substantially in texture or gradation from the surrounding material. Clay lumps larger than 1 inch, or lightly cemented nodules larger than 1/2 inch, shall be pulverized to pass a No. 4 sieve or screened out of the raw soil prior to mixing.

F. Material from stockpiles and/or pits shall be excavated in successive vertical cuts extending across the stockpile or pit. All pockets or strata of unsuitable material not meeting the specification shall be rejected and wasted. The method of operating the pit or stockpile and the blending of material shall be adjusted as necessary to obtain material conforming to the specifications.

2.02 EQUIPMENT

A. Compaction Equipment: Equipment for compacting the soil cement mixture shall be suitable for the purpose of obtaining the specified density uniformly through the layer being compacted without damage to underlying layers of soil cement. Vibratory rollers, as described in Section 35 73 13.16 “Compacted Fill [Dams]” shall be used on layers placed parallel to the slope.

B. Spreading Equipment: Equipment for spreading the soil cement mixture shall be suitable for the purpose as approved and shall be operated in such manner as to produce a reasonably smooth uniform surface.

3.00 EXECUTION

3.01 PREPARATION

A. Prior to beginning placement, the Contractor shall develop and submit a placement plan showing the prepared plan and sequence for placement.

B. Before soil cement processing begins, grade and shape the area to be covered with soil cement as necessary to construct the soil cement in conformance with lines, grades, thicknesses, and cross-sections indicated. The embankment shall be firm and able to support the construction equipment and the soil cement layers without yielding or subsequent settlement and within the moisture content range specified in Section 35 73 13.16 “Compacted Fill [Dams].” The surface shall be rolled by one pass of the specified roller prior to placing soil cement. Immediately prior to the placement of the soil cement, the receiving surface shall be sprinkled with water to leave the surface in a moist condition.

C. Prior to beginning placement the Contractor shall develop and submit a placement plan showing the proposed plan for soil cement placement.

3.02 TRANSPORTING

A. Transport the soil cement mixture from the mixing plant in clean equipment provided with suitable protective devices for use in unfavorable weather. The total elapsed time between the addition of water to the mixture and the start of compaction shall be the minimum possible. Haul time shall not exceed 30 minutes, and compaction shall start as soon as possible after spreading. In no case, shall the total elapsed time from mixing to completion of compaction exceed 60 minutes. The mixture shall not be left undisturbed for longer than 30 minutes at any time during this period.

B. Equipment shall not be operated on finished soil cement except where specifically permitted. Any damage resulting to the finished surface of the soil cement from such an operation shall be repaired by the Contractor at no cost to the Owner.

3.03 PLACEMENT

A. General:

1. Soil cement shall not be placed until the required excavations and preparation of the subgrade are completed and the subgrade has been inspected and approved by the Engineer.

2. Place soil cement in either horizontal layers or in layers parallel to the slope as indicated.

3. Soil cement placement operations may commence when the air temperature is not less than 40 degrees Fahrenheit and a rising temperature is expected for the work period. Soil cement shall not be placed on a frozen foundation or if the soil to be processed is frozen or if the weather conditions are such that the material being processed is frozen or if weather conditions are such that the material being processed cannot be completely compacted and protected before the onset of damaging weather (overnight lows below 40 degrees Fahrenheit, cold fronts, rainstorms). The temperature of the soil cement shall not be allowed to drop below 32 degrees Fahrenheit for seven (7) days after placement. If temperatures are expected to be below 45 degrees Fahrenheit, the Contractor’s method for protection shall be approved by the Engineer before placement of any soil cement.

4. When the mean air temperature does not exceed 90 degrees Fahrenheit, the moisture content at the time of compaction shall be within the range specified. When the mean air temperature exceeds 90 degrees Fahrenheit or conditions promoting rapid drying of

the soil cement mixture exist, the moisture content of the mixture may be increased up to 2 percentage points above optimum unless otherwise specified. Any increase in moisture content shall be less than the quantity that causes the soil cement to become unstable during the compaction and finishing operations.

3.04 COMPACTION

A. General: At the start of compaction, the soil cement mixture shall be in a uniform, loose condition throughout the full depth. Proceed with the compaction and spreading so that the length of time from mixing to completion of compaction does not exceed 1 hour. When any of the compaction operations are interrupted prior to completion of compaction so that the mixture which has not been completely compacted is left unfinished for more than 30 minutes for any reason, or when the soil cement mixture, before completion of compaction, is wetted by rain so that the average moisture content exceeds the tolerance at the time of final compaction, remove and replace the entire layer affected in accordance with these specifications at the expense of the Contractor and no payment shall be made for cement used in the removed material. If, in the opinion of the Engineer, the surface of a layer of soil cement has been rutted or compacted by hauling equipment sufficiently to reduce the effectiveness of compaction by the roller, scarify the surfaces as ordered, prior to compacting. Excess soil cement material not compacted with the lift or removed from the lift after compaction shall be wasted.

B. Density and Moisture: Uniformly compact the soil cement to an average of (10 test running average) 98 percent of maximum density. The minimum density of any test shall be 95 percent of maximum density. The moisture content at the time of compaction shall be between 1 percent dry and 2 percent wet of optimum. The moisture content shall in any case be less than that which causes the soil cement to become unstable during compaction and finishing operations. Optimum moisture and maximum density shall be determined using ASTM D558 or USBR Engineering Monograph No. 26.

3.05 FINISHING

A. After compaction, the soil cement layer shall be further shaped, if necessary, to the required lines, grades, and cross-sections and rolled to a reasonably level surface in not longer than 2 hours from the time water is added to the mixture. As part of the compaction where multiple lifts are required, the top of each soil cement layer shall be left with depressions approximately 1/2 inch deep. The purpose of the depressions is to prevent a smooth surface and provide some interlocking with the overlying lift. Sweep away loose material and accumulated debris immediately prior to placement of the next layer.

B. At the end of each day's work or whenever construction operations are interrupted for more than 3 hours, form a construction joint by cutting back along the unfinished edge of the soil cement to form a full-depth face perpendicular to the compacted surface face. An alternate joint detail which provides a stair step half the thickness of the soil cement layer may be proposed by the Engineer. This shall be provided at no additional cost to the Owner.

3.06 BONDING SURFACES

A. Keep compacted surfaces of soil cement that are to receive an overlying or adjacent layer of soil cement moist continuously until placement of the overlying or adjacent layer of soil

cement; except do not keep surfaces moistened for a longer period than 7 days. The bonding surface shall be power-broomed then moistened immediately before placing overlying layer.

B. If more than 12 hours' time has elapsed between completion of one horizontal layer and placement of an overlying horizontal layer, place a bedding grout of 1 part cement and 2 parts sand uniformly spread over the lift. The grout shall be 1/8 inch thick and shall not be disturbed by hauling or processing equipment. Bedding grout is not required to bond adjacent soil cement layers placed by plating parallel to the slope.

3.07 CURING

A. Keep temporarily exposed surfaces moist as set forth in Paragraph **[3.06]**. Exercise care to ensure that no curing material other than water is applied to the surfaces that will be in contact with succeeding layers.

B. Keep permanently exposed surfaces in a moist condition for 7 days.

C. Curing moisture shall be maintained by sprinkling or spraying with water or by covering with continuously moistened canvas, cloth mats, straw, sand, earth or other approved material. Any damage to the soil cement or protective covering within 7 days shall be repaired at the Contractor's expense.

D. If protective cover is to be applied, it shall be applied as soon as practicable, with a maximum time limit of 24 hours between the finishing of the surface and the application of the protective cover or membrane.

E. If moisture only is to be used, it shall begin within 24 hours of completion of placement. Moisture shall be applied a minimum of 1 time per 24 hours. During hot or windy weather conditions, moisture shall be applied three to four times per 24 hours as directed by the Engineer.

F. When necessary, protect the soil cement from freezing for 7 days after the construction by a covering of loose earth, straw, or other suitable material.

G. Remove all loose earth used for curing.

H. Curing compound shall not be allowed.

3.08 FIELD QUALITY CONTROL

A. Tests shall be required throughout the Work to monitor the quality of the soil cement.

B. The Contractor shall provide a probe with a blunt end to check the lift thickness during placement and after compaction. The probe shall be marked for measurement to the nearest 1/2 inch.

END OF SECTION

31 11 00 CLEARING AND GRUBBING

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to perform operations in connection with clearing, grubbing, and disposal of cleared and grubbed materials.

1.02 QUALITY ASSURANCE; DEFINITIONS

A. Clearing: Clearing is defined as the removal of trees, shrubs, bushes, and other organic matter at or above original ground level.

B. Grubbing: Grubbing is defined as the removal of stumps, roots, boards, logs, and other organic matter found at or below ground level.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 PREPARATION

A. Mark areas to be cleared and grubbed prior to commencing clearing operations. The Owner's Representative shall approve clearing and grubbing limits prior to commencement of clearing operations.

B. Trees and shrubs outside of the clearing limits, which are within 10 feet of the clearing limits, shall be clearly marked to avoid damage during clearing and grubbing operations.

C. Remove trees and brush outside the clearing limits, but within the immediate vicinity of the work, upon receipt of approval by the Owner's Representative, when the trees or brush interfere with the progress of construction operations.

D. Clearly mark trees and shrubs within the clearing limits, which are to remain, and protect the trees and shrubs from damage during the clearing and grubbing operations.

E. The clearing limits shall not extend beyond the project limits.

F. Establish the clearing limits as follows:

1. Embankments plus 10 feet beyond the toe of the embankment.
2. Excavations plus 5 feet beyond the top of the excavation.
3. Roadways, runways, taxiways, and parking areas plus 5 feet beyond the edge of pavement or R.O.W. limits.
4. Underground utility trench top width plus 8 feet.

G. Establish the grubbing limits as follows:

1. Embankments plus 2 feet beyond the toe of the embankment.
2. Concrete structures plus 2 feet beyond the edge of the footing.

3. Roadways, runways, taxiways, and parking areas plus 1 foot beyond the edge of pavement.

4. Underground utility trench top width plus 5 feet.

3.02 INSTALLATION

A. Clearing: Clearing shall consist of the felling, cutting up, and the satisfactory disposal of trees and other vegetation, together with the down timber, snags, brush, rubbish, fences, and debris occurring within the area to be cleared.

B. Grubbing:

1. Grubbing shall consist of the removal and disposal of stumps and roots larger than 1 inch in diameter.

2. Extend grubbing to the depth indicated below: In the case of multiple construction items, the greater depth shall apply.

a. Footings: 18 inches below the bottom of the footing.

b. Walks: 12 inches below the bottom of the walk.

c. Roads and Taxiways: 18 inches below the bottom of the subgrade.

d. Parking Areas: 12 inches below the bottom of the subgrade.

e. Embankments: 24 inches below existing ground.

f. Concrete Structures: 18 inches below the bottom of the concrete.

3.03 FIELD QUALITY CONTROL

A. Completely remove timber, logs, roots, brush, rotten wood, and other refuse from the Owner's property. Disposal of materials in streams shall not be permitted and no materials shall be piled in stream channels or in areas where it might be washed away by floods. Timber within the area to be cleared shall become the property of the Contractor, and the Contractor may cut, trim, hew, saw, or otherwise dress felled timber within the limits of the Owner's property, provided timber and waste material is disposed of in a satisfactory manner. Materials shall be removed from the site daily, unless permission is granted by the Engineer to store the materials for longer periods.

END OF SECTION

31 23 10 STRUCTURAL EXCAVATION AND BACKFILL

1.00 GENERAL

1.01 SUMMARY

A. This Section specifies excavation, backfill materials, backfill placement and compaction procedures, and other construction activities incidental to project structures.

B. The Specification does not include excavation and backfilling for utility lines, manholes, valve boxes, and other minor structures related to utility lines. Refer to Section 31 23 33 "Trenching and Backfill [Utilities]" for utility line related excavation and backfill.

1.02 QUALIFICATION ASSURANCE

A. Testing Agency: An independent testing agency that is AASHTO accredited.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Qualification Data: For testing agency.
2. Provide list of compaction equipment to be used.
3. Backfill material classifications: For each soil or aggregate backfill material provide a certification by the testing agency.
4. Compaction Test Results: Submit test results within 24 hours of successful testing.

1.04 STANDARDS

A. Material classification, placing, and testing shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents.

1. ASTM International (ASTM) Standards:

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Any other testing required by these specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards as designated by the Engineer.

1.05 DELIVERY AND STORAGE

A. Deposit material to be used for backfill in storage piles at points convenient for handling of the material during the backfilling operations and as required to prevent contamination with other materials.

1.06 JOB CONDITIONS

A. Review subsurface investigations. Limited subsurface investigations have been performed by PSI, Inc.. Geotechnical reports from that investigation are available as a part of the Construction Documents for information purposes only.

B. Review the Site and determine the conditions which may affect the structural excavation, prior to the commencement of the excavation.

2.00 PRODUCTS

2.01 BACKFILL MATERIALS

A. Structural Earth Backfill: Structural fill shall be on-site excavated course materials free of organic materials and particles larger than 3-inches and defined in Table 3.2 on Page 9 of the soil report provided by PSI.

B. Clay Cap: Clay cap shall be excavated onsite fat clays that are free of organic materials and particles larger than 3" in diameter.

C. Lean Concrete Backfill: Lean concrete in accordance with Section 03 30 00 "Cast-In-Place Concrete."

D. Mud Slab: Lean concrete in accordance with Section 03 30 00 "Cast-In-Place Concrete."

E. Cement Stabilized Sand: Shall be in accordance with Section 31 05 23.13 "Soil Cement."

F. Topsoil: Topsoil shall be Class 12 Earth Fill as specified in Section 31 05 13 "Soils for Earthwork."

G. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand, or recycled, crushed concrete; ASTM D448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and 5 to 15 percent passing No. 200 sieve; maximum plasticity index of 7; complying with deleterious substance limits of ASTM C33 for fine aggregates.

H. Levelling Course For Slab-On-Grade:

1. Provide a 3-inch layer of compacted Fine-Graded Granular Material.

2.02 COMPACTION EQUIPMENT

A. Compaction equipment shall conform to the following requirements.

1. Heavy Compaction Equipment:

a. Tamping Compactor: Steel wheels with rectangular face, tapered pads that prevent fluffing the soil. Compactor shall be equipped with cleaning fingers to remove soil accumulation from between pads.

1). Operating Weight, Minimum: 30,000 pounds.

2). Wheels or Drum Size, Minimum: 4 feet diameter.

3). Travel Speed, Maximum: 10 mph.

b. Pneumatic Rollers: Minimum eight-tire, pneumatic roller with a modular ballast system and flexible operating weight, and which will equally distribute load between tires to provide compaction uniformity.

1). Operating Weight Range: As required for specified compaction, 36,000 to 50,000 pounds.

2). Tire Pressure Range: 80 psi to 100 psi.

3). Travel Speed, Maximum: 10 mph.

4). Distance Between Edges of Adjacent Tires: Less than 50 percent of tire width.

c. Vibratory Rollers: Smooth drum roller with 90 percent of the static weight transmitted through a single drum.

1). Static Weight, Minimum: 20,000 pounds

2). Centrifugal Force Per Drum, Minimum: 40,000 pounds

3). Frequency: 1400 v/min

4). Drum Size: Diameter 5 feet, +/- 1 foot; width between 6 and 9 feet.

5). Travel Speed: 5 mph for self-propelled; 2 mph for towed.

6). No backing up of the vibratory roller will be allowed on an embankment unless the vibrating mechanism is capable of being reversed.

2. Hand-Directed Compaction Equipment: Use power tampers and vibratory plate compactors in areas where it is impracticable or unacceptable to use heavy compaction equipment.

3.00 EXECUTION

3.01 PREPARATION

A. Clear and grub the area to be excavated prior to the start of excavation in accordance with Section 31 11 00 “Clearing and Grubbing [Civil].

3.02 EXCAVATION FOR FOUNDATIONS

A. General: Excavate subgrade to the depth indicated on Drawings, +/- 0.1 feet tolerance Extend limits of the excavation beyond the perimeter of the foundations as indicated on the Drawings.

1. Exposed subgrade surfaces shall be level and of sound, stable material; free of mud, frost, snow, or ice. Testing agency or Owner’s representative shall confirm exposed subgrade is a suitable bearing material based on the Construction Documents.

2. Proof roll the exposed subgrade in accordance with TxDOT Item 216. Do not proof roll wet or saturated subgrades.

3. Where unsound or unstable material is uncovered, notify Owner's representative Remove objectionable material and replace after approval is received from Owner's representative. Replacement material shall be as indicated here unless otherwise indicated on Drawings:

    a. Rock subgrade replacement material: Lean concrete.

    b. Soil subgrade replacement material: Compacted structural fill, Flowable fill, or Cement stabilized sand.

B. Mud Slab: Where indicated, install mud slab on exposed foundation subgrade surface within 8 hours of subgrade exposure. Confirm subgrade is free of loose, unsound, and/or deleterious material before placement of mud slab.

C. Excavation Safety: All excavations shall be in accordance with OSHA requirements.

3.03 WATER IN FOUNDATION EXCAVATIONS

A. General:

1. Prevent water infiltration into foundation excavations. Remove standing water from excavation prior to placing concrete. If removal of standing water is not possible due to continuous water infiltration, then contact Owner's representative for additional direction regarding placing concrete underwater.

2. Do not dewater a foundation excavation while placing concrete or for a period of at least 24 hours after concrete placement.

B. Rock Foundation Subgrade: If rock material becomes weathered due to water infiltration, then remove weathered material and provide rock replacement material to restore foundation subgrade elevation.

C. Soil Foundation Subgrade: If foundation subgrade becomes saturated do not disturb the subgrade. Wait for water to evacuate the subgrade and subgrade surface to adequately stiffen prior to placing concrete. If subgrade is disturbed, then wait until subgrade has dried out, excavate disturbed subgrade and provide replacement material as indicated above.

3.04 COMPACTED BACKFILL

A. General: Backfill excavated spaces and areas not occupied by the permanent structure.

1. Backfill behind a retaining wall or basement-type wall shall not be placed until the concrete has reached its 28-day compressive strength or 7 days, whichever is longer.

2. Unless otherwise indicated on Drawings, structures with a top slab shall not backfilled until the top slab has been in place at least 4 days.

3. Structures with soil on opposing (opposite) sides shall be backfilled to prevent uneven loading of the structure – evenly raise backfill on opposing sides of the structure. The maximum differential backfill height between opposing sides is 1 foot.

4. Do not permit rollers to operate within 3 feet of structures.

5. Maximum Loose Lift Height:

    a. Heavy Compaction Equipment: 8 inches.

b. Hand-Directed Compaction Equipment: 4 inches.

6. Previous Compacted Layer: If backfill placement occurs over a period of time greater than 24 hours, then scarify and recompact the previous day's final compacted layer.

a. Scarify and Recompact: 6-inch depth; adjust the moisture content; recompact.

b. Saturated subgrades shall not be worked on until sufficiently dry and harden so as not to be rutted with compaction equipment. Scarify and recompact layers damaged by weather or construction equipment.

B. Moisture: Prior to compacting backfill, mix and aerate or water the loose lift backfill material as necessary to adjust the moisture content and evenly distribute throughout. The material shall contain moisture within the limits specified below.

1. In accordance with ASTM D6938, determine the optimum moisture content for the maximum dry density.

2. Backfill moisture content shall be as indicated in Table 1, "Compacted Fill."

3. Aggregate fill: Completely cohesionless materials, shall be at a moisture content which will allow use of the specified compaction equipment and consistent achievement of the specified density.

C. Compaction: As required to achieve the specified density, increase the number of passes above the minimum specified and/or modify the weight of the equipment.

1. Determine the maximum dry density in accordance with ASTM D698 for cohesive soils and ASTM D4253 for cohesionless soils.

2. Minimum number of passes for all compacted fill types: 8.

3. Cohesive Soils: A tamping compactor or tamping compactor followed by a pneumatic roller shall be used.

4. Cohesionless or low cohesive soils: A vibratory roller or vibratory plate compactors shall be required if the material is cohesionless or with less than 15 percent passing the No. 200 sieve. Confirm applicability of vibratory compaction equipment in the field.

5. Overlap passes a minimum of 1 feet for heavy compaction equipment and 50 percent of the baseplate width for hand-directed equipment.

6. Backfill density shall be as indicated in Table 3.4 in the Geotechnical Report by PSI

3.05 FIELD QUALITY CONTROL

A. Owner is responsible for the costs involved in providing an approved testing agency to perform quality control testing of backfill operations and verification of subgrade bearing material. The testing laboratory shall make tests of in-place density and moisture in accordance with ASTM Standards previously mentioned in this Section. The testing agency shall monitor backfill operations continuously or at intervals acceptable to the Owner's representative. It shall be the responsibility of the Contractor to notify the testing agency a minimum of two business days before backfill operations begin.

1. Unless noted otherwise, in-place density tests shall be conducted at a rate of one test per 5000 square feet or a minimum of three for every lift.

END OF SECTION

31 23 23.34 FLOWABLE FILL

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment, and incidentals necessary to mix and place flowable fill, consisting of Portland cement, fine aggregate, fly ash, and water in the proper proportions as specified hereinafter. Flowable fill (Controlled Low-Strength Material, CLSM) shall be used to bed and backfill around piping, utilities, and structures where indicated.

1.02 QUALITY ASSURANCE

A. Design Criteria – Flowable Fill Proportions and Consistency: Flowable fill shall be proportioned to give the necessary workability, strength, and consistency, and shall conform to the following governing requirements:

1. Permeability: Maximum permeability limit of $1x10^{-6}$ cm/sec. This limit shall apply at all locations where flowable fill is used as a utility trench plug (dam) within trench backfill materials.
2. Subsidence: Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per ft.) of flowable fill depth. Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C940.
3. Strength for Excavatable Flowable Fill: Unconfined compressive strength at 28-days when tested in accordance with ASTM D4832: 100 psi (+/- 50 psi).
    a. The 1-year strength shall not exceed 150 psi
    b. Where indicated provide Excavatable Flowable Fill around utilities, unless noted otherwise.
    c. Excavatable Flowable Fill shall be excavatable with hand tools and conventional machinery such as backhoes.
4. Strength for Non-Excavatable Flowable Fill: Unconfined compressive strength at 28-days when tested in accordance with ASTM D4832: 150 psi minimum.
    a. Where indicated provide Non-Excavatable Flowable Fill below structures and/or around structures, unless noted otherwise.
5. Fluidity: Flowable fill shall be self-consolidating and non-segregating in accordance with ASTM C1611:
    a. Slump Flow Test: Minimum 20-inch mean spread.
    b. Visual Stability Index (VSI) Test: Less than or equal to 1.

B. Factory Testing: The Contractor shall be responsible for the design of the material. A trial mix shall be designed by an independent testing laboratory, retained by the Contractor. The testing laboratory shall submit verification that the materials and proportions of the trial mix design meets the requirement of the Specifications. In lieu of trial mix design, Contractor may submit historical data for a mix design used successfully in previous similar work. The Contractor shall not make changes in materials, either in gradation, source, or

brand, or proportions of the mixture after having been approved, except by specific approval of the Engineer.

C. Owner Testing: It is the responsibility of the Contractor to achieve and maintain the quality of material required by this Section. However, the Owner may secure the services of an independent testing laboratory to verify the quality of the flowable fill. The Owner shall have the right to require additional testing, strengthening, or replacement of flowable fill which has failed to meet the minimum requirements of this Section.

1.03 SUBMITTALS

A. Submit mix design on each material required. Provide backup data as required below.

B. Submit historical or trial mix data and test results as a basis for mix design approval. Required data shall include:

1. Permeability test results if plugs are required on Project.

2. Subsidence test results.

3. Strength test results for Excavatable and Non-Excavatable Flowable Fill if used on Project.

4. Fluidity test results.

1.04 STANDARDS AND REFERENCES

A. Materials shall meet recommendation for mix design and placement, as published by National Ready Mixed Concrete Association.

B. The applicable provisions of the following references and standards shall apply to this Section as if written herein in their entirety.

American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Specification for Concrete Aggregates
ASTM C40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C150	Specification for Portland Cement
ASTM C618	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
ASTM C 940	Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 1611	Standard Test Method for Slump flow of Self Consolidating Concrete
ASTM D 4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

2.00 PRODUCTS

2.01 MATERIALS

A. Cement: Portland cement conforming to the specifications and test for Type I Portland cement of the American Society for Testing and Materials, Designation C-150.

B. Fine Aggregate: Fine aggregate consisting of natural, washed and screened sand having clean, hard, strong, durable, uncoated grains complying with the requirements for ASTM C33. The sand shall generally be of such size that all will pass a 3/8-inch sieve, at least 95 percent pass a 1/4-inch screen and at least 80 percent pass a No. 8 sieve. Aggregate shall not contain strong alkali, or organic material which gives a color darker than the standard color when tested in accordance with ASTM Specification Designation C40.

C. Fly Ash/Pozzolans: Fly ash shall be an ASTM C618, Class "C" fly ash. The fly ash may be used in controlled low-strength material.

D. Water: Water for flowable fill shall be clean and free from oil, acid, alkali, organic matter or other harmful impurities. Water which is suitable for drinking or for ordinary household use will be acceptable for concrete. Where available, water shall be obtained from mains of a waterworks system.

E. Performance Additive: As required to meet specification requirements:

1. Darafill by Grace Construction Products or approved equal.
2. Rheocell Rheofill by BASF The Chemical Company.
3. Sika Lightcrete Powder by Sika Corporation.
4. Approved equal.

F. Chemical admixtures for concrete per ASTM C 494, as required by performance requirements.

2.02 MIXES

A. In the determination of the amount of water required for mix, consideration shall be given to the moisture content of the aggregate. The net amount of water in the mix will be the amount added at the mixer; plus the free water in the aggregate; and minus the absorption of the aggregate, based on a 30 minute absorption period. No water allowance shall be made for evaporation after batching.

B. The methods of measurement of materials shall be such that the proportions of water to cement can be closely controlled during the progress of the Work and easily checked at any time by the Owner's representative. To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from sources which will insure a uniform quality and grading during any single day's operation and they shall be delivered to the Work and handled in such a manner that the variation in moisture content will not interfere with the steady production of flowable fill of reasonable degree of uniformity. Sources of supply shall be approved by the Owner's representative.

C. All material shall be separately and accurately measured. Measurement may be made by weight or by volume, as determined by the Contractor; however; all equipment for measurement of materials shall be subject to approval by the Owner's representative.

3.00 EXECUTION

3.01 INSTALLATION

A. Contractor shall give the Owner's representative sufficient advance notice before starting to place material in any area, to permit inspection of the area, and preparation for pouring.

B. Conduct the operation of depositing the material so as to form a compact, dense, impervious mass, and so as not to develop air pockets in confined spaces.

C. Unless specified otherwise, flowable fill shall be uniformly placed to the depth shown on the Drawings. The fill shall be brought up uniformly to the top of excavation elevation. Placement of flowable fill shall then cease and the fill protected from traffic for a period of 72 hours.

   1. To prevent pipe flotation place material in lifts or provide alternate means.

   2. Around structures, material shall be placed in lifts. Lift depth shall not exceed one-tenth of total structure embedment into subgrade nor 5 feet, whichever is less.

   3. When multiple lifts are required, material shall be allowed to harden before placing next lift. Hardening time varies with each mix. Verify flowable fill has reached a penetration number of 1500, in accordance with ASTM C 403, but not less than 5 hours.

D. The material shall be placed against undisturbed trench walls, and shall not be placed on or against frozen ground.

E. At time of placement the ambient temperature shall be 35 F and rising.

3.02 FIELD QUALITY CONTROL

The testing laboratory shall sample material in accordance with ASTM D5971. The testing laboratory shall monitor backfill operation continuously or at intervals acceptable to the Owner and Engineer at structures. It shall be the responsibility of the Contractor to provide sufficient advance notification to the testing laboratory before backfill operations begin.

A. Strength: A strength test is the average of two cylinders per ASTM D4832.

B. Fluidity: A fluidity test is a Slump Flow Test and a VSI Test per ASTM C1611.

C. For all tests required, at a minimum perform one test per day, but not less than one per 150 cubic yards.

END OF SECTION

31 23 33 TRENCHING AND BACKFILL

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment and incidentals necessary to perform operations in trenching, pipe bedding, backfilling, clearing, grubbing and site preparation; handling, storage, transportation and disposal of excavated material; pumping and dewatering; preparation of subgrades; protection of adjacent property; fills, grading; and other appurtenant work. Trenching, backfilling, and pipe embedment procedures shall be in full compliance with Section 31 23 33.14 "Trench Safety." Earth removed from excavations and which is not required for backfill shall be removed from the Site by the Contractor at his own expense, unless arrangements are made with the Owner through his representative to allow disposal on Site. If permitted, the Contractor shall dump and spread excess earth in a manner agreed upon by the Contractor and the Owner. Excavations, other than trench excavation, are not part of this Section.

1.02 QUALITY ASSURANCE

Classification:

A. Excavations shall include material of whatever nature encountered, including but not limited to clays, sands, gravels, conglomeritic boulders, weathered clay shales, rock, debris and abandoned existing structures. Excavation and trenching shall include the removal and subsequent handling of materials excavated or otherwise handled in the performance of the Work.

B. Bidders must satisfy themselves as to the actual existing subsurface conditions prior to the submittal of a proposal to complete the proposed Work.

C. Trench excavation shall consist of excavation to the lines and grades indicated, required for installation of the pipe, pipe bedding, backfill, and to accommodate trench safety systems.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

A. Sieve analysis on embedment materials.

B. Test results indicating soil resistivity for embedment material used on metal pipe.

C. Record Data: Certified test reports for compaction tests.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 "Document Management."

B. Section 03 30 00 "Cast-In-Place Concrete."

C. Section 31 23 33.14 "Trench Safety."

1.05 STANDARDS

A. The following publications, referred to hereafter by basic designation only, form a part of this Section to the extent indicated by the references thereto:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C535	Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Lost Angeles Machine
ASTM D448	Standard Classification for Size of Aggregate for Road Bridge Construction
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)
ASTM G57	Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

B. Any other testing required by these specifications and not specifically referenced to a standard shall be performed under ASTM or other appropriate standards as designated by the Engineer.

C. Reference herein or on the Drawings to soil classifications shall be understood to be according to ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.06 DELIVERY AND STORAGE

Excavated materials to be used for backfill may be deposited in stockpiles at points convenient for rehandling the material during the backfilling process. The location of stockpiles shall be within the limits of construction easements or public right-of-way. The location of stockpiles is subject to the approval of the Owner or the Owner's representative. Keep drainage channels clear of stockpiled materials.

1.07 JOB CONDITIONS

A. Place no embedment or backfill material during freezing weather or upon frozen subgrades or previously placed frozen embedment or backfill materials.

B. A high ground water table is typical for the project sites. Contractor is responsible for providing all dewatering and wet trench construction at no additional cost.

2.00 PRODUCTS

2.01 MATERIALS

A. Concrete for Backfill, Blocking, Cradling and Encasement: Unless other strength requirements are designated, concrete used shall be 1500 psi as specified in Section 03 30 00.01 "Cast-In-Place Concrete."

B. Class 1 Earth Fill: Limited to clays and sandy clays classified as CH material with a liquid limit greater than or equal to 50, a plasticity index greater than or equal to 25, and a minimum of 60 percent passing the No. 200 sieve, which are free of organic materials.

C. Class 3 Earth Fill: Consist of any materials classified as CH, CL, SM, SP, SP-SM, SC, and GC, which have a minimum plasticity index of 4, which are free of organic materials.

D. Class 12 Earth Fill: Consist of soils suitable for topsoil which are relatively free of stones or other objectionable debris, which have sufficient humus content to readily support vegetative growth. The suitability of soils for topsoil shall be subject to the approval of the Engineer.

E. Class 10 Aggregate Fill: Consists of washed and screened natural sands or sands manufactured by crushing stones complying with the requirements and tests of "Standard Specifications for Concrete Aggregates", ASTM C33. The gradation as included in ASTM C33 is as follows:

Sieve Size Square Opening	Percent Passing
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

Class 10 Aggregate Fill shall have not more than 45 percent passing any sieve and retained on the next consecutive sieve of those shown above, and its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

F. Cement: Type I Portland Cement.

G. Flowable Fill: Flowable fill shall be in accordance with Section 31 23 23.34 "Flowable Fill."

H. Modified Flowable Fill: Modified flowable backfill in areas of possible future excavation shall consist of a mixture of native soils or manufactured materials, cement and/or fly ash, air entraining material and water which produces a material with unconfined compressive strength of between 250 and 450 psi after 28 days. Any materials used shall be primarily granular, with a plasticity index less than 12 and with 100 percent passing a 3/4-inch sieve. The flowable mixture shall be mixed in a pub mill, concrete mixer, or transit mixer and shall have a minimum slump of 5 inches. The flowable mixture must be allowed to set prior to the placement of any overlying materials. Modified flowable backfill in permanent areas such as abandoned pipe closures shall contain the same materials and have an unconfined compressive strength greater than 250 psi after 28 days.

I. Embedment Geotextile Material: Embedment geotextile material shall be Mirafi 180N polypropylene or approved equal.

J. Utility Detection Tape: Utility pipe detection tape, green in color for sewer, blue in color for water, with black non-degradable printing reading "CAUTION PRESSURIZED WASTEWATER LINE BURIED BELOW" or "CAUTION WATER LINE BURIED BELOW" shall be installed over all PVC, HDPE, or fiberglass pipelines 8 inches and larger. The tape shall be bright-colored, continuous-printed plasticized aluminum tape, intended for direct-burial service; not less than 6 inches wide by 5 mils thick. Detection tape must be installed above the pipe zone, 12 inches above pipe.

K. Tracer Wire: All piping shall be installed with a continuous, insulated TW, THW, THWN or HMWPE insulated copper, 10 gauge or thicker wire for pipeline location purposes by means of an electronic line tracer. The wire shall be installed along the entire length of pipe. The insulation color shall match the color of the pipe being installed. Sections of wire shall be spliced together using approved splice caps and water proof seals. Twisting the wires together is not acceptable.

L. TRACER BOX TEST STATIONS: Copperhead Industries, LLC. Snakepit or approved equal. Provide tracer boxes as indicated on the plans for termination of tracer wire. Tracer boxes shall be "Roadway Box" model with cast iron covers. Install tracer boxes with concrete collar cast around them. Boxes shall be traffic rated.

2.02 MIXES; SAND-CEMENT BACKFILL/EMBEDMENT (CEMENT STABILIZED SAND)

A. The cement-sand mixture must consist of at least 1.5 sacks of cement per ton of sand.

B. The cement-sand mixture must have a minimum unconfined compressive strength of 100 PSI in 48 hours, when compacted to a minimum of 95% of Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78), without additional moisture control, cured and testing in accordance with ASTM C31.

C. Sand shall be free of any cohesive material and shall meet the following gradation and plasticity index requirements:

Sieve Size	Percent Passing
1"	100
1/2"	95-100
No. 40	80-100

D. PI and LL Amounts:

1. Plasticity Index: 6 or less
2. Liquid Limit: 25 or less

3.00 EXECUTION

3.01 PREPARATION

A. Site:

1. Clear sites of logs, trees, roots, brush, tree trimmings and other objectionable materials and debris which are to be occupied by pipe trenches, and grub stumps. Designate material not salvaged for reuse as surface material as spoiled and dispose of material in accordance with Paragraph 3.01.E, Disposal of Spoil Material.
2. Do not remove trees outside of the required working area unless their removal is authorized in writing by the Engineer and with the approval of the local governing authority. Adequately protect the trees left standing from permanent damage by construction operations. Standing trees may be trimmed where necessary to facilitate construction, but only with written authorization from the Engineer.

B. Dewatering:

1. Provide and maintain adequate dewatering equipment to remove and dispose of surface and ground water entering the excavations, trenches, or other parts of the Work. Keep each excavation dry during subgrade preparation and continually thereafter until the proposed pipe is installed. Maintain the proper procedures necessary to protect against damage to the proposed Work from hydrostatic pressure, flotation, or other water related causes.
2. Dewater excavations which extend down to or below ground water elevation by lowering and keeping the ground water level a minimum of 2 feet below the bottom of the excavation.
3. Divert surface water or otherwise prevent water from entering excavated areas to the fullest extent possible without causing damage to adjacent property.
4. Provide and maintain any piping or conduit necessary to facilitate drainage. Do not alter area drainage patterns to the extent that adjacent property and landowners become threatened with localized flooding and/or water damage. Should such a situation occur, the Contractor shall be responsible for repairing the damage at no additional cost to the Owner.

C. Grades

1. It is intended that the line(s) be laid to the grades as shown on the plans. The precise and detailed pipe layout is to be prepared by the Contractor and submitted to the Engineer for information and review. The responsibility for the workability of the detailed layout remains with the Contractor. High points must be located at air valves and the pipe sections containing air valves must have a horizontal grade. At drainage

crossings, the depth of cut shall be increased to prevent uncovering of the pipe by surface erosion, as shown on the plans.

2. Where unforeseen conditions warrant a revised grade during construction, the Contractor must submit a revised pipe layout to the Engineer for approval. No intermediate “highs” or “lows” will be allowed in the pipe grade without the approval of the Engineer.

D. Protection of Existing Structures and Utilities:

1. Prior to the start of construction, communicate with the representatives of the local utility companies, including the oil, gas, telephone and communications companies, and local water and sewer utilities operating in the location of the proposed construction area. Seek the utility companies’ assistance in locating existing facilities to avoid conflicts during construction. The location, number, depth, and owner of utilities indicated are for information purposes only, and all utilities and structures may not be shown or may not be in the location shown.

2. Where construction endangers adjacent structures, utilities, embankments and/or roadways, the Contractor shall, at his own expense, carefully support and protect such structures so that no damage occurs throughout the construction process. In case damage should occur, the Contractor shall be responsible for restoring the damaged structure to a condition acceptable to the Owner of that structure and shall bear all cost of such reparations.

3. Repair or replace damaged street surfaces, driveways, sidewalks, curbs, gutters, fences, drainage structures, or other such facilities to the satisfaction of the Owner. Structures shall be returned to a condition equal to or better than the original condition and of same or better material and quality.

E. Blasting: Blasting shall not be allowed in any instance.

F. Disposal of Spoil Material:

1. Suitable material from excavations which meets the requirements for pipe backfill material as indicated, except stripping excavation, may be reused. Designate the remaining excavated materials as spoiled material and dispose of material off the Site in accordance with all applicable laws, ordinances, and codes. Contractor shall be responsible for the storage, transportation, and deposition of spoiled material and shall be responsible for acquiring the necessary permits, and the payment of fees and duties at no additional cost to the Owner.

2. No burning of materials shall be permitted on the Site.

3.02 TRENCH EXCAVATION

A. General: The trenches shall be excavated to the alignment and depth indicated or as necessary for the proper installation of the pipe and appurtenances. Brace and dewater the trench if necessary so that the workmen may work therein safely and efficiently. Any specific requirement listed in Paragraph 3.00, Execution, may be modified as necessary to meet OSHA requirements. However, if trench widths are wider than indicated, the Contractor shall be responsible for determining and furnishing the proper class of

embedment and piping for the installation with no additional compensation to the Contractor.

B. Trench Width: The trench widths shall be as shown on the Drawings.

C. Pipe Foundation Subgrade:

1. Excavate the trench to an even grade to permit the installation of the pipe so that the full length of the pipe barrel is supported on the proper depth of bedding material. The entire foundation subgrade area in the bottom of the excavations shall be firm, stable material, and the material shall not be disturbed below required grade except as described in this Section. Where the character of the subgrade material is such that proper subgrade cannot be obtained at the elevation indicated, deepen the excavation to a satisfactory subgrade material.

2. Remove the material until a firm, stable, and uniform bearing is reached and the subgrade brought back to the required grade with the specified bedding material compacted in place or with lean concrete material. The expense of replacing any unsatisfactory subgrade shall be borne by the Contractor.

3. In water bearing sand, washed shell or other approved granular material will be required with geo-textile fabric wrap as indicated in the construction details. Contractor must notify the Engineer when water bearing sands are encountered.

D. Correcting Faulty Grade: Should any part of the trench be excavated below required grade, correct the trench with bedding material, thoroughly compacted, or with lean concrete, at no additional compensation to the Contractor.

E. Care of Surface Material for Reuse: If local conditions permit reuse, keep surface material suitable for reuse separate from the general excavation material.

F. Trenching Methods: The use of any suitable trench digging machinery is permitted except in places where such operations may cause damage, above or below ground, in which case, employ hand methods.

G. Pipe Clearance in Rock: Remove ledge rock, rock fragments, shale, or other rock to provide proper clearance for bedding materials. Provide adequate clearance for properly jointing pipe laid in rock trenches at bell holes.

3.03 BACKFILL

A. Bedding within Pipe Zone:

1. Concrete Cradle, Encasement or Concrete Arch: Where indicated, install the pipe in concrete cradle, encasement, or concrete arch. Take precautions to prevent pipe movement or deflection during construction. Where pipes are placed below structures, completely encase pipes in 1500 psi concrete, and extend up to bottom of structure.

2. Concrete Blocking: Place blocking to rest against firm undisturbed trench walls. The supporting area for each block shall be at least as great as that indicated and shall be sufficient to withstand the thrust, including water hammer, which may develop. Each block shall rest on a firm undisturbed foundation of trench sides and bottom.

B. Aggregate Fill Bedding:

1. After the trench has been cut to the depths indicated, install bedding geotextile material below the bedding layer (if required), bring up the bedding layer to a point slightly above grade in maximum 6-inch lifts and uniformly compact to the density indicated. Form bell holes and scoop out a trough to grade so that the pipe is uniformly supported by the embedment material. Lay and joint the pipe. Bring up the embedment material in maximum 6-inch lifts on either side of the pipe to the elevation above the pipe shown on the Drawings. Uniformly compact the pipe as indicated.

2. After moisture is gone from the embedment material, place utility detection tape and backfill and compact the remaining backfill by tamping or other appropriate methods. Water jetting shall not be permitted.

3. Install utility detection tape and tracer wire.

C. Compaction Requirements:

1. Compact earth fill and cohesive aggregate fill in maximum 6-inch lifts with pneumatic rollers or power hand tampers and make a minimum of eight passes.

2. Compact cohesionless aggregate fill in maximum 6-inch lifts with vibratory rollers or vibratory plate power hand compactors and make a minimum of eight passes.

3. The acceptability of the compaction equipment shall be based upon the results of a test section. Compact earth fill and cohesive aggregate fill to a minimum of 95 percent of maximum dry density as determined by ASTM D698, Standard Proctor.

4. Compact Class 1 and 2 earth fill at a moisture content within minus 0 to plus 5 percentage points of the optimum moisture content. Compact the remaining classes of earth fill and cohesive aggregate fill at a moisture content within minus 2 to plus 5 percentage points of optimum moisture content. The moisture ranges listed above are minimum and maximum limits. A tighter moisture range within these limits may be required to consistently achieve the specified density.

5. Compact cohesionless aggregate fill on which it is not practical to control the density by “Proctor” methods to a minimum of 75 percent relative density as determined by ASTM D4253 and D 4254, or at the discretion of the Engineer, by a field compaction mold method correlated to ASTM D4253 and D 4254.

6. Compact cohesionless aggregate fill at a moisture content within a range that accommodates consistent placement and compaction to the minimum relative density specified above.

7. The Owner will arrange and pay for density and moisture testing. The testing frequency and methods shall be as requested by the Engineer. The Engineer may waive testing requirements on cohesionless bedding where testing is not practical because of limited space between the pipe and trench walls, however, the minimum number of passes of the compaction equipment specified above shall be achieved.

3.04 FINISHING

A. Grade and rake areas smooth and even which do not receive any type of paved surface, to allow drainage to drain away from the structures and toward the roads and streets or the

natural drainage course. Break up large clods of earth and remove rocks, trash or debris near the surface.

B. Finish the top portion of backfill beneath established sodded (lawn) areas with not less than 6 inches of topsoil corresponding to, or better than, that underlying adjoining sodded areas.

3.05 FIELD QUALITY CONTROL

A. Compact backfill and appropriate embedment material to a minimum of 95 percent of maximum density at a moisture content of 0 to plus 5 percent of optimum for backfill and at optimum for sand-cement embedment as determined by ASTM D698, Standard Proctor.

B. Make periodic tests of compaction for conformance with this Section by an approved testing laboratory selected and paid for by the Owner. Contractor shall pay for re-testing until acceptable test results are obtained.

3.06 CLEAN AND ADJUST

A. Remove surplus pipeline materials, tools, rubbish and temporary structures and leave the construction site clean, to the satisfaction of the Engineer.

END OF SECTION

31 23 33.14 TRENCH SAFETY

1.00 GENERAL

1.01 WORK INCLUDED

A. This specification consists of the basic requirements which the Contractor must comply with in order to provide for the safety and health of workers in a trench. This specification is for the purpose of providing minimum performance specifications, and the Contractor shall develop, design, and implement the trench safety system. The Contractor shall bear the sole responsibility for the adequacy of the trench safety system and providing “a safe place to work” for the workman.

B. Should the trench safety protection system require wider trenches than specified elsewhere, the Contractor shall be responsible for the costs associated with determining adequacy of pipe bedding and class, as well as, purchase and installation of alternate materials.

1.02 STANDARDS

A. The following standard shall be the minimum governing requirement of this specification and is hereby made a part of this specification as if written in its entirety.

Occupational Safety and Health Standards - Excavations (29CFR Part 1926), U.S. Department of Labor, latest edition.

B. Comply with the applicable federal, state, and local rules, regulations, and ordinances.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION (NOT APPLICABLE)

END OF SECTION

31 64 00 CAISSON LIFT STATIONS

1.00 GENERAL

1.01 SECTION INCLUDES

A. Constructing external walls of lift station wet well structures by caisson method, including base slab and excavation cell partitions, if any. Valve/pump chamber to be constructed by open cut.

B. If the method of construction is not specified, the Contractor may select the caisson method as an alternate to open-cut method for wet well construction, subject to approval by the Owner's Representative.

1.02 MEASUREMENT AND PAYMENT

A. Include cost for construction using the caisson method in the lump sum amount for the lift station.

B. No separate measurement will be made for payment of concrete in wet well caisson except as listed in an approved schedule of values.

1.03 DEFINITION

A. Caisson is defined as the external walls of a concrete structure, together with any excavation cell partition walls, erected at-grade or in a starter pit, and sunk by gravity to the final position through excavation inside the structure under dry or wet conditions. The complete caisson includes the structural base slab. The caisson walls provide ground support during construction and for the permanent installation.

B. Dry construction means that the Contractor operates sufficient external ground water control system to maintain the ground water level and the piezometric head safely below the excavation bottom within the caisson.

C. Wet construction means that the external hydrostatic ground water pressure is counteracted by water or a slurry within the caisson.

1.04 SUBMITTALS

A. Make submittals in accordance with all provisions and sections of these specifications.

B. Submit drawings and design calculations prepared and signed by the Contractor's Engineer Licensed in Texas showing:

1. Modifications proposed to the lift station structure design required for caisson construction. Structural design performed by the Contractor's Engineer shall meet the Design Criteria of Paragraph 1.05.

2. Wall design including complete design of cutting shoe. Include any special designs required by Contractor's selected method of installation such as water jet, bentonite and grout pipes, and injection ports, and dimensions of annular space for bentonite lubrication. Show increased wall thickness for dead weight if required to sink the caisson.
3. Height of each concrete placement lift and construction joint locations. Show blockouts and other penetration designs that may be modified to accommodate caisson construction tolerances.
4. Structural connections, such as keys and dowels, between caisson wall and structural base slab. For wet caisson construction, show seal slab minimum thickness and elevation to allow construction of the structural slab in the dry.
5. Structural analyses of the caisson wall considering stresses potentially caused during the caisson sinking operations.

C. Submit safety plan to meet OSHA requirements. Submit these procedures for record purpose only and not for approval by the Owner's Representative. Address in the plan, as a minimum but not limited to the following:
1. Protection against caisson instability, soil instability, and ground water inflow.
2. Safety for caisson access and exit, including ladders, stairs, walkways, and hoists.
3. Protection against equipment operations, and for lifting and hoisting equipment and material.
4. Support of surcharge weights, if any are required for caisson sinking.
5. Type and size of ventilation systems.
6. Monitoring systems for hazardous gases, noting quantity and locations of monitors.
7. Protection against flooding of the caisson and inflow into sewers when connected to the caisson structure.
8. Protection of workers and the public, including traffic barriers, accidental or unauthorized entry, and falling objects.
9. Safety supervising responsibilities.

D. Submit concrete mix designs and placement procedure for seal slab tremie concrete to be used in wet construction, if applicable.

E. Building and Structures Assessment: Submit for review prior to construction, a building and structures assessment plan. Preconstruction and post-construction assessment reports shall be provided for buildings and structures located within a distance equal to the depth of the caisson but at least 50 feet in plan from the proposed caisson perimeter. Photographs or a video of any existing damage to structures in the vicinity of the caisson shall be included in the assessment reports. Photographs or videos shall be taken in the presence of Owner's representative.

F. Caisson Survey. Submit the caisson survey results together with a report identifying required modifications, if any, to complete the lift station and to comply with specified tolerances.

G. Submit a ground and surface water control plan in accordance with requirements in this Section as required for the selected construction method.

H. Submit survey data and other monitoring observations to the Owner's Representative each week.

1.05 DESIGN CRITERIA

A. The Contractor is responsible for final design of lift station caisson features, where caisson construction is approved by the Owner's Representative. The Contractor is also responsible for redesign of features which require modification to facilitate caisson construction. Structural Designs and other engineered items of the caisson shall be signed and sealed by a qualified Professional Engineer licensed in the State of Texas.

B. The caisson construction alternative applies only to reinforced concrete construction. Revisions to other systems and materials shown in the Contract Documents will not be permitted. Revisions of the structure's internal dimensions will not be permitted. The wall and slab concrete thicknesses shown in the contract documents are minimum and shall not be reduced for alternative designs by the Contractor's Engineer. The Contractor may make increases as required for the construction method.

C. The caisson structure shall be designed to resist buoyancy due to ground water at finished grade or the 100-year flood elevation plus an additional 3 feet, whichever is higher. Uplift resistance may be provided by a combination of concrete weight and soil friction. The minimum factors of safety against uplift as applied to each component are:

1. $S_{fa} = 1.5$, factor of safety against uplift, concrete weight.
2. $S_{fc} = 3.00$, factor of safety against uplift, soil friction

D. Structural connections between base slab and caisson wall shall be designed to transfer full base reactions from slab to wall. Full base reactions are:

1. For downward load: weight of components supported on the slab plus the weight of liquid at maximum elevation in wet well as indicated.

2. For upward load: (a) soil bearing reactions; and (b) hydrostatic uplift pressures, together with any potential soil uplift pressure caused by instability, for empty wet well. Hydrostatic pressures shall be as defined in Paragraph C.

E. The caisson walls shall be designed with vertical reinforcement to withstand a tension force, potentially caused by caisson hang up during sinking due to soil friction, equal to one half the weight of the caisson.

F. The caisson wall shall be designed to withstand stresses caused by tilting potentially occurring during caisson sinking to the maximum allowable construction tolerance of 1 inch in 5 feet. The structural analysis shall be based on an assumption that one-third of the caisson periphery becomes unsupported due to the tilt. The analysis of tilt induced stresses shall be performed for each concrete placement lift.

G. Locate bentonite injection ports, if required, on the outside of the caisson in positions to prevent slurry from flowing into the excavation. Locate jet ports, if required, only on the inside of the caisson in positions preventing washout of soil below the cutting shoe.

H. For wet construction, the Contractor shall design a seal slab for placement under fluid and capable of resisting the full hydrostatic head, as defined in Paragraph 1.05 C, above, and any soil uplift pressure when the fluid is removed.

I. Geotechnical parameters for caisson design shall meet the conditions and recommendations provided in the geotechnical report made available to the Contractor. In the event of conflict between the geotechnical report and these specifications, the specifications shall govern.

J. Reinforced concrete design shall meet the requirements of ACI 318 and the recommendations of ACI 350.

2.00 PRODUCTS

2.01 CONCRETE

A. Provide concrete in accordance with Section 03 30 00 – Cast-In-Place Concrete. Concrete for seal slabs placed by tremie method shall be in accordance with Contractor's mix design as approved by the Owner's Representative.

2.02 STEEL REINFORCEMENT

A. Provide reinforcement in accordance with Section 03 21 00 – Reinforcing Steel.

2.03 EMBEDDEM ITEMS

A. Materials and schedule for embedded jet, bentonite or grout piping required for caisson construction shall be defined in the construction drawings prepared by the Contractor.

2.04 BACKFILL

A. Backfill starter pit, or other excavations requiring grade restorations adjacent to the caisson with either select material or cement stabilized sand.

B. Provide select material in accordance with Section 31 23 10 - Structural Excavation and Backfill.

C. Provide cement stabilized sand in accordance with Section 31 05 23.13 – Soil Cement.

2.05 GROUT

A. Use sand-cement pressure grout conforming to Section 31 68 19 – Foundation Drilling and Grouting.

3.00 EXECUTION

3.01 SITE PREPARATION

A. Perform site preparation for site clearing and to grade the site to required elevation. Provide for site drainage.

B. Relocate and protect utilities to be maintained that may be affected by the caisson construction area, including starter pit.

C. Install security fencing around caisson construction areas to prevent accidental or unauthorized entry.

D. Provide for control of ground water and surface water according to Section 31 23 10 - Structural Excavation and Backfill.

1. For dry construction, maintain the piezometric groundwater level and hydrostatic head below the excavation bottom in the caisson, as necessary to maintain stability, and to prevent heave of the soil layers underlying the final excavation elevation. The piezometric level shall be a minimum of 3 feet below the final excavation bottom when that elevation is reached.

2. For wet construction, maintain the fluid level within the caisson above the piezometric level within the soils surrounding the caisson, and above the piezometric level in the soils below the excavation bottom.

E. Remove hard surface or subsurface materials or other obstructions that may prevent caisson sinking before caisson construction starts.

F. Compact disturbed soils to 95 percent of maximum density as determined by ASTM D698. Compact the soils at moisture content sufficient to develop required density.

3.02 CAISSON WALL CONSTRUCTION

A. Place concrete as specified in Section 03 30 00 – Cast-In-Place Concrete.

B. Install waterstops centered in construction joints as shown on drawings and specified in Section 03 30 00 – Cast-In-Place Concrete. Vertical construction joints will not be permitted unless specifically indicated on the construction drawings by the Contractor's Engineer.

C. Unless higher strength is required by the Contractor's design, allow concrete of the first lift to achieve sufficient strength for a minimum curing period of 3 days before launching the caisson, to prevent structural damage.

D. Inspect the concrete surfaces after form removal and repair defects before the wall section is sunk into the ground.

3.03 CAISSON EXCAVATION

A. Excavation is unclassified and includes, without exception, removal of materials encountered. Dispose of excavated soils or other materials, including soils mixed with bentonite or other slurries.

B. Sink the caisson to a depth at least equal to the design depth shown on the Drawings.

C. Grout the caisson in place by displacement and solidification of bentonite in the annular space. Fill bentonite injection and water jet pipes with non-shrink sand- cement pressure grout.

D. Remove soft or otherwise disturbed soil from the excavation bottom before placement of the seal slab. For wet conditions, determine the conditions of the excavation bottom by probing, witnessed by the Owner’s Representative.

3.04 BASE SLAB CONSTRUCTION

A. Place a non-reinforced concrete seal slab in the caisson bottom within 4 hours after verification that stable, undisturbed bottom conditions have been achieved. Place the seal slab by tremie method for wet construction.

B. Place the structural base slab in the dry.

C. As soon as practical after placement of the seal slab and clean-up, place the base slab reinforcement and place reinforcement steel and dowel connections between the base slab and caisson wall. Place bentonite waterstop continuously around the joint between the base slab and the wall as specified in Section 03 30 00 - Cast-In-Place Concrete. Locate the waterstop as shown on the construction drawings. Immediately pour the concrete for the base slab.

D. Maintain dewatering and other measures to prevent bottom heave until the structural base slab has been cast and reached the design strength determined by the Contractor's Engineer for the caisson design, but not less than 7 days after the structural base slab has been cast.

3.05 CAISSON CLEAN UP AND INSPECTION

A. Clean the interior of the caisson after the seal slab has been poured and before base slab is poured. Remove soil, mud, slurries, spilled grout or concrete, or other materials not part of the structure from the caisson and clean the surfaces.

B. Inspect the caisson for possible structural damage or damage to any embedded items occurring during excavation and caisson sinking. Notify and allow the Owner’s Representative to witness caisson inspection. Repair and replace any damage before proceeding with construction.

3.06 CAISSON CONSTRUCTION TOLERANCES

A. Maximum acceptable deviation of the caisson from the vertical at all levels and locations is 1 inch in 5 feet. The maximum total tilt of the caisson from the horizontal, as measured at or near the top of each concrete placement lift in two perpendicular directions, shall not exceed 1 inch in 5 feet, at any time during caisson sinking.

B. Maximum acceptable horizontal deviation from the design location of the center of the caisson at the ground surface level is 12 inches.

C. The installed elevation of the base of the caisson structure shall be equal to or lower than the elevation shown in the Drawings. The top of the caisson structure shall be at the elevation shown on the Drawings.

D. Provide block-outs with allowance for pipe entry deviations of not less than plus or minus 1.5 inches vertically and plus or minus 6 inches horizontally, plus caisson construction tolerances.

E. The tolerances defined above are only acceptable provided that the Contractor can adjust sewer connections, structural, mechanical and electrical components to resolve any deviation from plumbness, horizontal or vertical location as approved by the Owner’s Representative. Adjustments must be made without adversely affecting operation or maintenance of the lift station. Functionality must be met as designed and shown, without modification. Required changes to systems due to out of tolerance conditions are subject to

removal of the entire structure, redesign of the affected systems, or monetary compensation, as approved by the Owner's Representative.

3.07 BACKFILL

A. If utilized, remove any starter pit shoring to a depth of at least 8 feet below the ground surface and for at least 5 feet in all directions from pipes and tunnels penetrating the shoring. Remove shoring concurrent with backfilling operations. Perform shoring removal and backfilling so that stability of the pit is maintained.

B. Compact backfill material in accordance with Sections 31 23 10 - Structural Excavation and Backfill.

3.08 MONITORING

A. Ground Water. Monitor the ground water conditions and piezometric levels around the caisson and in the strata below the excavation bottom by daily observations while ground water control installations are in operation.

B. Caisson

1. Monitor the caisson installation to verify that no settlement or heave is observed for 10 consecutive days starting not later than the 50 days after structural completion.

2. During caisson sinking operations until the caisson is secured by grout and the base slab hardened, determine and record the plumbness of the caisson at least once each shift at two locations, 90 degrees apart.

3. During caisson sinking operations place or mark horizontal control lines at or near the top of each lift on opposite sides. Determine and record deviations from the horizontal at least once each shift. The tilt measured on different lifts shall be added to determine the total tilt of the caisson.

4. As soon as the caisson has been secured, install 4 benchmarks, 90 degrees apart, on the top concrete placement for settlement monitoring of the installed caisson. The benchmarks shall be transferred to higher elevation on the structure as required due to continued lift station construction. Continue weekly monitoring of settlement points until 60 days after completed construction of the structure.

5. Install and monitor borehole heave points in the caisson for dry construction . Survey heave points before excavation starts and upon retrieval when the final excavation bottom has been reached.

3.09 CAISSON SURVEY

A. When the caisson has been secured, the seal slab poured, and, in the case of wet construction, when the fluid has been pumped out, survey the installed caisson for compliance with the tolerances defined in Paragraph 3.06, Caisson Construction Tolerances. The survey shall include:

1. Location of center of caisson at ground level.

2. Elevation of top and bottom of caisson and structural slab connection.

3. Elevation and locations of penetrations and embedded items and any other support points for lift station installation completion.
4. Deviation from plumb from the caisson top to structural slab at two locations 90 degrees apart.

3.10 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 03 30 00 - Cast-In-Place Concrete.

3.11 DISPOSAL OF EXCESS MATERIAL

A. Remove excavated material from the job site in accordance with Section 01564 - Waste Material Disposal.

B. Provide adequate barriers to prevent bentonite slurry from running over construction area.

END OF SECTION

31 68 19 FOUNDATION DRILLING AND GROUTING

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to drill, wash, and pressure test grout holes; make grout connections; furnish, handle, transport, store, mix, and inject the grouting materials; care and disposal of drill cuttings, wastewater, and waste grout; cleanup of areas upon completion of the work and other such operations as are incidental to the drilling and grouting.

1.02 QUALITY ASSURANCE

A. Definitions:

1. Stop: A stop is a depth at which an expanding plug or packer is positioned.

2. Zone: A zone is a predetermined partial depth of curtain. No zone shall exceed 50 feet in vertical extent. In general, grouting in a given zone and section shall be finished before work is started in the next zone. Curtain grouting zones along the embankment shall generally extend from the bottom of the hole to the top of the hole.

3. Section: A section is a portion of the grout curtain measuring 250 feet in length. The grout curtain has been subdivided into sections as described in Paragraph **[3.01D]**.

4. Advance Holes: Holes drilled in a grout line adjacent to and of the same order as a given grout hole. Initially, two advance holes shall be drilled and grouted in conjunction with each grout hole, and no additional holes shall be grouted in the section until these three holes are completely grouted. Advance holes may be on either side of a grout hole, but shall be in the un-grouted portion of a section when the grouting operation is proceeding from one end of the section to the other.

5. Order: An order is a designation given to holes located at the same interval along the grout line (i.e. primary, secondary, tertiary, etc.).

B. Equipment Quality: Demonstrate equipment prior to commencement of drilling and grouting. Equipment shall be replaced at any time during the drilling and grouting process if the performance is unsatisfactory.

C. Records: Keep records of grouting operations including, but not limited to, the results of washing, pressure testing, and grouting.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Records of grouting operations for record data purposes if requested.

1.04 STANDARDS

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

1. American Society for Testing and Materials (ASTM) Standards:

ASTM C595	Specification for Blended Hydraulic Cements

1.05 DELIVERY AND STORAGE

A. Store a sufficient quantity of materials at or near the site of work to insure that grouting operations will not be delayed by a shortage of materials.

B. Store sand so to avoid the inclusion of any foreign materials in the grout. Construct the storage piles so as to prevent segregation. The sand shall remain in free draining storage for at least 72 hours prior to use. Store a sufficient quantity of sand at or near the site of the work to insure that grouting operations are not delayed by shortage of sand.

1.06 JOB CONDITIONS; COMMUNICATIONS

A. When the Contractor has the individual elements of the plant so located that communication by normal voice between these elements is not satisfactory, a mechanical or electrical means of communication, such as a telephone or other suitable device shall be installed.

2.00 PRODUCTS

2.01 MATERIALS

A. Water: The water used for pressure testing and in the grout shall be as indicated for concrete mixing water.

B. Cement: Cement used in the grout shall be as indicated in Section 03 30 00 "Cast-In-Place Concrete." The use of bulk cement shall be permitted provided the Contractor employs methods of handling, transporting, and storage that are satisfactory; otherwise, only cement furnished in bags shall be accepted for use in the work. In the event the cement is found to contain lumps or foreign matter of a nature and in amounts which may be deleterious to the grouting operations, screening through a standard 100 mesh screen shall be required at no additional cost to the Owner.

C. Sand: Sand for grout shall consist of hard, tough, durable, uncoated particles, composed of natural sand. The shape of the particles shall be generally rounded or cubical. If the sand is a combination of separately processed sizes or classification, the different components shall be batched separately or, subject to written approval by the Engineer, blended prior to delivery to the mixing plant. The sand shall have a fineness modulus of 1.5 to 2.0 and conform to the following gradation requirements:

Sieve Designation U.S. Std. Square Mesh	Cumulative Percentage by Weight Passing
No. 8	100
No. 16	95-100
No. 30	60-85
No. 50	20-50
No. 100	10-30

Sieve Designation U.S. Std. Square Mesh	Cumulative Percentage by Weight Passing
No. 200	0-5

2.02 MIXES

A. The grout mixes shall be varied to meet the characteristics of each hole as determined by conditions encountered. The water-cement ratio by volume shall be varied in the field to meet the characteristics of each hole, as revealed by the pressure testing and grouting operation, and shall range between 3:1 and 0.6:1. Intermediate proportions may be required to suit the conditions encountered in the individual grout hole. The constituents of the grouts may be varied to include any or all of the additives:

1. Neat Cement Grout: Cement and water used for backfilling holes shall have a water/cement ratio of 1:1.

2. Mortar Grout: Cement, sand, and water.

2.03 EQUIPMENT

A. General: Drilling and grouting equipment used shall be of a type, capacity, and mechanical condition suitable for doing the work, as described in the following paragraphs. The power and equipment and the layout shall meet the applicable requirements of local, State, and Federal regulations and codes. Demonstrate that the mechanical condition of the equipment is satisfactory in the presence of the Engineer at the job site prior to commencement of work. Equipment shall be inspected prior to commencement of work, and any deficiencies noted shall be corrected before proceeding further. Substitution of any piece of equipment after commencement of the work shall not be allowed. Any piece of equipment that is not operating satisfactorily shall be replaced.

B. Drilling Equipment: Standard rotary drilling equipment using water or an air-water mixture as a circulating medium or percussion, air circulation equipment shall be used to perform the drilling. No foaming agents or soap shall be allowed. The equipment shall be capable of drilling holes with a minimum diameter of NX size at an inclination not to exceed 30 degrees measured from the vertical.

C. Grouting Equipment: The grout plant shall be capable of supplying, mixing, stirring, and pumping the grout into holes in a continuous, uninterrupted flow. The plant shall have the capacity adequate for the job, producing grout of uniform consistency. Equipment and accessories shall be maintained in first-class operating condition at all times; and any grout hole that is lost or damaged or prematurely plugged due to mechanical failure of equipment, improper mixing, or inadequacy of grout supply shall be replaced by another hole, drilled by the Contractor at his expense. The power source shall maintain full, even power simultaneously to the systems.

1. Pump: An air or fuel-driven, progressing-cavity-type pump capable of delivering grout slurries at a capacity adequate for the job. The pump shall be a progressive cavity pump such as Robbins and Meyers' "Moyno" or approved equal. Piston pumps are prohibited.

2. Grout Mixer: A mechanical grout mixer capable of effectively mixing and stirring grout having water/cement ratios ranging from 0.6:1 to 6.0:1 measured by volume shall be provided. The mixer shall be capable of producing grout at the capacity and consistency

that is necessary for the job and acceptable to the Engineer. The mixer shall be equipped with a suitable water metering gauge. Neat cement grout shall be passed through a No. 16 screen in route from the grout mixer to the pump.

3. Sump: If necessary, a mechanically agitated sump shall be provided to effectively stir and hold in suspension solid matter contained in the grout. If a sump is not used, fast acting gates may be substituted between the mixing tub and the pump hopper.

4. Header: A circulating grout header shall be used. Control valves shall be connected to the return line and the header. A bleeder valve and a pressure gage with a gage protector shall also be on the header. The header shall be joined directly to the riser pipe by means of a quick connector union. If a flexible connector is also used, the connector shall not exceed 6 feet.

5. Packers: The packers shall be able to seal the grout hole at specified elevations and shall be capable of withstanding the maximum effective grout pressure to be used. Leather packers shall not be used. Packers for pressure washing and testing and grouting should be so designed as to admit 1-1/2- or 2-inch I.D. water or grout pipe into the zone actually being washed, tested, or grouted. Inflatable packers shall be checked for leaks whenever used. In the course of grouting, packers may be grouted in place. Have an adequate number of extra packers on the job in order to avoid unnecessary delays.

6. Accessories: Such valves, pressure gages, pressure hoses, small tools, and accessories as may be necessary to provide a continuous supply of grout and accurate pressure control shall be provided. The pressure hose, grout supply line, riser pipe, and downhole supply lines from header to packer shall have an inside diameter of 1-1/2 or 2 inches. Only mineral oil filled gages, with a minimum error of less than 1 percent shall be permitted. Records of calibrations and corrections shall be included in the quality control reports as specified in Paragraph **[1.02C]** of this specification.

D. Pressure Testing Equipment: Furnish pressure testing equipment and the necessary pumps, packers, gages, and accessories to wash and pressure test each grout hole.

3.00 EXECUTION

3.01 GROUT HOLES

A. General: Drill holes for grouting at the locations required, within a 4-inch tolerance at the surface, in the direction, and to the depths indicated. The Engineer may require certain holes be drilled 2 feet deeper than indicated for exploratory purposes. Keep records as specified in Paragraph 1.02C.

B. Grout Hole Drilling: No core recovery shall be required for grout hole drilling. The diameter of the holes shall be at least NX size at the point of maximum penetration, and the hole shall be of sufficient diameter to allow use of an expansion plug or packer. Grout holes shall be vertical or inclined and shall not exceed an angle greater than 30 degrees measured from the vertical. The actual angles and bearings for the holes shall be determined in the field. Measure the angle and bearing at which drilling is to be initiated at any hole as accurately as possible using a Brunton compass or similar device. Upon completion of drilling, wash the grout hole as specified in Paragraph 3.02B. Maintain the grout holes in an open and unobstructed condition until grout injection into the hole is completed. Clean out and

redrill any grout hole which becomes obstructed prior to completion of the injection of grout into the hole at the Contractor's expense.

C. Backfilling: Backfill grout and existing holes with grout by the tremie method. Grout shall consist of Portland cement and water, with a water/cement ratio of 1:1 or less. Place grout from the bottom of the hole by the tremie method, and keep the end of the grout tube submerged in the grout at all times until the hole is filled. Do not backfill holes containing injected grout until the injected grout has set. Backfill any settlement of the grout occurring as a result of withdrawal of the casing or grout shrinkage with additional grout.

D. Single Line Drilling and Grouting Sequence:

1. Divide the single line portions of the grout curtain into 250-foot sections. Drill and grout primary holes at 50-foot intervals, secondary holes at 10-foot intervals, and tertiary holes at 5-foot intervals. Drill quaternary holes at 2-1/2-foot spacings only if deemed necessary by the Engineer.

2. Before grout injection is started, drill the nearest two advance holes at a spacing approved by the Engineer. Wash and pressure test the hole to be grouted and thoroughly wash the adjacent advance hole. If communication exists between the holes, use packers in the advance holes to shut off the leak.

3. Sequence the drilling and grouting operation such that no drilling is permitted within 50 feet of any hole which is being grouted or has been grouted within the previous 8 hours. After the primary holes for a given 250-foot section are grouted, drill and grout the secondary holes between the primary holes on 10-foot centers. Drill and grout the tertiary holes, splitting the spacing of the secondary holes. Complete each section before proceeding to the adjacent section.

3.02 PROCEDURES FOR DRILLING AND GROUTING

A. General: Perform drilling and grouting using the methods defined herein. However, as conditions develop in the prosecution of the work, some deviations from these procedures and the use of other procedures and sequences may be required.

B. Washing and Pressure Testing:

1. Washing: Immediately upon completion of drilling each grout hole, thoroughly wash the hole by circulating clear water from the bottom of the hole to the top of the hole. Continue the circulation until the wash water clears or for a maximum of 10 minutes. If there is no drill water return, run the pump run at maximum capacity for a period not longer than 10 minutes. No separate payment shall be made for washing. Wash pressure shall not exceed the maximum allowable for grouting.

2. Pressure Testing:

a. Immediately prior to pressure testing, record the water level in the hole to be grouted and the advance holes. Pressure test the lowest zone in the hole with water, using a packer to isolate the zone. Isolate and pressure test progressively higher zones by packers to isolate the take zones and to determine the grouting procedures to be used. Where necessary, use packers to isolate individual zones during pressure testing to avoid damage to overlying or underlying foundation soils.

b. Pressure test each zone with clean water under continuous pressure with a packer or packers in each hole for a minimum of 5 minutes after maximum pressure has been reached. Maximum pressure testing pressures shall be the same as the maximum grouting pressures specified in C.2 of this Paragraph. If after 5 minutes, there is significant increase in the rate at which water is taken, continue the test up to 15 minutes, since this increase may indicate that fractures are being opened. Pressure test the zone using procedures, set-up, and equipment identical to that used for grouting. Inject water up to the maximum pressure to be allowed during grouting of the zone. When muddy water is being returned from the hole, adjacent holes, or surface openings, continue pressure testing until the water clears, but not longer than 60 minutes. When a new or increased return of clear water occurs from one or more of the advance holes, allow water to flow from these holes for 5 minutes, after which shut off the flow from these advance holes and pressure test the initial hole for an additional 5 minutes. Where no pressure can be built up, test the zone at the maximum pumping capacity for 5 minutes. Personnel controlling any part of the grouting operation shall pay close attention to water losses and pressures.

c. If a hole takes no water in all zones, indicating no need for grouting, remove the packer assembly and leave the hole open for backfill grouting and/or for use as an advance hole.

C. Grouting:

1. General: Perform pressure grouting operations using actual mixes, pumping rates, and pressures determined for each hole based upon subsurface conditions.

2. Grouting Pressures: Grouting pressures to be used in the work will vary with conditions encountered in the respective holes. Total maximum pressures shall be 1.0 psi per foot of depth and a minimum pressure of 10 psi. The midpoint of the zone is taken as the depth from which the maximum allowable pressure is calculated.

3. Wasted Grout: Grout that cannot be placed for any reason, within 1 hour after mixing, or sooner if stiffening occurs, shall be wasted.

4. Equipment Arrangement and Operations: The arrangement of the grouting equipment shall be such as to provide a continuous circulation of grout throughout the system and to permit accurate pressure control by operation of a valve on the grout return line, regardless of how small the grout take may be. Prevent the equipment and lines from becoming fouled by the constant circulation of grout and by the periodic flushing out of the system with water. Flushing shall be done with the grout intake valve closed, the water supply valve open, and the pump running at full speed.

5. Cavities:

a. If a cavity of more than 1 foot in vertical extent is encountered by a grout hole, modify normal grouting procedures specified herein as follows:

b. Seat the packer and inject grout at additional stops immediately below and above the cavity, as well as at the stops at the top of each zone. If the packer or drill rods cannot be effectively lowered through the cavity due to the extent or the occurrence of unstable fill, seat the packer and inject grout at a stop immediately above the cavity. Seat packers in the grout and advance holes at the same

elevation. After grouting, remove the packer in the grout hole, allow the grout to harden, redrill the grout, and extend the hole to the final specified depth. If an open hole or high water take condition exists, as determined by loss of drill water or inability to build up pressure during washing and pressure testing operations, start grouting with the grout pump operating as nearly as practicable at constant speed at all times, and start grouting with a thick mix, or use mortar grout if necessary, until the required pressure has been reached.

c. If necessary, drill and grout additional holes arranged in a grid pattern determined by the subsurface conditions. If pressures fail to build up, or the cavity is too large to grout in this manner, continue grouting with the curtain beyond the cavity.

D. Stop Grouting Procedures:

1. Stop grouting is a method whereby each hole is drilled to final depth and grouted by stops through an expansion plug or packer which is set at successively shallower depths. It involves the placement of a grout curtain by drilling and grouting in accordance with the following general procedure.

2. The general procedure is presented only as a guideline of acceptable stop grouting practice and may be modified in the field to accommodate varying foundation conditions. However, unless otherwise permitted by the Engineer, the grouting procedure shall be as follows:

a. Following pressure testing, connect the grout header to the hole to be grouted and circulate water through the entire system: from the sump, through the pump, through the lines to the header, into the hole and back through the lines to the sump. Use packers in the advanced holes, if necessary. If water communication was established between holes during pressure testing, leave the cutoff valves at the communicating advance holes open at the start of the grouting operation to permit water to vent freely to the surface. When grout appears at the surface, close the cutoff valves.

b. Add cement to the fluid in the grout mixer. The initial mix shall have the water to cement ratio no thinner than 3:1 by volume; however, the exact proportions shall be determined in the field to meet the conditions of the particular hole to be grouted. After closing the grout header at the hole, circulate the grout through the system until a second batch of grout is mixed. Open the header at the hole and allow the first batch of grout to enter the hole. Carefully control the header to prevent any instantaneous surge in pressure. After grout has entered the hole, allow the pressure to rise very gradually. The next batch shall then be mixed and discharged as described above.

c. Continue this procedure as long as there is no appreciable build up in pressure. Gradually thicken the mix proportion as long as there is no rapid build-up in pressure; however, do not thicken the mix so much that the grout take is significantly decreased. During the course of grouting, when three-fourths of the maximum allowable pressure is reached, closely control the header to ensure that as the grout mix is thickened, pressure build-up does not occur too rapidly, and that the maximum allowable pressure is not exceeded.

d. When the maximum allowable pressure is reached, do not thicken the mix any further. If the rate of grout take suddenly decreases significantly, immediately add water until only water is being circulated through the grout system and into the hole. Inject water into the hole for a minimum of 2 minutes, after which time, resume normal grouting operations at a lower pressure, using a grout mix at least one step thinner than that previously being injected. During periods of continuous grouting, add water to the sump and circulate through the system and into the hole for a period of 2 minutes every 2 to 3 hours, unless refusal is being approached. If any delay and stoppage of grouting operations occurs while grout is being injected into a hole (due to equipment failure), make every effort to ensure that water is injected into the hole during the period of delay.

e. Make frequent and periodic inspections of the area in the vicinity of the grout hole while grouting to check for grout leaks, especially at known bore holes, wells, springs, and seeps. If a grout leak is found, reduce grouting pressure. Caulk the leak(s) with oakum, wicking, burlap, wood wedges, or lead wool and build a small sand dike around or mounded on the leak. An accelerator may be added to the grout leak(s) at the ground surface. When grout no longer issues from the leak(s), gradually build back up grouting pressure to the previous level and resume normal operations. If the leaking cannot be completely stopped, continue grouting operations, but reduce the pressure.

f. Once the rate of grout take (in sacks per minute) has begun to steadily decrease, do not thicken the mix any further; however, if there is a rapid decrease in the rate of grout take, thin the mix. The grouting of a zone in any hole shall be considered complete when the hole takes 1 cubic foot or less of grout over a 10-minute period.

g. After refusal is reached, close the header and allow the grout to circulate through the lines, while water is added to the sump, thinning the existing mix to the water/cement ratio to be used in the next hole. Move the grout header to the adjacent or advance hole with the next highest water take; however, leave the packer in place and cap the grout pipe with a valve and pressure gage until the pressure on the newly placed grout has dropped to or below the maximum pressure allowed for the next higher zone; raise the packer to the top of the next higher zone. In the meantime, begin grouting on the next hole with an initial mix using the techniques and procedures described above. When grouting is completed on this hole, move the header to the last advance hole and repeat the above procedure again.

h. When grouting of the specified zone for all groups of three holes has been completed, pressure test and grout the next higher zone (if any) as previously described. When all zones of all three grout and advance holes have been grouted, install the packers at the top (and bottom if required) of the lowest zone in the next three holes of the same order. Pressure test and grout these holes as previously described. When the primary holes along one grout line are completed, drill, pressure test, and grout secondary holes as needed using the above procedures. Tertiary (and higher order) holes in the lines shall be completed successively, using the above procedures. After grouting is completed in each section, backfill the holes as specified in Paragraph 3.01C of this Section.

3. Pressure grouting shall not be required any higher than Elevation 12'.

3.03 FIELD QUALITY CONTROL

A. General: Establish and maintain quality control for all operations to assure compliance with contract requirements and maintain records of quality control for construction operations. Run any tests required by these specifications, keep sufficient records of all operations, assure that satisfactory drilling and grouting equipment is provided and kept in good mechanical condition, comply with the requirements of these specifications, provide protection to work and proper cleanup of work areas.

B. Reporting: Furnish a copy of these records, as well as, a record of any corrective action taken, to the Owner or Engineer by the Contractor as Record Data.

END OF SECTION

APPENDIX A

A1.00 MEASUREMENT AND PAYMENT

A1.01 GENERAL

A. The contract prices for the various items of work and materials, as described in Paragraph **[A1.03]**, Payment, shall constitute full compensation for mobilizing, demobilizing, and furnishing the equipment necessary to perform the drilling and grouting of the structure in accordance with these specifications; drilling, washing, and pressure testing of grout holes; care and disposal of waste water and waste grout; clean-up of the site; furnishing, handling, transporting and storing of grout materials; and for furnishing labor and supplies incidental to the work. No payment shall be made for grout or the material constituents thereof, which has been wasted for any reason.

A1.02 MEASUREMENT

A. Drilling of grout holes shall be measured for payment on the basis of the linear feet of holes actually drilled as shown on the drawings or as directed by the Engineer.

B. Pressure washing and pressure testing shall be measured for payment on the basis of the number of grout holes pressure washed and pressure tested.

C. Placing grout shall be measured for payment on the basis of the number of cubic feet of materials by absolute volume, regardless of proportions of the mixes, satisfactorily placed in grout holes.

D. Portland cement used in the grout shall be measured for payment on the basis of the number of tons of cement used in the grout satisfactorily placed in grout holes.

A1.03 PAYMENT

A. Payment for drilling grout holes shall be made at the contract unit price per linear foot for "Drilling Grout Holes." This payment shall be full compensation for labor, equipment, and materials, and for performing operations necessary to drill the grout holes.

B. Payment for pressure washing and pressure testing shall be made at the contract unit price per each grout hole pressure washed and pressure tested for "Washing and Pressure Testing of Grout Holes." This payment shall be full compensation for labor, equipment and materials, and for performing operations necessary to pressure wash and pressure test the grout holes.

C. Payment for placing grout in grout holes shall be made at the contract unit price per cubic foot for "Placing Grout." This payment shall be full compensation for proportioning the mix as directed, and mixing and injecting the grout as specified herein or as may be directed. Separate payment shall be made for the cement used in the grout.

D. No separate payment shall be made for packers grouted in the holes. The cost of packers shall be included in the unit price bid for "Placing Grout."

E. Payment for the Portland cement shall be made at the contract unit price per ton for "Portland Cement in Grout."

END OF APPENDIX A

31 91 19.13 TOPSOIL PLACEMENT & GRADING

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment and incidentals necessary to place topsoil, free from rock and foreign material in areas designated to receive sodding or seeding.

2.00 PRODUCTS

2.01 TOPSOIL

A. GENERAL

The topsoil shall be fertile loam, easily cultivated and free from objectionable material, and shall have a relatively high erosion resistance and be readily able to support the growth of the planting, seeding, or sodding specified on the plans.

B. SOURCES

1. The topsoil may be obtained from the right-of-way at sites of proposed excavation, or it may be obtained from sources outside the right-of-way, secured by the Contractor, and meeting the approval of the Engineer.

2. Topsoil required in addition to salvaged topsoil from the project shall be secured from approved off-site borrow sources. Excavated material from construction which is suitable for topsoil shall be salvaged and used before any topsoil is obtained from borrow source.

3.00 EXECUTION

3.01 INSTALLATION

Stockpile topsoil material at locations approved by the Owner's Representative. Remove any trash, wood, brush, stumps or other objectionable materials prior to placement. The source and stockpile areas shall be kept drained and in a neat and presentable condition. Place and spread topsoil to a uniform depth to provide 6" compacted depth, while maintaining drainage in areas to be seeded or sodded.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

32 11 23 AGGREGATE BASE COURSES

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment and incidentals necessary to perform operations in connection with the construction of flexible base. Flexible base shall consist of a foundation for a road surface or for other courses. Construct the flexible base foundation course as specified herein in one or more courses in conformance with the typical sections, lines, and grades indicated in the plans.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

Sieve analysis liquid and plastic limits and plasticity index of the material to be used as record data.

1.03 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety:

American Society for Testing and Materials (ASTM) Standards:

ASTM C131	Test Methods for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D2217	Practice of Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.04 DELIVERY AND STORAGE

Deliver materials in approved vehicles. Stockpile materials in locations that are acceptable to the Owner’s Representative and shape to drain.

2.00 PRODUCTS

2.01 MATERIALS

A. Base; General:

1. The materials shall be crushed or uncrushed as necessary to meet the requirements hereinafter specified, and shall consist of durable coarse aggregate particles mixed with approved binding materials. The material shall be approved by the Owner’s Representative.
2. Should the Contractor elect to produce the material from local pits, secure the material from the sources approved by the Owner’s Representative. The pits as utilized shall be

opened in such a manner to immediately expose the vertical faces of the various strata of acceptable material and unless otherwise directed, the material shall be secured in successive vertical cuts extending through the exposed strata, in order that a uniform mixed material will be secured.

B. Types:

1. Unless the type of material to be used is specified on the plans, the Contractor may use any one of the following types, provided the material proposed for use by the Contractor meets the requirements set forth in the specification test limits tabulation.

2. Type A: Crushed Limestone:

   a. The material shall be obtained from approved sources, shall be crushed, and shall consist of durable particles of limestone mixed with approved binding materials. The material shall be approved by the Owner's Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size	Percent Passing
1-3/4"	100
3/8"	40-80
No. 4	25-60
No. 40	15-35

   b. The material when tested under "The Wet Ball Method for Determining the Disintegration of Flexible Base Materials" shall not develop more than 50 percent soil binder.

   c. Materials passing the No. 40 sieve shall be known as "Binder" and shall meet the following requirements:

      1). The liquid limit shall not exceed 40 when tested in accordance with ASTM D423.

      2). The plastic limit shall be determined by testing in accordance with ASTM D424.

      3). The plasticity index shall not exceed 12 nor be less than 4 when calculated in accordance with ASTM D424.

      4). The preparation of samples for testing according to ASTMD4318 and shall be in accordance with the requirements of ASTM D2217.

      5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 45 percent when tested in accordance with ASTM C131.

3. Type B: Processed Gravel:

   a. The materials shall be obtained from approved sources and shall consist of durable particles of gravel mixed with approved binding materials. The material shall be approved by the Owner's Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size Square Opening	Percent Passing
1-3/4”	40-80
No. 4	40-80
No. 4	25-60
No. 40	15-35

b. Materials passing the No. 4 sieve shall be known as “Binder.” The portion of material passing the No. 40 sieve shall be known as “Soil Binder” and shall meet the following requirements:

1). The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318.

2). The plastic limit shall be determined by testing in accordance with ASTM D4318.

3). The plasticity index shall not exceed 10 when calculated in accordance with ASTM D4318.

4). The preparation of samples for testing according to ASTM D4318 and shall be in accordance with the requirements of ASTM D2217.

5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 55 percent when tested in accordance with ASTM C131.

4. Type C: Bank-Run Gravel:

a. The materials shall be obtained from approved sources and shall consist of durable particles of gravel mixed with approved binding materials. The material shall be free from thin or elongated pieces, lumps of clay, soil, loam, or vegetable matter. The material shall be approved by the Owner’s Representative at the source. The processed material when properly slaked and tested by standard laboratory methods shall meet the following requirements:

Sieve Size	Percent Passing
1-3/4”	95-100
No. 4	25-70
No. 40	15-35

b. Materials passing the No. 4 sieve shall be known as “Binder.” The portion of material passing the No. 40 sieve shall be known as “Soil Binder” and shall meet the following requirements:

1). The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318.

2). The plastic limit shall be determined by testing in accordance with ASTM D4318.

3). The plasticity index shall not exceed 10 when calculated in accordance with ASTM D4318.

4). The preparation of samples for testing according to ASTM D4318 and shall be in accordance with the requirements of ASTM D2217.

5). Materials retained on the No. 4 sieve shall have a percent wear of not more than 55 percent when tested in accordance with ASTM C131.

3.00 EXECUTION

3.01 PREPARATION

A. In conformance with the typical sections, lines, and grades indicated, excavate and shape the road bed. Remove unstable or otherwise objectionable material from the subgrade and replace with approved material. Fill holes, ruts, and depressions with approved material. Sprinkle the subgrade, if necessary, and reshape and roll to the extent directed in order to place the subgrade in an acceptable condition to receive the base material. The surface of the subgrade shall be smooth and conform to line, grade, and typical sections. Prepare sufficient subgrade in advance to ensure satisfactory prosecution of the work.

B. Utilize material excavated in the preparation of the subgrade in the construction of adjacent shoulders and slopes or otherwise disposed of as directed. Secure any additional material required for the completion of the shoulders and slopes from sources indicated or designated by the Owner's Representative.

C. Immediately before placing the base course material, check the subgrade for conformance with the grade and typical sections indicated. The surface of the subgrade shall not show deviation in excess of 1/4 inch in 5 feet in cross-section, nor 1/2 inch in 16 inches longitudinally.

3.02 PLACEMENT

A. Number of Courses: Where the base course exceeds 6 inches in thickness, construct the base course in two or more courses of equal thickness as indicated on the typical section.

B. Placing Types A, B, and C: Spread and shape the material deposited on the subgrade the same day. Move the material at least once from the original position in which it is deposited. In the event of inclement weather or other unforeseen circumstances which render impractical the spreading of the material during the first 24 hour period, scarify and spread the material as directed by the Owner's Representative. Sprinkle the material, if directed, and then blade, drag, and shape to conform to the typical section as indicated. Correct or replace and remove areas and "nests" of segregated course or fine material with well graded material as directed by the Owner's Representative. If additional binder is considered desirable or necessary after the material is spread and shaped, furnish and apply material in the amount directed by the Owner's Representative. Carefully incorporate such binder with the material in place by scarifying, harrowing, brooming, or by other approved methods.

C. First Course (Types A, B, and C): Sprinkle the course as necessary and compact to the extent necessary to provide not less than the percent density as hereinafter specified under "Density." In addition to the requirements specified for density, compact the full depth of the flexible base to the extent necessary to remain firm and stable under construction equipment. After each section and course of flexible base is complete, the independent testing laboratory shall make tests of the material. If the material fails to meet the density

requirements, rework the material as necessary to meet the requirements. Throughout this entire operation, maintain the shape of the course by blading, and smooth the surface upon completion in conformity with the typical sections, lines, and grades indicated. On the surface of which pavement is to be placed, correct any deviation in excess of 1/4 inch in cross-section and in a length of 16 inches measured longitudinally by loosening, adding, or removing material, reshaping, and re-compacting by sprinkling and rolling. Immediately correct irregularities, depressions, or weak spots which develop by scarifying the areas affected, adding suitable material as necessary, reshaping, and re-compacting by sprinkling and rolling. Should the base course, due to any reason or cause, lose required stability, density, and/or finish before the surfacing is complete, re-compact and refinish the base course at the Contractor's sole expense.

D. Succeeding Courses (Types A, B, and C): Use the same construction methods as prescribed for the first course. Prior to placing the surfacing on the completed base, "dry cure" the base to the extent directed by the Owner's Representative.

E. Density: The density of the flexible base material shall not be less than 95 percent maximum dry density as determined by ASTM D698. Perform testing of densities of compacted base in accordance with a method approved by the Owner's Representative.

F. Curb and Gutter: Place and compact paving types with flexible base under the curb and gutter at the same time and in the same operation as the flexible base under the pavement. Place the flexible base in 6-inch maximum courses. Place and compact the first course under both the curb and gutter and the pavement.

END OF SECTION

32 12 16 ASPHALT PAVING

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, materials, equipment and incidentals necessary to perform operations in connection with the construction of hot mix asphaltic concrete (HMAC) base course, leveling-up course and surface course or any other combination of these courses. Construct the pavement on the previously completed and approved subgrade, base, or existing pavement.

1.02 QUALITY ASSURANCE

Design Criteria: Use the services of an independent testing laboratory to prepare a mix design to comply with Texas Department of Transportation, Standard Specification Item 340 or may use a previously prepared mix design meeting the specification requirements with satisfactory substantiation of experience with the mix.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

Mix design as record data.

1.04 STANDARDS

A. Hot mix asphaltic concrete (HMAC) pavement shall conform to the requirements of the current Texas Department of Transportation (TXDOT), Standard Specification for “Dense-Graded Hot Mix Asphaltic “, Item 340.

B. Asphaltic material shall comply with Texas Department of Transportation (TXDOT) Standard Specification Item 300.

1.05 DELIVERY AND STORAGE

Haul the asphaltic mixture to the job site in tight vehicles previously cleaned of foreign materials. Arrange the dispatching of vehicles so that all material delivered shall be placed and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers may be required. The inside of the truck body may be given a light coating of oil, if necessary, to prevent the asphaltic mixture from adhering to the body.

1.06 JOB CONDITIONS

A. Do not apply prime coat when the air temperature is below 50 F and falling, but may be applied when the air temperature is above 40 F and rising, the air temperature being taken in the shade and away from artificial heat. Do not place asphaltic material when general weather conditions, in the opinion of the Owner’s Representative are not suitable.

B. The asphaltic mixture shall be at a temperature between 225 and 350 F when dumped from the mixer. The Owner’s Representative shall determine the temperature, within the above

limitations. The mixture when dumped from the mixer shall not vary from the selected temperature more than 30 F.

2.00 PRODUCTS

2.01 MATERIALS

A. Aggregate: Conform to TXDOT Standard Specification Item 340. The Type "B" mixtures and at least three bins when producing Type "D" mixture. These bins shall contain the following sizes of aggregate, in percentages by weight or by volume, as applicable.

1. Gradation for base course or leveling-up course shall comply with Type B listed as follows:

a. Type "B" (Fine Graded Base Course):

Sieve Size	Percent Passing by Weight or Volume
1"	98-100
3/4"	84-98
5/8"	75-95
3/8"	60-80
No. 4	40-60
No. 8	29-43
No. 30	13-28
No. 50	6-20
No. 200	2-7
VMA percent minimum	12
The asphaltic material shall form from 3.5 to 7 percent of the mixture by weight unless specified otherwise on the plans.	

2. Gradation for surface course shall comply with Type D listed as follows:

a. Type "D" (Fine-Graded Surface Course):

Sieve Size	Percent Passing by Weight or Volume
1/2"	98-100
3/8"	85-100
No. 4	50-70
No. 8	35-46
No. 30	15-29
No. 50	7-20
No. 200	2-7

VMA percent minimum	14
The asphaltic material shall form from 4 to 8 percent of the mixture by weight unless specified otherwise on the plans.	

B. Asphaltic Materials: Comply with TXDOT Standard Specification Item 300. In general, the grade of asphalt shall be AC-10. Other grades of asphalt shall be considered if weather conditions or mix design appear to warrant a change. Prime coat shall comply with TXDOT Standard Specification Item 300, Grade MC-30. Tack coat shall meet the requirements of cutback asphalt RC-250.

2.02 EQUIPMENT

A. The equipment necessary for the construction of the hot mix asphaltic concrete pavement shall be on the project site and shall be approved by the Owner's Representative as to condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used. Equipment shall be maintained in good repair and operating condition.

B. Spreading and Finishing Machines:

1. The spreading and finishing machine shall be of a type approved by the Owner's Representative and capable of producing a surface that shall meet the requirements of the typical cross section and surface test.

2. Rollers:

a. Pneumatic Tire Roller: The roller shall consist of not less than seven pneumatic tire wheels, running on axles in such a manner that the rear group of tires shall cover the entire gap between adjacent tires of forward group; mounted in a rigid frame; and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such a manner that the roller may be turned within a minimum circle. The tire shall afford surface contact pressures up to 90 pounds per square inch or more. The roller shall be so constructed as to operate in both forward and a reverse direction with suitable provisions for moistening the surface of the tires while operating; and shall be approved by the Owner's Representative.

b. Two-Axle Tandem Roller: The roller shall be an acceptable power-driven, steel-wheel tandem roller weighing not less than 8 tons. The roller must operate in forward and reverse directions; contain provisions for moistening the surface of the wheels while in motion; and shall be approved by the Owner's Representative.

c. Three-Wheel Roller: The roller shall be an acceptable power-driven, all steel three wheel roller weighing not less than 10 tons. The roller must operate in forward and reverse directions; contain provisions for moistening the surface of the wheels while in motion; and shall be approved by the Owner's Representative.

d. Vibratory Steel Wheel Roller: If approved for use by the Owner's Representative, this roller shall have a minimum weight of 6 tons. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact

the material on which it is used. The roller shall be operated in accordance with the Manufacturer's recommendations.

3. Straightedges: The Contractor shall provide acceptable straightedges for the surface testing. Satisfactory templates shall be provided as required by the Owner's Representative.

3.00 EXECUTION

3.01 PREPARATION

A. Prime Coat: Apply a uniform coat of prime coat asphaltic material to the surface of the prepared subgrade, sub-base, or base, applied at a rate of not less than 0.15 gallon per square yard of surface. Apply a thin uniform coat of the prime coat material to contact surfaces of gutters, manholes, and other structures.

B. Tack Coat: Thoroughly clean the surface of the asphalt base course and apply a uniform coat of tack material meeting the requirements for cutback asphalt RC-250. Apply a tack coat when the surface to be paved is Portland cement concrete, brick, or asphaltic pavement. Apply the tack coat using sprayer at a rate not exceeding 0.05 gallon per square yard surface. Paint all asphalt edges and contact surfaces of curbs, gutters, vertical faces, and other structures in actual contact with asphaltic mixes with asphaltic material to provide a closely bonded, water-tight joint.

C. Compacted Thickness of Asphaltic Concrete Surface Courses and Base Courses:

1. Surface Course: The compacted thickness or depth of the asphaltic concrete surface shall be as indicated on the plans. Where the plans indicate a depth or thickness of the surface course greater than 2 inches compacted depth, same shall be placed in multiple courses of equal depth, each which shall not exceed 2 inches compacted depth. A tack coat is required between any of the multiple courses, and applied at the rate specified.

2. Base Course: The compacted thickness or depth of each base shall be as indicated. Where the plans indicate a depth or thickness of the course greater than 4 inches, same shall be accomplished by constructing multiple lifts of approximately equal depth, each of which shall not exceed these maximum compacted depths. An additional tack coat is required between any of the multiple lifts, and applied at a rate specified.

3.02 PLACEMENT

A. Place the asphaltic mixture on an approved base course with the previously specified spreading and finishing machine in such a manner that, when properly compacted, the finished course shall comply with the maximum thickness requirements, shall be smooth, of uniform density and meet the requirements of the typical cross-sections and the surface test. During the placing and spreading of the asphaltic material, take care to prevent the spilling of the material onto adjacent pavement, gutters, or structures.

B. In small areas, which are inaccessible to the spreading and finishing machine, hand spreading may be authorized by the Owner's Representative, provided an acceptable surface can be obtained.

3.03 COMPACTION

A. Rolling with the three-wheel and tandem rollers shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Rolling with the pneumatic tire roller shall be done as directed by the Owner's Representative. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic surface material. If displacement should occur, correct the situation at once by the use of rakes and fresh asphaltic mixtures. The roller shall not be allowed to stand on the surface course when it has not been fully compacted and allowed to cool. To prevent adhesion of the surface to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted. Rollers must be in good mechanical condition. Take the necessary precautions to prevent the dripping of gasoline, oil, grease, or other foreign matter on the surface course while the rollers are in motion or when standing. In areas where surface course cannot be compacted with the roller, hand tamps, lightly oiled, shall be used to secure the required compaction.

B. With approval by the Owner's Representative, the vibratory steel wheel roller may be substituted for the three-wheel roller and tandem roller. Each course, after final compaction, shall contain from 5 to 9 percent air voids determined by TXDOT Test Method TEX207-F and TEX-227-F.

3.04 FIELD QUALITY CONTROL

A. Surface Tests: The finished surface of the pavement after compression shall be smooth and true to the established line, grade, and cross-section. When tested with a 16-foot straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of 1/16 inch per foot from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed 1/4 inch at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

B. Pavement Thickness Test: Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the Owner or their authorized representative unless otherwise specified in the special provisions or in the plans. The number and location of tests shall be at the discretion of the Owner's Representative. The cost for the initial pavement thickness test shall be at the expense of the Owner. In the event a deficiency in the thickness of the pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the Contractor's expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.

END OF SECTION

32 31 13 CHAIN LINK FENCE AND GATES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidentals necessary to install chain link fencing as specified herein. Chain link fencing shall include personnel, barbed wire security strands.

B. The fence shall have a fabric height of 6 ft with a three- strand barbed wire top, making a total minimum height of 7 ft.

C. All proposed fencing shall match the existing fence. The requirements within this specification and details on the plans provide the minimum requirements. Contractor is required to rehabilitate the existing fence by stretching existing fabric and barbed wire, replacing or resetting any damaged or loose posts, cleaning and applying cold galvanize to any existing rusty components, and all other appurtenant work to bring the existing fence to a like new rehabilitated condition.

1.02 QUALITY ASSURANCE

A. The manufacturer shall be a company engaged in the manufacturing of chain link fencing and shall be in compliance with the Chain Link Fence Manufacturer's Institute (CLFMI).

B. The chain link fencing shall be Standard Industrial grade and shall meet the requirements of that grade, according to the CLFMI "PRODUCT MANUAL".

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

A. Record Data:

1. Manufacturer's product data sheets and specifications

2. Certification for materials and coatings

3. Shop drawings showing material sizes and weights, fencing heights mounting details, gates and operators

4. Manufacturer’s Warranty Information.

B. O&M Manual – Manufacturer’s warranty information.

1.04 STANDARDS

The applicable provisions of the following references and standards shall apply as if written herein in their entirety:

A. American Society for Testing and Materials (ASTM) Standard

ASTM A53	Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A123	Zinc (Hot Galvanized) Coatings on Products, Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip
ASTM A392	Zinc Coated Steel Chain Link Fabric
ASTM A491	Aluminum-Coated Steel Chain Link Fence Fabric
ASTM A570	Hot Rolled Sheet and Strip, Structural Quality
ASTM A585	Aluminum-Coated Steel Barbed Wire
ASTM A817	Standard Specifications For Metallic-Coated Steel Wire For Chain Link Fence Fabric
ASTM A824	Metallic-Coated Steel Marcelled Tension Wire
ASTM F567	Installation of Chain Link Fence
ASTM F626	Fence Fittings
ASTM F688	Polyvinyl Chloride (PVC) Coated Steel Chain Link Fence Fabric
ASTM F900	Industrial and Commercial Swing Gates
ASTM F1083	Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1184	Industrial and Commercial Horizontal Slide Gates

B. Chain Link Fence Manufacturers Institute (CLFMI)

CLF2445	Product Manual

1.05 DELIVERY AND STORAGE

Products shall be stored at the site on wood platforms raised above the surrounding grade, and covered with weather-resistant coverings.

1.06 JOB CONDITIONS

A. Contractor shall visit the site and determine the conditions which must be taken into consideration in the installation of the fencing. Report any condition which could affect the quality of installation.

B. Ascertain soil condition at the site and provide drilling equipment suitable for boring to the required depth.

1.07 GUARANTEE

Products furnished in this section shall be guaranteed in writing by the manufacturer's standard warranty in addition to Contractor's warranty.

2.00 PRODUCTS

2.01 MATERIAL

A. CHAIN LINK FABRIC: 9 gauge galvanized steel wire fabric, Class I, having a coating weight of 1.2 oz per square feet, and a 2" mesh. Top edge of mesh shall have selvage edge and bottom of fabric shall be twisted.

B. TOP RAIL: 1-5/8" O.D. galvanized pipe, weighing not less than 2.27 pounds per foot, with outside sleeve-type couplings at least 7" long.

C. LINE POSTS: For fence height over 6 ft., line posts shall be galvanized 2" H-column, weighing not less than 3.65 pounds per foot, or 2-3/8" O.D. schedule 40 pipe, weighting not less than 3.65 lbs/ft. Spacing not to exceed 10'-0". Fabric shall be tied to columns with 6 gauge galvanized clips on 14" centers and to pipe with 11 ga galvanized steel tie wire.

D. TERMINAL/CORNER POSTS: For fence fabric over 6 ft in height, the posts shall be 2-7/8" O.D. diameter, weighing 5.79 lbs /ft. Posts shall be equipped with 1/4" x 3/4" tension bars, 12 gauge x 1" wide tension bands, and 3/8" carriage bolts, bands on approximately 14" centers. Hardware shall be galvanized.

E. BOTTOM TENSION WIRE: No. 7 galvanized or aluminum-coating spring coil or tension wire which shall hold fabric in proper alignment and be resilient so as to restore alignment when fabric is deflected. Fabric shall be fastened to bottom tension wire with No. 12 ½ gauge galvanized or aluminum coated rings. Steel tension wire shall be Class 2 (1.20 oz. per sq. ft.) and aluminum coated wire shall have 0.40 oz aluminum per sq. ft.

F. BARBED WIRE: 12 1/2 gage, twisted zinc coated barbed wire with 14 gauge 4 point barbs on 5" spacing, conforming to ASTM A121, Class 2.

G. BARBED WIRE SUPPORT ARMS: Heavy weight pressed steel arms having an incline of 45 degrees. The arms shall have holes which allow passage of top rail and slots to receive barbed wire at proper spacings. Arms shall be capable of a downward pull at the outside of the arm of 250 pounds.

H. WIRE TIES: 9 gauge aluminum.

I. POST TOPS: Pressed steel or malleable iron, galvanized. Top posts shall be designed to permit passage of the top rail.

J. STRETCHER BARS: One piece galvanized steel having a minimum size of 1/4" x 3/4".

K. STRETCHER BAR BANDS: Galvanized steel. Tension bars shall be formed from flat or beveled steel and shall have a minimum thickness after galvanizing of 0.078 inch by 3/4 inch for posts 4" O.D. or less, and 0.1.8 inch by 7/8 inch for posts larger than 4" O.D.

L. BOLTS: 5/16" x 1-1/4" galvanized steel carriage bolts with nuts, or other appropriate fasteners according to the application.

M. STRUCTURAL AND MISCELLANEOUS STEEL: Rolled steel shapes conforming to ASTM A36, galvanized according to ASTM A123.

2.02 CONCRETE

Concrete used for setting posts, ribbon curb/mowstrip and other accessories shall be Class B and shall otherwise meet the requirements of Section 03 30 00.01 “Cast-in-Place Concrete.”

2.03 HORIZONTAL-SLIDE GATES

A. General: Comply with ASTM F1184 for single slide gate types:

1. Gate must be able to bel opened and closed easily by one person.

2. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.

3. UL 325 and ASTM F-2200 compliant

B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 1184 and the following:

1. Gate Fabric Height: Shall match adjacent fence fabric height.

2. Gate Opening Width: As indicated on plans

3. Gate Frame: Fabricate chain link cantilever slide gates in accordance with ASTM F- 1184, Type II, Class 2, using aluminum members conforming to ASTM B 221, alloy and temper 6061- T6.

C. Frame Corner Construction:

Welded frame with panels assembled with bolted or riveted corner fittings and 5/16-inch-diameter, adjustable truss rods for panels 5 feet wide or wider.

D. Extended Gate Posts and Frame Members: When barbed wire top is specified, the end members of the gate frames shall be extended 1 ft above the top horizontal member to

which 3 strands of barbed wire, uniformly spaced, shall be attached by use of bands, clips or hook bolts.

E. Track Assembly: Manufacturer's standard track, with framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Roller Guards: As required per ASTM F 1184 for Type II, Class 1 gates.

G. Hardware:

A. Latches shall be shall be galvanized steel with stainless steel hardware for approval by the Owner.

B. Hangers, roller assemblies, and stops fabricated from galvanized steel with stainless-steel fasteners.

3.00 EXECUTION

3.01 PREPARATION

Accurate locate borings for setting posts. Intermediate posts shall be spaced at even spacing between terminal or gate posts.

3.02 CONCRETE MOWSTRIP/RIBBON CURB

A. Construct and place concrete per Section 03 30 00 “Cast-in-Place Concrete”, including reinforcement, placement, curing, and all related work.

B. Subgrade Preparation

1. Subgrade for curbing shall be excavated so as to have a cushion, a minimum of 2 inches thick of limestone base which shall be spread, wetted and thoroughly tamped. If dry, the cushion shall be sprinkled lightly before concrete is deposited thereon. Where the subgrade is rock, or gravel, 70% of which is rock, the 2-inch cushion need not be used. The OWNER will determine if the subgrade meets the above requirements.

2. If the subgrade is undercut, or the natural ground is below "top of subgrade", the necessary backfill shall be made with an approved material compacted with a mechanical tamper. Hand tamping will not be permitted.

C. Expansion Joints

1. Expansion joint material shall be provided at intervals not to exceed 50 feet and shall extend the full width and depth of the concrete. Templates for "dummy" joints shall be of steel, not less than 3/16 of an inch in thickness and patterned to the shape of the curb. Templates shall be cleaned and oiled and spaced to cut the curb intersections 10

feet in length. The templates shall extend a distance of 8 inches into the curb from the top down.

2. Two round smooth dowel bars 3/8 of an inch in diameter and 18 inches long shall be installed at each expansion joint. One 9-inch end of each dowel shall be thoroughly coated with hot oil asphalt so that it will not bond to the concrete; approved types of slip joints may be used in lieu of coating ends of dowels. The dowels shall be placed on the vertical centerline 3 inches from the top and bottom.

3.03 FENCE INSTALLATION

A. The gates shall be installed by skilled and experienced fence erectors and on level grades. Set line posts in concrete piers having a minimum size of 14" in diameter and 42" deep. Gate posts shall be set in concrete a minimum of 18" in diameter and 48" deep. The complete fence shall discourage tampering with connections and ends shall be secured to prevent easy removal or disconnecting.

B. The fence shall be installed by skilled and experienced fence erectors and on level grades. Set line posts in concrete piers having a minimum size of 10" in diameter and 36" deep. Corner and terminal posts shall be set in concrete a minimum of 12" in diameter and 48" deep. The complete fence shall discourage tampering with connections and ends shall be secured to prevent easy removal or disconnecting.

C. Post braces shall be provided for each corner, pull, and end post for use when top rail is omitted or with fabric 6 feet or more in height, and shall consist of a round tubular brace extending to each adjacent line post at approximately mid-height of the fabric, and a truss consisting of a rod not less than 5/16" nominal diameter from the line post back to the corner, pull, or end post, with a turnbuckle or other equivalent provision for adjustment. Truss rods may be eliminated in any line of fence where there is a continuous center rail.

D. Post tops shall consist of combinations tops with barbed wire supporting arms. Top shall be provided with a hole suitable for the through passage of the top rail. The post tops shall fit over the outside of posts and shall exclude moisture from posts.

E. Top rails shall be in lengths not less than 18 feet, and shall be fitted with couplings or wedged for connecting the lengths into a continuance run. The couplings shall be not less than 6 inches long, with .070 minimum wall thickness, and shall allow for expansion and contraction of the rail. Suitable ties or clips shall be provided in sufficient number for attaching the fabric securely to the top rail at intervals not exceeding 24".

F. Ties or clips shall be provided for attaching the fabric to all line posts at intervals not exceeding 15"; and not exceeding 24" when attaching fabric to top rail or tension wire.

G. Provide one tension bar for each end and gate post, and two for each corner and pull post. Bands or clips of galvanized steel shall be provided in for attaching the fabric and stretcher bars to all terminal posts not exceeding 15".

3.04 GATE OPERATOR [NOT USED]

3.05 FIELD QUALITY CONTROL

A. Gate posts shall be accurately located to within 2".

B. Intermediate posts shall not deviate from perfect alignment in a run by more than 1/2".

C. Spacings between intermediate posts between corner and terminal post shall not exceed 3".

3.06 CLEAN AND ADJUST

Adjust all gates to permit free and easy openings without binding.

END OF SECTION

32 31 32 WOOD FENCES AND GATES

1.00 GENERAL

1.01 SECTION INCLUDES

A. Wood fences.

B. Wood gates.

C.Excavation for posts.

1.02 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete

1.03 REFERENCES

American Society for Testing and Materials (ASTM) Standards:

ASTM C 94	Standard Specification for Ready-Mixed Concrete.
ASTM C 177	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
ASTM D 143	Standard Test Methods for Small Clear Specimens of Timber.
ASTM D 198	Standard Test Methods of Static Tests of Lumber in Structural Sizes.
ASTM D 1413	Standard Test Method for Wood Preservatives by Laboratory Soil-Block Cultures.
ASTM D 1761	Standard Test Methods for Mechanical Fasteners in Wood.
ASTM D 2395	Standard Test Methods for Specific Gravity of Wood and Wood-Based Materials.
ASTM D 4761	Standard Test Methods for Mechanical Properties of Lumber and Wood-Base Structural Material
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials.
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials.

A. American Wood Preservers Association (AWPA) E1-06 - Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00 – Document Management.

B. Product Data: Manufacturer's data sheets on each product to be used indicating sizes, profiles, surface finishes, and performance characteristics, and including:

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Installation methods.

4. Instructions on care and cleaning of wood products.

C. Verification Samples: For each finish product specified, two samples, minimum size 9 inches (229 mm) square, representing actual product, color, and patterns.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle products in accordance with the manufacturer's instructions

B. Store level and flat, off ground or floor, with supports at each end and maximum 24 inches on center.

C. Do not stack wood over 8 feet (203 mm) high.

D. Cover wood with waterproof covering, vented to prevent moisture buildup.

2.00 PRODUCTS

2.01 MATERIALS

A. General

1. Gate hinges and post caps shall be of galvanized steel

B. Wood : Cedar slats wood :

C. Bottom, mid and top ail: Minimum 2-inch x 6-inch x 8ft SP #2 treated

D. Corner, Gate, End, or Line Posts

1. Steel Pipe

a. ASTM 53

b. Size as indicated on drawings

2. Accessories

a. Post cap Provide one cap for each post

b. Cap to have provision for barbed wire when necessary

3. Setting Materials

a. Concrete

b. Minimum 28-day compressive strength of 3,000 psi

4. Fasteners
    a. Fastener withdrawal, tested to ASTM D 1761:
        1). Nail: 163 pounds per inch.
        2). Screw: 558 pounds per inch.

2.02 COMPONENTS

A. Fence System:
    1. Fence height:
        a. 8 feet.
        b. Custom height as indicated on the Drawings.
    2. Components:
        a. Fence posts.
        b. Post caps: Submit to Owner for selection.
            1). Pyramid.
            2). Flat.
            3). Crown
        c. Top rail
        d. Bottom rail covers/Pickets, 67 inches.
        e. Bottom rail covers/Pickets, 91 inches.
        f. Fence brackets.
B. Surface texture: Smooth.
    1. Color: Submit to Owner for selection

2.03 ACCESSORIES

A. Fasteners: 1-5/8 inch galvanized or corrosion-resistant coated steel. Provide finish nails where applicable.

B. Concrete: Provide as Specified in Section 03 30 00.01 - Cast-in-Place Concrete; minimum 3000 PSI compressive strength at 28 days, with a 3 to 5-inch slump.

C. Concrete: Provide concrete conforming to ASTM C 94; minimum 2500 PSI compressive strength at 28 days, with a 3 to 5-inch slump.

D. Gate Hardware:
    1. Provide two hinges per gate leaf minimum, and size to gate weight and conditions.
    2. Provide center gate stop and drop rod for double gates.
    3. Provide with latching mechanism.
    4. Provide with padlock provisions.

3.00 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.02 PREPERAATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions

3.03 INSTALLATION

A. Wood Fence Framing

1. Steel Posts are required for all required screening fences.
2. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30 degrees or more.
3. Space line posts uniformly at 10 feet on center.
4. Set all posts in concrete.
    a. Drill holes in firm, undisturbed or compacted soil.
    b. Drill hole diameter 4 times greater than outside dimension of post (minimum 12 inches).
    c. Set post bottom 24 inches below surface when in firm, undisturbed soil.
    d. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
    e. Place concrete around posts in a continuous pour.
    f. Trowel finish around post. Slope to direct water away from posts.
5. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

B. Slats

1. Place slats approximately 1 inch above the ground, and on a straight grade between posts by excavating high points of the ground.
2. Fasten slats to top and bottom railings with 2 galvanized screws designed for wood fence construction at both the top and bottom rail.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

32 92 13 HYDRO MULCHING

1.00 GENERAL

1.01 WORK INCLUDED

Furnish labor, material, equipment and incidentals necessary to prepare the ground, furnish and install fertilizer and hydromulching seed of the kind specified for all areas disturbed by the construction operations.

1.02 SUBMITTALS

Submittals shall be in accordance with section 01 33 00 “Document Management” and must include:

A. Texas Testing Seed Label

B. Specification of fertilizer and mulch

1.03 STANDARDS

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

Texas Seed Law

1.04 GUARANTEES

The Contractor shall fertilize and reseed any area which fails to survive for a period of one year from the date the project is accepted by the Owner.

2.00 PRODUCTS

2.01 MATERIALS

A. GENERAL

Seed used must carry a Texas Testing Seed label showing purity and germination, name, type of seed, and that the seed meets all requirements of the Texas Seed Law. Seed furnished shall be of the previous season's crop and the date of analysis shown on each tag shall be within nine (9) months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers.

B. SEED

1. For areas outside of TxDOT ROW:

   The specified seed shall equal or exceed the following percentages of purity and germination:

Common Name	Purity	Germination
Common Bermuda Grass	95%	85%
Gulf Coast Annual Rye	95%	90%

2. For areas within the TxDOT ROW:

   The specified seed shall be equal to or exceed the percentage of purity and germination per TxDOT standards for the seed mix specified within the TxDOT permit. Provide seed meeting 2.01.B.1 if no mix is indicated within the TxDOT permit.

C. MULCH

The mulch shall be natural cellulose fiber mulch produced from grinding clean, whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7%. The mulch shall be designed for use in conventional mechanical planting, hydraulic planting of seed or hydraulic mulching of grass seed, either alone or with fertilizers and other additives. The mulch shall be such that, when applied, the material shall form a strong, moisture-retaining mat without the need of an asphalt binder.

D. FERTILIZER

Pelleted or granulated type fertilizer of the composition for the season of the year at which applied shall be used:

1. Early season (April 1-June 1) 21-0-0

2. Normal season (June 1-Sept 1) 10-10-5

3. Late season (Sept 1-Nov 1) 6-12-12

3.00 EXECUTION

3.01 PREPARATION

After the areas disturbed by construction operations have been backfilled and completed to the original pre-construction lines and grades shown on the plans and as provided for in other items of this contract, perform hydromulch seeding in accordance with the requirements hereinafter described.

3.02 INSTALLATION

A. CULTIVATION

Cultivate areas to be seeded to a depth of at least 4". Cultivate the seedbed sufficiently to reduce the soil to a state of good tilth when the soil particles on the surface are small enough and lie closely enough together to prevent the seed from being covered too deep for optimum germination. Cultivation of seedbed will not be required in loose sand where depth of sand is 4" or more. Maintain the cross-section previously established throughout the process of cultivation and any necessary reshaping shall be done prior to any planting of seed.

B. PLANTING SEASON AND APPLICATION RATES

1. Perform planting between the dates specified for each type except when specifically authorized in writing. The seeds planted per acre shall be of the type specified with the mixture, rate, and planting dates as follows:

2. Common Bermuda Grass - hulled, twenty (20) pounds per acre - February through August or a combination of

3. Common Bermuda Grass - unhulled, fifteen (15) pounds per acre and Gulf Coast Annual Rye - unhulled, fifteen (15) pounds per acre - August through February.

4. Apply fertilizer uniformly at the average rate of four hundred (400) pounds per acre.

C. HYDRO MULCH (CELLULOSE FIBER) SEEDING

Uniformly distribute the fertilizer, seed or seed mixture, in the quantity specified over the areas to be seeded. Mechanical equipment shall be such that all varieties of seed as well as fertilizer may be distributed at the same time, provided that each component is uniformly applied at the specified rate. When seed and fertilizer are to be distributed as a water slurry, apply the mixture to that area to be seeded within 30 minutes after all components are placed in the equipment. Upon completion of planting the seed, spread cellulose fiber mulch uniformly over the area at the following rates:

Sandy soils with 3:1 slope or less – min. 2000 lbs/acre

Sandy soils with greater then 3:1 slope – min. 2300 lbs/acre

Clay soils with 3:1 slope or less - min. 2500 lbs/acre

Clay soils with greater then 3:1 slope - min. 3000 lbs/acre

The rates are given in dry weight of mulch per acre. A mulching machine, approved by the Owner's Representative, shall be equipped to eject the thoroughly wet mulch material at a uniform rate to provide the mulch coverage specified.

D. MAINTENANCE

1. Water the planted area at such times as necessary for a period of one (1) year after final acceptance of the project by the Owner or until the seeding is accepted per 3.02.D.3.

2. Fertilize and reseed any area which fails to survive for a period of one (1) year from the date the project is accepted by the Owner or until the seeding is accepted per 3.02.D.3.

3. Disturbed areas with slopes less than or equal to 4:1 slopes will be accepted when there is a minimum of 70% established coverage. Any slopes or grades exceeding a 4:1 must have a minimum of 90% established coverage to be accepted.

END OF SECTION

DIVISION 33

UTILITIES

33 01 30.16 TV INSPECTION OF SEWER PIPELINES

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide all television equipment, technical assistance, labor, tools and associated incidentals and appurtenances required to internally inspect the new sewer mains shown on the Drawings. Verify the mains are properly cleaned in preparation of inspection and/or rehabilitation. The internal TV inspection shall document the post rehabilitation / installation status of the new pipe for total acceptance of work done.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Television inspection logs in paper and digital format.

2. Digital format video of television inspection.

1.03 REFERENCE SPECIFICATIONS

A. Section 01 33 00 “Document Management.”

B. Section 02 96 00 “Temporary Bypass Pumping.”

1.04 TELEVISION CAMERA

A. The television camera used for inspection must be specifically designed and constructed for internal inspection of sanitary sewer pipe with partial liquid flow through it. Lighting for the camera must allow a clear picture of the entire periphery of the pipe above the existing flow. The camera will operate in 100 percent humidity conditions. The camera, television monitor, and other components of the video system shall produce a picture quality satisfactory to the Owner’s representative.

1.05 COMMUNICATION EQUIPMENT

A. When manually operated winches are used to pull the television camera through the main, set up two-way radio or other suitable means of communication between the two manholes of the line section being inspected to ensure good communications between members of the crew.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 TELEVISING

A. Move the camera through the main in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer line condition. In no case shall the television camera be pulled at a speed greater than 30 feet per minute. Use manual

winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer main condition. Identify locations of defects by means of a measurement device (distance meter) above ground. Marking on the cable or similar practices that require interpolation for depth of manhole is not allowed. Check accuracy of the distance meter with a walking meter, roll-a-tape, or other suitable device satisfactory to the Owner.

1. Television Inspection Logs: Keep printed location records that clearly show the camera location in relation to an adjacent manhole for each infiltration point or defect observed during inspection. In addition, record other points of significance such as locations of service line entry points, unusual conditions, roots, storm sewer connections, broken pipe, presence of scale and corrosion, and other discernible features. Submit a copy of such records and copies of the video in digital format to the Owner's representative.

3.02 REPAIR OF DAMAGED MAIN

A. If the main is damaged and requires repair prior to rehabilitation, make such repairs as directed by the Owner's representative. Any pavement cut excavation and repair must comply with the details in the Drawings. If the main is damaged through the negligence of the Contractor, make repairs as approved by the Owner's representative at no additional cost to the Owner.

END OF SECTION

33 05 01.02 DUCTILE IRON PIPE & FITTINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install ductile iron pipe and fittings, including taps, connections, and appurtenances as required for a functional system as indicated herein. Unless otherwise noted, all above grade exposed pipe, fittings, and appurtenances shall be flanged while below grade piping, fittings and appurtenances shall be mechanical joint or push on joints. Trenching, backfilling, and pipe embedment shall be as shown on the Drawings and in accordance with Section 31 23 33 "Trenching and Backfilling".

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

A. ACCEPTABLE PIPE MANUFACTURER'S

1. U.S. Pipe – Domestic Only
2. Tyler Pipe – Domestic Only
3. Griffin Pipe – Domestic Only
4. American Ductile Iron Pipe – Domestic Only
5. McWane – Domestic Only

B. ACCEPTABLE FITTING MANUFACTUERERS

1. Tyler/Union – Domestic Only
2. Approved Equal

C. Factory Testing: The manufacturer shall perform all tests as required by AWWA C151. Welded outlets shall be hydrostatically tested at a pressure of 250 psi for a period of 1 hour. No leakage shall be allowed.

D. Experience Requirements: Pipe shall be the product of a manufacturer who has a minimum of 10 years' successful experience manufacturing pipe of the particular type specified and the total pipeline shall be the product of one pipe manufacturer. The manufacturer shall have a minimum of 10 years' successful experience in the design and manufacturing of pipe joints of similar design, working pressure, pipe diameter and wall thickness as specified.

E. Pipe Classification: Pipe manufacturer shall manufacture the pipe to meet the installation conditions, cover depth, and bedding and backfill requirements as shown on the Drawings or specified and furnish the correct class of pipe to meet these conditions. If additional requirements are required, pipe manufacturer shall coordinate their requirements with the Contractor.

F. Manufacturer's product data sheets for coatings and linings.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

A. Record Data:

1. Catalog data, including dimensions of new pipe and fittings and recommendations for handling and storage; details of lining and coating; thrust restraint provisions; hydrostatic pressure test plan and results; affidavit stating the pipe furnished complies with AWWA C151, AWWA C104, AWWA C110, AWWA C111, and these specifications; mill certificates, including chemical and physical test results for each heat of metal, if requested during pipe manufacturing operations; record drawings, including a schematic location-profile and a tabulated layout schedule, referenced to the pipeline stationing.

2. AIS Certifications.

B. Shop Drawings:

1. Mechanical joint connections; connections to differing pipe materials.

2. Piping layout drawings.

1.04 REFERENCE SPECIFICATIONS

Section 31 23 33 “Trenching and Backfilling”

1.05 STANDARDS

A. Except as modified herein, the applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Water Works Association (AWWA) Standards:

AWWA C104	Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C105	Standard for Polyethylene Encasement for Ductile Iron Piping
AWWA C110	Standard for Ductile Iron and Gray Iron Fittings
AWWA C111	Standard for Rubber Gasket Joints for Ductile Iron Pipe and Fittings
AWWA C150	Standard for Thickness Design of Ductile Iron Pipe
AWWA C151	Standard for Ductile Iron Pipe
AWWA C153	Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C600	Standard for Installation of Ductile Iron Water Mains and Appurtenances
AWWA C606	Grooved and Shouldered Joints

2. Steel Structures Painting Council (SSPC) Standard: SSPC SP6, Commercial Blast Cleaning.

3. All ductile iron pipe and fittings for potable water systems shall conform to American National Standards/National Science Foundation (ANSI/NSF) Standard 61 and must be certified by an organization accredited by ANSI.

1.06 DELIVERY AND STORAGE

Handling and storage of pipe and fittings shall comply with AWWA C600 and the manufacturer's recommendations. It is desired that the pipe be hauled direct from the pipe plant to the right-of-way and strung along the pipeline route, thus avoiding rehandling of the pipe and the possibility of damage thereto. Where fully loaded truck and trailer cannot operate along the pipeline route, pipe may be unloaded at access points along the route and brought to the trench side by approved methods; however, the Contractor shall be responsible to ensure that the pipe is undamaged at the time of laying.

1.07 GUARANTEES

The product shall be warranted and guaranteed per the General Conditions of the Specifications.

2.00 PRODUCTS

2.01 MATERIALS

A. Ductile Iron Pipe:

1. Ductile iron pipe shall be made of ductile iron in accordance with AWWA C151. All ductile iron pipe shall have a minimum working pressure of 250 psi. Pipe shall be rated for pressure in accordance with AWWA C151 for pressure class of pipe as indicated. Standard joint length shall be 18 to 20 feet. Flanged ductile iron pipe shall be in accordance with AWWA C115 with a minimum thickness class of 53.

2. Pipe manufacturer shall manufacture the pipe to meet the installation conditions, cover depth, and bedding and backfill requirements as shown on the Drawings or specified and furnish the correct class of pipe to meet these conditions.

B. Fittings: Fittings shall be ASTM A536 ductile iron or ASTM A48 cast iron in accordance with AWWA C110 or AWWA C153. Fittings shall be rated for a minimum working pressure of 250 psi, unless specified otherwise. Factory welded outlets may be used in lieu of tee fittings for 18-inch and larger tee fittings. Factory welded outlets shall have a minimum pressure rating of 250 psi. Factory welded outlets may not be used near sources of vibration, such as pump stations or roads.

Provide carbon steel hardware for above grade flanged pipe and fittings. Provide 316 stainless steel hardware for pipe and fittings within the wet well. Provide Cor-Blue T-Bolts or approved equal for buried pipe and fittings.

C. Joints for Pipe and Fittings:

1. Joints shall be in accordance with AWWA C110, AWWA C111, and AWWA C151. Standard joints for ductile iron pipe and fittings shall be push-on. Where indicated, joints shall be mechanical joint, flanged, or grooved.

2. Flanged joints shall have pressure ratings equal to or greater than adjacent pipe. Flange pattern shall match pattern of valve, fitting, or appurtenance to be attached. Flanges on ductile iron pipe shall be ductile iron.

D. Provisions for Thrust:

1. Thrust at bends, tees, plugs, or other fittings shall be resisted by restrained joints or concrete thrust blocks. If thrust cannot be accommodated using restrained joints, thrust blocking or concrete anchors to restrain thrust shall be used. Contractor shall indicate which method of restraint was used on the As-Built drawings.

2. Restrained joints shall be used for a sufficient distance from each bend, tee, plug, or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purpose of thrust restraint, design pressure shall be 1.5 times the design working pressure class indicated.

3. The length of pipe with restrained joints to resist thrust forces has been indicated in the plans. Contractor shall consult with Engineer for any fitting configurations that are not address by the plans. Any additional restraint shall be provided at no additional cost to the owner. Thrust Restraint Design for Ductile Iron Pipe, Ductile Iron Pipe Research Association using the following parameters:

   a. Laying condition equal AWWA C600 Type 4 bedding.

   b. If polyethylene encasement is used, restrained length shall be doubled to account for reduced soil to pipe friction resistance.

4. Where indicated and where required for thrust restraint, joints shall be restrained. Restrained joints shall be mechanically interlocking joints. Restrained joints shall be U.S. Pipe "TR Flex", American Ductile Iron Pipe "Flex Ring", or Clow Corporation "Super-Lock". Restraining fittings using set screws, restraining gaskets, gripper type glands, and field-cuts of restrained joints shall be Mega-Lug, or approved equal. Field welding shall not be allowed. Restrained joints shall be capable of sustaining the design pressure as specified herein. Refer to Section 22 10 00.01 “Miscellaneous Piping and Appurtenances” for additional thrust restraint methods.

E. Coating:

1. Coat the exterior of buried pipe and fittings with a 1 mil bituminous coating in accordance with AWWA C110 and AWWA C151, unless specified otherwise.

2. Coat the exterior of above grade pipe and fittings in accordance with section 09 96 00.01 “High-Performance Coatings”.

3. In addition to the factory applied asphaltic coating, all buried ductile iron pipe and fittings shall have a tube-type polyethylene encasement in accordance with AWWA C105. Polyethylene encasement shall be 8 mils thick or 4 mils thick and cross-laminated. Both ends of the pipe shall be thoroughly sealed with adhesive tape or plastic tie straps at the joint overlap. Place circumferential wraps of tape at 2-foot intervals along the barrel of the pipe to minimize the space between the encasement and the pipe.

F. Lining: Ductile iron pipe and fittings shall be lined with factory installed Protecto 401 Ceramic Epoxy Lining by Enduron or American Polybond Plus (fusion bonded epoxy and fusion bonded polyethylene) or an approved equal. Lining primers, applications, and thicknesses shall be in accordance with manufacturer’s recommendations for sanitary sewer applications, but shall not be less than 40 mils.

G. Flexible Joint Couplings:

1. Flexible joint couplings shall be Dresser Style 38, Rockwell Style 411, Victaulic Depend-O-Lok - E x E, Type II or approved equal, unless otherwise shown.

2. Provide restrained flexible joint couplings or restrained flexible joints on all pipes connecting to concrete structures and at other locations shown on the Drawings. Restrained flexible couplings shall be Victaulic Depend-O-Lok F x F Type II, restrained Dresser or approved equal. Restrained flexible joints shall be U.S. Pipe "TR Flex", American Ductile Iron Pipe "Flex Ring", Clow Corporation "Super-Lock", or approved equal.

H. Insulated Connections: Where insulated connections are indicated, the pipe manufacturer shall furnish dielectric insulation gaskets, sleeves, and two plastic washers for each bolt. Insulating kits shall be Insulket or approved equal.

3.00 EXECUTION

3.01 INSTALLATION

A. General: Install ductile iron pipe, fittings, specials, valves, and hydrants in accordance with AWWA C600 and the Specifications. Trenching and backfilling shall be in accordance with Section 31 23 33 “Trenching and Backfilling” Before lowering into the trench, inspect each joint of pipe. Pipe will then be accepted, rejected, or repaired.

B. Pipe Laying: Lower pipe, fittings, and special castings into trench by crane or other suitable method. Do not roll in or "dump" into the trench. Handle pipe and fittings with belts, slings, or other equipment designed to prevent damage to the pipe and coating. Remove dirt and trash that may be in the barrel of the pipe, on the spigot or in the bell while the pipe is suspended. Keep the pipe clean during the laying operation and free of sticks, dirt, and trash, and at the close of each operating day seal the open end of the pipe with a gasketed night cap. Do not lay pipe in water.

C. Pipe Alignment: Install pipe and fittings to the line and grade indicated. In areas where the line and grade indicated cannot be achieved using standard manufactured bends and fittings, make slight adjustments by deflecting joints. Joint deflections may not exceed the lesser of the maximum deflections stipulated in AWWA C600 or 75 percent of the manufacturer’s maximum recommended deflection. Use fittings as required to maintain pipe centerline within 2 feet of called centerline. Resolve any conflicts with existing utilities and structures.

D. Joint Making:

1. Jointing Mechanical Joint Pipe:

a. Joint this type of pipe in accordance with the manufacturer's recommendations, with uniform torque on bolts.

b. After carefully cleaning both spigot and bell and after slipping the follower ring and gasket over the spigot end, slip the spigot into the bell. Apply a lubricant to the spigot to assist in assembly.

c. Carefully seat the gaskets by hand to be even in the bell at all points.

d. After drawing up the follower ring to uniform bearing against the gasket, insert the bolts and tighten by hand in pairs using bolts opposite each other.

e. Tighten the nuts to hold the required pressure. Extension wrenches or pipes over wrench handles shall not be permitted. Use 10-inch ratchet wrenches to tighten the nuts to a uniform torque.

f. The finished joint shall be watertight.

2. Making Flanged Joints: Erect flanged pipe in accordance with the controlling dimension as specified. Thoroughly clean each piece of flanged pipe to remove dirt, rust, grease, and other foreign matter. Thoroughly wire brush flanged faces to ensure even bearing for gaskets and mating flanges. Place full face gasket, use drift pins to align holes, and tighten flange bolts, each in turn, at a uniform torque around the joint. Finished joints shall be watertight.

3. Making Push-On Joints

   The jointing of this type of joint shall be as recommended by the manufacturer. The procedure for jointing shall be generally as follows:

   a. Thoroughly clean and dry the spigot and bell before starting the assembly of the joint. Wipe the gasket clean with a cloth.

   b. Place the gasket into the gasket seat in the bell.

   c. Apply a thin film of lubricant to the surface of the gasket that will come in contact with the entering pipe spigot. If necessary, also apply lubricant to the spigot.

   d. Make the joint by exerting sufficient force on the entering pipe so that its plain end will move past the gasket to the seat of the bell.

   e. If restrained joints are used, orient pipe to permit ease of assembly. Place locking device after installation of spigot into bell.

4. Making Split-Sleeve Coupling Joints:

   a. Exterior surfaces of the pipe shall be clean, smooth and free from weld beads, seams, scars, indentations, roll marks, exterior coatings and flat spots.

   b. Install split-sleeve couplings in accordance with the manufacturer's latest installation instructions.

E. Polyethylene Encasement: Wrap bituminous coated ductile iron pipe in polyethylene encasement in accordance with AWWA C105. Repair or replace encasements which have tears, rips, or punctures in the polyethylene wrap.

F. Painting: Paint piping which is submerged or exposed to the atmosphere in accordance with Section 09 96 00.01 "High-Performance Coatings."

3.02 FIELD QUALITY CONTROL

Perform a hydrostatic test as specified in Section 33 05 05.31 "Hydrostatic Testing"

END OF SECTION

33 05 01.09 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install polyvinyl chloride pipe and fittings to the diameters indicated for water supply pressure piping. Trenching, backfilling, and pipe embedment shall be in accordance with Section 31 23 33 “Trenching and Backfilling.”

B. This project is subject to the American Iron Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

A. Certification: Domestic water piping shall be approved by the Underwriters Laboratory and shall be accepted by the State Fire Insurance Commission for use in water distribution systems. PVC water pipe shall bear the seal of approval (or “NSF” mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

B. Design Criteria: The maximum allowable load for PVC pipe installations shall produce a maximum deflection of 4 percent.

C. Acceptable Manufacturers

1. J-M Pipe
2. Certainteed
3. North American Pipe
4. Can-Tex
5. Underground Solutions
6. Diamond Plastics Corp.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

A. Certified test reports from the Manufacturer’s testing facility or an approved testing laboratory.

B. Manufacturer’s data on piping and jointing methods as record data.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 “Document Management”

B. Section 01 40 00 “Quality Management”

C. Section 31 23 33 “Trenching and Backfilling”

D. Section 33 05 01.02 “Ductile Iron Pipe and Fittings”

1.05 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety. PVC piping and fittings shall be in full compliance with the applicable standards and specifications for each type of plastic pipe involved. Pipe may be rejected for failure to comply with any requirement of this specification.

A. American Society for Testing and Materials (ASTM) Standards:

ASTM D1785	Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2466	Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 40
ASTM D3139	Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F1674	Standard Test Method for Joint Restraint Products for Use with PVC Pipe

B. American Water Works Association (AWWA) Standards:

AWWA C104	Cement-Mortar Lining for Ductile Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile Iron Fittings
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C900	Standard for Poly Vinyl Chloride (PVC) Pressure Pipe, 4 through 12 Inches
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 through 48 Inches

1.06 DELIVERY AND STORAGE

Store PVC material so that there is no exposure to sunlight.

2.00 PRODUCTS

2.01 MATERIALS

A. Pipe:

1. 4 thru 16-inch diameter unrestrained: (wastewater force main)

   AWWA C900, DR-25 C.I. O.D. PVC

2. 4 thru 16-inch diameter restrained: (wastewater force main)

   AWWA C900, DR-25 C.I. O.D. Fusible PVC, CertaLok, Approved Equal

B. Small Diameter PVC Pressure Piping:

1. Smaller than 4 inches in size shall be Type 1, Grade 1, Polyvinyl Chloride, Schedule 80 pipe conforming to ASTM D1785, provide NSF 61 approval for potable waterlines.

2. For pipe 2 inches in diameter and smaller, joints shall be glued.

3. For pipe larger than 2 inches in diameter, joints shall be bell and spigot push-on type as specified in ASTM D3139.

C. Fittings: 3- through 12-inch ductile iron fittings per section 33 05 01.02 “Ductile Iron Pipe and Fittings”. Fittings for piping smaller than 3 inches shall be in accordance with ASTM D2466.

D. Flexible Couplings

1. Coupling shall be in accordance with AWWA C219.
2. Coupling body shall be constructed of ASTM A536 ductile iron.
3. Coupling shall incorporate a restraining gland with multiple gripping wedges made of ductile iron meeting ASTM A536.
4. All parts shall have a fusion bonded epoxy coating.
5. Couplings shall be rated at 250 psi working pressure.
6. Hardware shall be made of high strength 316 Stainless Steel.
7. Approved manufacturers:
    a. Romac Industries, Inc.
    b. Approved Equal

E. Restrained Couplings

1. Coupling body shall be constructed of ASTM A36 steel or ductile iron.
2. Coupling shall incorporate a restraining gland with multiple gripping wedges made of ductile iron meeting ASTM A536.
3. All parts shall have a fusion bonded epoxy coating.
4. Couplings shall be rated at 250 psi working pressure.
5. 316 SS Hardware
6. Approved manufacturers:
    a. Romac Industries, Inc.
    b. Approved Equal

F. Mechanical Joint Restraint

1. Joint Restraints shall consist of multiple gripping wedges incorporated into a gland meeting ANSI/AWWA C110.
2. 316 SS Hardware
3. Gland and wedges shall be made of ductile iron meeting ASTM A536.
4. Restraints shall be approved by the manufacturer for use on the pipe specified.
5. Restraint devices shall be List by Underwriters Laboratories.
6. Restraint device and wedges shall be coated with a fusion bonded epoxy coating.
7. Restraint shall be rated at 250 psi working pressure.

8. Approved Manufacturers:
    a. Ebaa Iron, Inc.
    b. Star Pipe Products
    c. Ford Meter Box Company
    d. Approved Equal

G. Pipe Bell Restraints
1. The restraint shall be manufactured of ductile iron conforming to ASTM A536.
2. The restraint devices shall be coated with a fusion bonded epoxy coating.
3. Restraint shall use a bolted split serrated ring for gripping PVC pipe behind the pipe bell. A split serrated ring or a plurality of individually-acting gripping surfaces shall be used for gripping PVC pipe on the spigot, or plain end pipe.
4. The restraint devices shall be coated with two coats of thermoset epoxy coating.
5. The connecting tie rods that join the two rings shall be made of 316 Stainless Steel that conforms to ANSI/AWWA C111/A21.11.
6. The assembly shall have a rated pressure to match the pipe rating the restraint is to be install on with a minimum two to one safety factor.
7. Restraint shall be rated at 250 psi working pressure.
8. Approved Manufacturers:
    a. EBAA Iron, Inc.
    b. Romac Industries, Inc.
    c. Approved Equal

H. Tapping Sleeves
1. Sleeve shall fully encompass the diameter of the pipe being tapped.
2. Sleeve shall have all stainless steel hardware.
3. Sleeves and integral flanges/MJ flange shall be constructed of 304 stainless steel.
4. Sleeves shall be rated for a maximum working pressure as follows:
    a. 4” – 12” diameters – 250 psig
    b. 14” – 24” diameters – 200 psig
5. Sleeve shall be certified to ANSI/NSF 61.
6. Approved Manufacturers:
    a. Mueller Co. – Model H-304MJ
    b. Approved Equal

I. Thrust Restraint: Thrust restraint devices shall be Mega-lug or approved equal and shall be factory tested and pressure rated in accordance with ASTM F1674. Joint restraint devices shall be designed specifically for use with PVC pipe of the joint type and pressure rating

specified. Refer to Section 22 10 00.01 “Miscellaneous Piping and Appurtenances” for additional thrust restraint materials.

J. Pipe requirements shall be verified with the plans; the most stringent requirements shall apply.

2.02 MARKINGS

A. The Pipe Manufacturer shall mark the piping with the size and appropriate AWWA/ASTM Standard designations as applicable.

B. Permanent marking on each joint of pipe shall include the following intervals of not more than five (5) feet:

1. Nominal pipe size and OD base (e.g., 4 CIPS).
2. Type of plastic material (e.g., PVC 12454B).
3. Standard Dimension Ratio and the pressure rating in psi for water at 73 degrees F (e.g., SDR 18, 150 psi)
4. AWWA designation with which the pipe complies (e.g., AWWA C-900).
5. Manufacturer's name or code and the national Sanitation Foundation (NSF) mark.

3.00 EXECUTION

3.01 INSTALLATION

A. Install pipe, fittings, and specials to the lines and grades indicated. Begin installation at the main supply line valve and make connections where indicated.

B. Carefully lower pipe, fittings, and specials into the trench to avoid damage to the pipe and/or fittings. Keep the pipe clean during laying operations, and seal the pipe against the entrance of objects at the close of each operating day.

C. Buried ductile iron fittings shall be installed per Section 33 05 01.02 “Ductile Iron Pipe and Fittings”.

D. Provide required clearance distances between potable water, sanitary sewer and reclaimed water mains per the Texas Administrative Code.

E. For solvent weld joints, cut square and smooth the ends of the plastic pipe and wipe clean. Apply solvent cement to the outside of the pipe and the inside of the fitting socket with a small brush. Immediately push the coated surfaces snugly together and rotate the pipe approximately one-half turn to insure uniform distribution of the cement. Remove the excess cement by wiping. Cement shall be of type which welds plastic surfaces together. Cement shall be as recommended by the Pipe Manufacturer and shall be compatible with the chemical conveyed.

F. All mechanical joints shall be restrained using a mechanical joint restraint.

G. Install additional restraints as indicated in the plans and per the manufacturer’s written installation instructions.

H. Wrap bell restraints in petrolatum tape upon completion per section 33 05 01.02 “Ductile Iron Pipe and Fittings.”

3.02 FUSIBLE PVC PIPE JOINING

A. The pipe shall be assembled and joined at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the pipe manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of the pipe and/or fusing equipment.

B. The butt-fused joint shall be true alignment and shall have uniform beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from the outside surface. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Owner’s Representative prior to insertion. All defective joints shall be cut out and replaced at no cost to the Owner. Any section of the pipe with a gash, blister, abrasion, nick, scar or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Owner’s Representative shall be discarded and not used.

C. Terminal sections pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp. The butt gap between pipe ends shall not exceed one-half (½) inch.

3.03 FIELD CONTROL HYDROSTATIC TESTING

A. Perform hydrostatic testing in accordance with Section 01 40 00 “Quality Requirements.” And 33 05 05.31 “Hydrostatic Testing”.

3.04 SERVICE CONNECTIONS (NOT USED)

3.05 FIELD QUALITY CONTROL

Do not enclose or cover any work until inspected.

END OF SECTION

33 05 01.13 SANITARY SEWER PIPE (PVC)

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment, and incidental necessary to install 4- through 48-inch gravity flow PVC pipe. Trenching, backfilling, and pipe embedment shall be in accordance with Section 31 23 33 “Trenching and Backfill.”

1.02 QUALITY ASSURANCE

A. Certification: The sewer pipe manufacturer shall provide certification that the pipe supplied conforms to these specifications and shall include laboratory tests results that support such certification. If the manufacturer is unable to provide the certification, an independent testing facility shall be utilized and retained at no cost to the Owner. The pipe supplied shall be permanently marked with the manufacturer’s name, the date of manufacture, and identification with the tests performed to warrant its certification as being in conformance with this standard.

B. Testing:

1. At a minimum, actual test results shall be required as follows:

    a. Load bearing tests.

    b. Material tests.

    c. Hydrostatic tests.

2. Tests on PVC pipe 4 through 48 inches shall be made in accordance with appropriate ASTM standard testing procedures and shall be performed on a minimum of 1 percent of the pipe purchased.

C. Inspection: An inspection of the pipe after delivery to the Project shall be made by a representative of the Owner. Pipe with visible defects which are indicative of poor structural condition or poor workmanship shall be rejected and replaced without cost to the Owner. Visible defects shall include cracks of any type, honeycombs, or any other defects of poor workmanship. Any pipe rejected shall not be returned under any condition to the Project. Provide CCTV video per Section 33 01 30.16 TV Inspection of Sewer Pipelines.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Shop Drawing including the following information:

    a. Product data sheet.

    b. Manufacturer.

    c. Nominal pipe diameter.

    d. Standard dimension ratio (SDR).

e. Cell classification.

f. Laying lengths.

g. Joint methods.

h. Manufacturers minimum radii for horizontal deflection.

1.04 REFERENCE SPECIFICATIONS

A. Section 01 33 00 “Document Management.”

B. Section 01 40 00 “Quality Management.”

C. Section 31 23 33 “Trenching and Backfill.”

1.05 STANDARDS

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

1. American Society of Testing and Materials (ASTM) Standards:

ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	Standard Specification for Poly (Vinyl Chloride) PVC Pressure Rated Pipe (SDR Series)
ASTM D2412	Standard Test Method for determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	“Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679 & Annex	Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F794	Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F1803	Standard Specification for Poly(Vinyl Chloride) (PVC) Closed Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

2. American Water Works Association (AWWA) Standards:

AWWA C900	Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm Through 1,500 mm)

2.00 PRODUCTS

2.01 MATERIALS

A. Gravity Pipe: ASTM D3034 4- to 15-inch SDR 35 (26) or ASTM F679 18- to 48-inch PS46 (115) Polyvinyl chloride pipe with bell and spigot compression joints. Pipe shall have a home mark on the spigot to indicate proper penetration when the joint is made.

1. Use green coloring for ground identification as sanitary sewer pipe.
2. PVC meeting the requirements of ASTM D1784, with a cell classification of 12454 or 12364.

B. Pressure Pipe: Refer to Section 33 05 01.09 "Polyvinyl Chloride (PVC) Pressure Pipe and Fittings."

C. Gaskets: Conform to ASTM F477.

D. Joints: Tested in accordance with ASTM D3212.

E. Services: Where pressure rated piping is called for on the Drawings, PVC service laterals shall be pressure rated.

F. Detectable Warning Tape:

1. Provide detectable warning tape as follows:
   a. Thickness: 5.0 mil overall thickness.
   b. Width: 3 inch minimum.
   c. Weight: 27.5 pounds per inch per 1000 square feet.
   d. Triple Layer with:
      1). Minimum thickness 0.35 mils solid aluminum foil encased in a protective inert plastic jacket.
      2). 100 percent virgin low density polyethylene.
      3). Impervious to all known alkalis, acids, chemical reagents and solvents within soil.
      4). Aluminum foil visible to both sides.
   e. Locatable by conductive and inductive methods.
   f. Printing encased to avoid ink rub-off.
   g. Color and Legends:
      1). Sewer Line:
         a). Color: Green (in accordance with APWA Uniform Color Code).
         b). Legend: Caution Sewer Line Below (repeated every 24 inches).

3.00 EXECUTION

3.01 INSTALLATION

A. Install pipe to the lines and grades indicated. Begin installation at the downstream discharge connection point and make connections where indicated.

B. Carefully lower sanitary sewage pipe into the trench to avoid damage to the pipe. Remove dirt and trash from the pipe while suspended. Keep pipe clean during laying operations, and seal the pipe against entrance of objects at the close of each operating day.

C. Where a gravity flow PVC wastewater line is within 9 feet of, and parallels a waterline, construct the sewer of PVC meeting ASTM or AWWA specifications with a minimum pressure rating for both the pipe and joints of 150 psi. The vertical separation shall be a minimum of 2 feet between outside diameters and the horizontal separation shall be a minimum of 4 feet between outside diameters. The gravity flow line shall be located below the waterline.

D. Where a gravity flow PVC wastewater line crosses a waterline, construct the wastewater line of PVC with a minimum pressure rating of 150 psi, and maintain an absolute minimum distance of 6 inches between outside diameters. In addition, the wastewater line shall be located below the waterline where possible and one length of the wastewater pipe must be centered on the waterline.

E. Where a gravity flow PVC wastewater line crosses over a waterline, construct all portions of the wastewater line within 9 feet of the waterline of PVC pipe with a pressure rating of at least 150 psi with one joint of pipe centered on the waterline, using appropriate adapters.

F. Minimum horizontal deflection shall be 133 percent of manufacturers minimum radius or 75 percent of the manufacturer's maximum recommended joint deflection.

3.02 FIELD QUALITY CONTROL

A. Testing shall be as specified in Section 01 40 00 "Quality Management."

B. Do not enclose or cover any Work until inspected.

C. CCTV sewer lines as specified in Section 33 01 30.16 "TV Inspection of Sewer Pipelines."

END OF SECTION

33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide and install underground water and sewer line using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring, guided horizontal boring. This Work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and erosion and sedimentation control and restoration.

1.02 QUALITY ASSURANCE

A. The requirements set forth in this document specify a wide range of procedural precautions necessary to provide the very basic, essential aspects of a proper directional bore installation and are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this Section. Adherence to the specifications contained herein, or the Owner's Representative approval of any aspect of any directional bore operation covered by this Section, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the Work authorized under the Contract.

1. Installer's Qualifications: Installation shall be by a competent, experienced contractor or subcontractor. The installation contractor shall have a satisfactory experience record of at least 3 years engaged in similar work of equal scope. If patented processes are involved based on the pipe selection, the Installer shall be licensed, trained and in good standing with the pipe Manufacturer.

2. Performance Requirements: Lateral or vertical variation in the final position of the carrier pipe from the line and grade established by the Drawings shall be permitted only to the extent of 4 percent for water lines and horizontal deflections for sewer lines, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe. Vertical deflections for sewer lines may be permitted as long as the slope is continuous (no sags), meets Texas Commission on Environmental Quality minimum slope requirements, and will flow by gravity with no surcharge and into existing or proposed downstream improvements.

3. Certification: Pipe products shall have been tested and approved by an independent third-party laboratory for continuous use at rated pressures. Pipe and couplings intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF Standard 61 by an acceptable certifying organization.

4. Design Criteria: The maximum allowable load for PVC pipe installations shall produce a maximum deflection of 4 percent.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Work Plan: Prior to beginning the Work, the Contractor shall submit to the Owner's Representative a work plan as Record Data detailing the procedure and schedule to be used to execute the Project. The work plan should include a description of all equipment to be used, down-hole tools, a list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable), list of Subcontractors, a schedule of work activity, a safety plan (including MSDS of any potentially hazardous substances to be used), traffic control plan (if applicable), all excavation locations, interfering utilities, and flow bypass, an erosion and sedimentation control plan and contingency plans for possible problems. Work plan should be comprehensive, realistic and based on actual working conditions for the Project.
2. Equipment: Contractor will submit specifications on directional drilling equipment as Record Data. Equipment shall include but not be limited to: drilling rig, butt fusion welding apparatus, mud system, mud motors (if applicable), down-hole tools, guidance system, rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that Contractor intends to use or might use will be submitted.
3. Material: Provide Shop Drawings of the pipe with material specifications, including size, type, diameter and Manufacturer's data and certifications on piping and jointing methods. The shop drawing shall include a Certificate of Adequacy of Design stating the pipe and fittings are satisfactory for the loads which will be imposed during for all loading conditions.
4. Contractor shall maintain a daily project log of drilling operations and a guidance system log along with a fusion report for all butt fused welding of joints with a copy given to Owner's Representative at completion of the Project.

1.04 STANDARDS

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

1. American National Standards Institute (ANSI) / NSF Standards:

ANSI/NSF 61	Drinking Water System Components – Health Effects

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

ASTM D2241	Standard Specification for Poly (Vinyl Chloride) PVC Pressure Rated Pipe
ASTM D3034	Standard Specification for type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D1784	Standard Specification for Rigid PVC Compounds and Chlorinated PVC Compounds
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pressure Pipe

3. American Water Works Associations (AWWA) Standards:

AWWA C901	Standard Specification for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 through 3 Inches, for Water Service
AWWA C900	Standard for PVC Pressure Pipe and Fabricated Fittings, 4 through 12 inches, for Water Distribution
AWWA C905	Standard for PVC Pressure Pipe and Fabricated Fittings, 14 through 48 inches, for Water Distribution
AWWA C906	Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 through 63 inches, for Water Distribution and Transmission

1.05 DELIVERY AND STORAGE

A. Store PVC pipe material so that there is no exposure to sunlight.

1.06 JOB CONDITIONS; PERMITS AND EASEMENT REQUIREMENTS

A. Where the Work is in the public right-of-way or railroad company right-of-way, the Owner will secure the appropriate permits or easements. The Contractor shall observe regulations and instructions of the right-of-way owner as to the methods of performing the Work and take precautions for the safety of the property and the public. Negotiations and coordination with the right-of-way owner shall be carried on by the Contractor, not less than 5 days prior to the time of his intentions to begin Work on the right-of-way.

B. Comply with the requirements of the permit and/or easement. Work within the Texas Department of Transportation (TXDOT) right of way shall comply with TXDOT requirements. If required by the right-of-way owner, obtain Protective Liability Insurance in the amount required by the particular company or other insurance as is specified in the permit at no cost to the Owner. Acquire a permit, agreement, or work order from the right-of-way owner as is required.

C. Construction along roads, railroads and public areas shall be performed in such manner that does not interfere with the operations of the roads, driveways, sidewalks, pedestrian traffic and railroads.

D. Barricades, warning signs, and flagmen, when necessary and specified, shall be provided by the Contractor.

E. No blasting shall be allowed.

F. Existing pipelines and underground conduits are to be protected. The Contractor shall verify location and elevation of any pipe lines, telephone cable and fiber optics before proceeding with the construction and shall plan his construction so as to avoid damage to the existing pipe lines or telephone cables. Verification of location (vertical and horizontal) of existing utilities shall be the complete responsibility of the Contractor.

2.00 PRODUCTS

2.01 GENERAL

A. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery and

recovery system of sufficient capacity to successfully complete the crossing, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system.

B. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this Project.

2.02 DRILLING SYSTEM

A. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pullback operations. The rig shall be grounded during drilling and pull-back operations. There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.

B. Drill Head: The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

C. Mud Motors (if required): Mud motors shall be of adequate power to turn the required drilling tools.

D. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

2.03 GUIDANCE SYSTEM

A. A Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to 100 feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to plus or minus 2 percent of the vertical depth of the bore hole at sensing position at depths up to 100 feet and accurate within 1.5 meters horizontally.

B. The Guidance System shall be of a proven type and shall be operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.

2.04 DRILLING FLUID MUD SYSTEM

A. Mixing System: A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. The drilling fluid reservoir tank shall be of sufficient size

for making the bore. Mixing system shall continually agitate the drilling fluid during drilling operations.

B. Drilling Fluids: Drilling fluid shall be composed of clean water and appropriate additives. Water shall be from an authorized source with a pH of 8.5 to 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No potentially hazardous material may be used in drilling fluid.

C. Delivery System: The mud pumping system shall have a minimum capacity to maintain correct boring alignment and be capable of delivering the drilling fluid at a constant pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12 inches high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

D. Drilling Fluid Recycling System: The drilling fluid recycling system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid reusable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

2.05 OTHER EQUIPMENT

A. Pipe Rammers: Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.

B. Restrictions: Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the Work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the Project.

2.06 PIPING MATERIALS

A. Sewer Line Materials:

1. PVC gravity sewer line piping shall be Certainteed Yelomine ASTM D2241 SDR21 PVC with Certalok Couplings or Certainteed AWWA C900, C 905 DR18 with Certalok Couplings, or Fusible PVC ASTM D3034 SDR 35 by Underground Solutions.

2. For pressure applications, PVC sewer line piping shall be Certainteed Yelomine ASTM D 2241 DR21 (CLASS 200) PVC with Certalok Couplings or Certainteed AWWA C900, C 905 DR18 (CLASS 235) with Certalok Couplings, or Fusible PVC ASTM D2241 SDR 26 (Class 160) or Fusible AWWA C900, C 905 DR25 (165 Pressure Rating), by Underground Solutions.

B. Pipe Markings: Pipe shall be legibly marked in permanent ink with the manufacturer and trade name, nominal size and DR rating/pressure class, hydrostatic proof test pressure, NSF

61 if applicable, manufacturer date code. Pipe and couplings shall also bear the mark of the certifying agency which have tested and approved the product for use in fire protection applications.

C. Tracer Wire: All piping shall be installed with a continuous, insulated TW, THW, THWN or HMWPE insulated copper, 10 gauge or thicker wire for pipeline location purposes by means of an electronic line tracer. The wire shall be installed along the entire length of pipe. The insulation color shall match the color of the pipe being installed. Sections of wire shall be spliced together using approved splice caps and water proof seals. Twisting the wires together is not acceptable.

D. PVC Couplings: Pipes shall be jointed using non-metallic couplings which have been designed as an integral system. High strength thermoplastic splines shall be inserted into mating precision machined grooves in the pipe and coupling to provide full 360-degree restraint with evenly distributed loading. No external pipe to pipe restraining devices which clamp onto or otherwise damage the pipe surface will be allowed. Pipe couplings shall have a leading beveled edge to reduce resistance during pulling operations. Couplings shall be designed for use at the rated pressure of the pipe which they are used and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the leakage requirements of ASTM D3139.

3.00 EXECUTION

3.01 GENERAL

A. The Engineer and Owner's Representative must be notified 48 hours in advance of starting the Work. The Directional Bore shall not begin until the Owner's Representative is present at the Site and agrees that proper preparations for the operation have been made.

B. The approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the Work as authorized under the Contract. It shall be the responsibility of Owner's Representative to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Contractor.

3.02 PERSONNEL REQUIREMENTS

A. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. The operator of the drilling rig must have at least 3 years directional drilling experience. A responsible representative who is thoroughly familiar with the equipment and type work to be performed, must be in direct charge and control of the operation at all times. In all cases the supervisor must be continually present at the Site during the actual Directional Bore operation. The Contractor shall have a sufficient number of competent workers on the job at all times to ensure the Directional Bore is made in a timely and satisfactory manner.

3.03 DRILLING PROCEDURES

A. Site Preparation: Prior to any alterations to work site, Contractor shall photograph or video tape entire work area, including entry and exit points, one copy of which shall be given to Owner's Representative and one copy to remain with Contractor for a period of 1 year

following the completion of the Project. Work sites shall be within right-of-way and shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Contractor shall confine all activities to designated work areas.

B. Drill Path Survey: Entire drill path shall be accurately surveyed by the Contractor with entry and exit stakes placed in the appropriate locations within the areas determined in the field with the Owner's Representative Locate existing utilities in advance of boring operations. The Contractor shall be responsible for repairing damage to existing utilities at no additional cost to the Owner. Repair of existing utilities shall proceed until complete and the existing utility is back in service. If Contractor is using a magnetic guidance system, drill path will be surveyed by the Contractor for any surface magnetic variations or anomalies.

C. Environmental Protection: Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by Contract Documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel may not be stored in bulk containers within 200 feet of any water-body or wetland.

D. Safety: Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner.

E. Pilot Hole:

1. Pilot hole shall be drilled on bore path with no deviations greater than 4 percent horizontally or vertically (water lines) over a length of 100 feet. In the event that pilot hole does deviate from bore path more than 4 percent, Contractor shall notify Owner's Representative who may require Contractor to pull-back and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fracture, inadvertent returns or returns loss occurs during pilot hole drilling operations, Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and then wait another 30 minutes.

2. If mud fracture or returns loss continues, Contractor will cease operations and notify Owner's Representative. Owner's Representative and Contractor will discuss additional options and Work will then proceed accordingly.

F. Reaming: Upon successful completion of pilot hole, Contractor will ream bore hole to a minimum of 25 percent greater than outside diameter of pipe using the appropriate tools. Contractor will not attempt to ream at one time more than the drilling equipment and mud system are designed to safely handle.

G. Pull-Back:

1. After successfully reaming bore hole to the required diameter, Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel and reamer to compact bore hole walls. Pull loads shall not exceed the limits shown in the following tables. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole.

PVC Maximum Pull Loads – Certainteed				
AWWA C900				
Size (in.)	**DR**	**Minimum Radius (ft.)**	**Maximum Pull In Force Tightest Radius (lb.)**	**Maximum Pull In Force Straight Pull (lb.)**
4	18	100	6700	8200
6	18	150	9000	12,800
8	18	200	18,000	25,200
10	18	250	25,600	35,200
12	18	300	26,440	41,100
16	18	450	44,000	68,500
4	14	100	8000	10,300
6	14	150	9300	14,700
8	14	200	18,900	28,800
10	14	250	24,900	38,300
12	14	300	28,300	48,300

PVC Fusible PVC - Underground Solutions Maximum Pull Loads			
AWWA C900			
Size (in.)	**DR**	**Minimum Radius (ft.)**	**Maximum Pull In Force (lb.)**
4	25	100	7700
6	25	144	16,000
8	25	189	27,600
10	25	231	41,600
12	25	275	58,800
4	18	100	10,600
6	18	144	21,900
8	18	189	37,800
10	18	231	56,800
12	18	275	80,300
4	14	100	13,400
6	14	144	27,700

8	14	189	47,700
10	14	231	71,800
12	14	275	101,600

2. During pull-back operations, Contractor will not apply more than the maximum safe pipe pull pressure at any time. In the event that pipe becomes stuck, Contractor will cease pulling operations to allow any potential hydro-lock to subside and will recommence pulling operations. If pipe remains stuck, Contractor will notify Owner's Representative to discuss options and then Work will proceed accordingly.

3.04 HDPE AND FUSIBLE PVC PIPE JOINING

A. The pipe shall be assembled and joined at the Site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

B. The butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from both the inside and outside surface such that the joint surfaces shall be smooth. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Owner's Representative prior to insertion. All defective joints shall be cut out and replaced at no cost to the Owner. Any section of the pipe with a gash, blister, abrasion, nick, scar or other deleterious fault greater in depth than 10 percent of the wall thickness, shall not be used and must be removed from the Site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Owner's Representative shall be discarded and not used.

C. Terminal sections pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp. The butt gap between pipe ends shall not exceed 1/2 inch.

3.05 PIPE TESTING

A. Following successful pull-back of pipe, Contractor will test pipe using potable water according to Section 01 40 00 "Quality Management." A calibrated pressure recorder will be used to record the pressure during the test period. This record will be presented to Owner's Representative.

3.06 TRACER WIRE TESTING

A. Upon completion the Contractor shall demonstrate that the wire is continuous and unbroken through the entire run of the pipe including full signal conductivity (including

splices). If the wire is broken, the Contractor shall repair or replace it. Pipeline installation will not be accepted until the wire passes a continuity test.

3.07 SITE RESTORATION

A. Following drilling operations, Contractor will de-mobilize equipment and restore the work site to original condition. All excavations will be backfilled and compacted to 95 percent of original density. Landscaping will be subcontracted to a local professional landscaping company.

END OF SECTION

33 05 23.33 PIPELINE CROSSING [HIGHWAYS, STREETS AND RAILROADS BY BORING, TUNNELING OR OPEN CUT]

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install pipe casings or tunnel liners by boring, tunneling or open cut as specified. This section sets forth the requirements for utility lines crossing roadways or railroads using bore, tunneling, or open cut.

1.02 QUALITY ASSURANCE

A. Design Criteria:

1. Casing Insulators: Casing insulators shall be designed by the Manufacturer to adequately support and electrically isolate the carrier pipe within the casing pipe under all conditions. Number and location of spacing insulators shall be determined by the Manufacturer to protect carrier pipe from damages. One insulator shall be placed within 2 feet of ends of casing.

B. Installer's Qualifications: Installation shall be by a competent, experienced contractor or sub-contractor. The installation contractor shall have a satisfactory experience record of at least 3 years engaged in similar work of equal scope.

C. Performance Requirements: Lateral or vertical variation in the final position of the pipe casing or tunnel liner from the line and grade established by the engineer shall be permitted only to the extent of 1 inch in 10 feet, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Shop drawings of the tunnel liner plate and fasteners from the tunnel liner plate manufacturer. Shop drawings shall include calculations for the design of the tunnel liner plate. Shop drawings are for record purposes only and will not be reviewed or approved by the Engineer.

2. Provide shop drawings of casing insulators including sketches of insulators with material components and dimensions and proposed locations of insulators.

1.04 STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO) Standards:

AASHTO M190	Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO	Standard Specifications for Highway Bridges, 1993

B. American Society of Testing and Materials (ASTM) Standards:

ASTM A36	Carbon Structural Steel
ASTM A123	Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
ASTM A135	Electric – Resistance – Welded Steel Pipe
ASTM A139	Electric – Fusion (Arc) – Welded Steel Pipe (NPS4 and Over)
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A307	Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength
ASTM A449	Quenched and Tempered Steel Bolts and Studs
ASTM A568/ A568M	Steel, Carbon, and High Strength, Low Alloy, Hot-Rolled and Cold-Rolled for Commercial Quality
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM D4254	Test Method for Minimum Index Density of Soils and Calculation of Relative Density

C. American Water Works Association (AWWA) Standards:

AWWA C206	Field Welding of Steel Water Pipe
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

1.05 JOB CONDITIONS; PERMITS AND EASEMENT REQUIREMENTS

A. Where the work is in the public right-of-way or railroad company right-of-way, the Owner will secure the appropriate permits or easements. The Contractor shall observe regulations and instructions of the right-of-way Owner as to the methods of performing the work and take precautions for the safety of the property and the public. Negotiations and coordination with the right-of-way Owner shall be carried on by the Contractor, not less than 5 days prior to the time of his intentions to begin work on the right-of-way.

B. Comply with the requirements of the permit and/or easement, a copy of which is included in the Appendix. The work within the Texas Department of Transportation (TXDOT) shall comply with TXDOT specifications. If required by the Right-of-Way Owner, obtain Protective Liability Insurance in the amount required by the particular company or other insurance as is specified in the permit at no additional cost to the Owner. Acquire a permit, agreement, or work order from the right-of-way Owner as is required.

C. Construction along roads and railroads shall be performed in such manner that the excavated material be kept off the roads and railroads at all times, as well as, all operating equipment. Construction shall not interfere with the operations of the roads and railroads.

D. Barricades, warning signs, and flagmen, when necessary and specified, shall be provided by the Contractor.

E. No blasting shall be allowed. Existing pipelines are to be protected. The Contractor shall verify location and elevation of any pipe lines and telephone cable before proceeding with the construction and plan his construction so as to avoid damage to the existing pipe lines or telephone cables. Verification of location of existing utilities shall be the complete responsibility of the Contractor.

1.06 OPTIONS

A. Casing Material: Unless specified otherwise, the Contractor may use steel pipe or reinforced concrete pipe where bore and/or tunnel is specified. Unless specified otherwise, the Contractor may use steel pipe or reinforced concrete pipe where open cut casing is specified. The material specification for casing pipe and tunnel liner are the minimum acceptable. The Contractor shall be fully responsible to insure the materials used are of sufficient strength for the installation method chosen and the soil conditions encountered.

B. Bore and Tunnel Methods: Unless specified otherwise, the Contractor may use boring, jacking, tunneling for the installation method of casing material. The Contractor shall be fully responsible to insure the methods used are adequate for the protection of workers, pipe, property, and the public. Provide a finished product as required.

2.00 PRODUCTS

2.01 MATERIALS

A. Steel Pipe: Steel casing pipe shall have a minimum yield strength of 35,000 psi. Casing shall meet ASTM A36, ASTM A568, ASTM A135, ASTM A139, or approved equal. Pipe shall be coated and lined in accordance with AWWA C210 or approved equal. Pipe joints shall be welded in accordance with AWWA C206. After pipe is welded, coating and lining shall be repaired. Unless specified otherwise, the minimum wall thickness of steel casing pipe shall be as follows:

Casing Diameter	Wall Thickness
4” to 24”	0.25”
25” to 42”	0.375”
43” to 60”	0.50”

B. Reinforced Concrete Pipe: Pipe casing shall conform to ASTM C76 and shall be of the size, class and length specified. Pipe shall be a minimum of Class IV for 42-inch and smaller diameters and a minimum of Class V for diameter larger than 42 inches.

2.02 MIXES

A. Cement Mortar: Consisting of 1 part cement to 2 parts clean sand with sufficient water to make a thick workable mix.

B. Pressure Grout Mix: Comprised of 1 cubic foot of cement and 3.5 cubic feet of clean fine sand with sufficient water added to provide a free flowing thick slurry. If desired to maintain solids in the mixture in suspension, 1 cubic foot of commercial grade bentonite may be added to each 12 to 15 cubic feet of the slurry.

2.03 MANUFACTURED PRODUCTS

A. Casing Insulators: Use casing insulators for any type of carrier pipe. Insulators shall consist of pre-manufactured steel bands with plastic lining and plastic runners. Insulators shall fit snug over the carrier pipe and position the carrier pipe approximately in the center of the casing pipe, to provide adequate clearance between the carrier pipe bell and the casing

pipe. Fasteners for insulators shall be stainless steel or cadmium-plated. Insulators shall be as manufactured by Cascade Waterworks Manufacturing Company or Pipeline Seal and Insulators, Incorporated or Perry Equipment Corporation.

B. Mortar Bands: Concrete cylinder pipe and mortar coated steel pipe may have thickened outside mortar bands in lieu of casing insulators. Mortar bands shall be properly position the pipe within the casing or tunnel liner.

3.00 EXECUTION

3.01 GENERAL CONSTRUCTION PROCEDURES

A. Excavation and Backfill of Access Pits:

1. Do not allow excavation over the limits of the bore or tunnel as specified. Trench walls of access pits adjacent to the bore or tunnel face shall be truly vertical. Shore the trench walls as necessary to protect workmen, the public, structures, roadways, and other improvements.

2. Excavations within the right-of-way and not under surfacing shall be backfilled and consolidated by tamping in 6-inch horizontal layers to 95 percent of maximum density as measured by ASTM D698. Surplus material shall be removed from the right-of-way and the excavation finished to original grades. Backfill pits immediately after the installation of the carrier pipe is completed. If carrier pipe is not installed immediately after casing pipe installation, the Right-of-Way Owner may require the access pits be temporarily backfilled until installation of carrier pipe.

3. Where seeding or sodding is disturbed by excavation or backfilling operations, such areas shall be replaced by seeding or sodding as specified in Section 31 23 33.16 “Trenching and Backfill.”

B. Installing Carrier Pipe In Casings:

1. Pipe to be installed within the casing or tunnel liner shall meet the requirements for this type of pipe as specified. Where indicated, place, align, and anchor guide rails and/or casing insulators inside the casing. If guide rails are used, place cement mortar on both sides of the rails.

2. Pull or skid pipe into place inside the casing. Lubricants such as flax soap or drilling mud may be used to ease pipe installation. Do not use petroleum products, oil or grease for this purpose. If guide rails are used, install pipe and hold down jacks after installation of carrier pipe.

3. After installation of the carrier pipe, mortar inside and outside of the joints as applicable.

4. After carrier pipe installation is completed, seal or plug the ends of the casing.

C. Free-Air System:

1. If required by OSHA standards, free-air systems shall be installed and maintained.

2. Installation of Pressure Grout Mix:

a. Install pressure grout mix in the void space between the outside of the casing pipe or tunnel liner and the excavation. For bore or jacks with casing pipe, install pressure grout mix immediately upon completion of setting casing pipe. For tunnel liner plate, install pressure grout mix at the end of each work day or more often as conditions warrant.

b. Unless specified otherwise, install pressure grouting through grout fittings for the casing pipe or tunnel liner plate 48 inches in diameter or larger. Grout fittings shall be fabricated into casing pipe and tunnel liner plate at a maximum spacing of 6 feet. Remove and plug grout fittings after pressure grouting.

c. Install pressure grout from the low end for all crossings where grout fittings are not used. Seal the low end and pressure grout until grout is extruded from the opposite end.

3.02 CROSSINGS INSTALLED BY BORING

A. Perform the boring from the low or downstream end unless specified otherwise. Bore the holes mechanically and use a pilot hole. By this method, an approximate 2-inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade. This pilot hole shall serve as the centerline of the larger diameter hole to be bored. Place excavated material near the top of the working pit and dispose of material as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting shall not be permitted.

B. In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and installation of the pipe immediately thereafter.

C. In locations where the soil formation is other than consolidated rock, insert the casing pipe simultaneously with the boring operation. This requirement applies to all bored holes of 18 inches or greater in diameter. For smaller diameter bored holes, it is desirable that the casing be installed as the boring progresses, but because of differences in soil formations, the time for inserting the casing shall be the Contractor's responsibility. In the event that caving sand or water bearing materials are encountered, insert the casing pipe simultaneously with the boring operation regardless of the diameter of the bored hole. In all cases, the security and integrity of the roadway is the primary concern. The Contractor shall be held fully responsible for the continued integrity of the structure of the roadway being crossed, whether or not a casing pipe is inserted simultaneously with the boring operation.

3.03 CROSSINGS INSTALLED BY TUNNELING AND JACKING

A. Jack the pipe from the low or downstream end, unless specified otherwise. Provide heavy duty jacks suitable for forcing the pipe through the embankment. In operating jacks, apply even pressure to the jacks used. Provide a suitable jacking head and bracing between jacks so that pressure will be applied to the pipe uniformly around the ring of the pipe. Provide a suitable jacking frame or back stop. Set the pipe to be jacked on guides, properly braced together, to support the section of the pipe and to direct it in the proper line and grade. Place the whole jacking assembly so as to line up with the direction and grade of the pipe.

In general, excavate embankment material just ahead of the pipe and material removed through the pipe. Force the pipe through the embankment with jacks into the space provided.

B. The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, shall conform to the contour and grade of the pipe. Provide a clearance of not more than 2 inches for the upper half of the pipe. This clearance shall be tapered off to zero at the point where the excavation conforms to the contour of the pipe. Extend the distance of the excavation beyond the end of the pipe depending on the character of the material, but do not exceed 2 feet in any case. Decrease the distance if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe.

C. If desired, use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with inside angles or lugs to keep the cutting edge from slipping back onto pipe.

D. When jacking of pipe has begun, carry on the operation without interruption to prevent the pipe from becoming firmly set in the embankment. Remove and replace any pipe damaged in the jacking operations. The Contractor shall absorb the entire expense.

END OF SECTION

33 31 13.12 FIBERGLASS WET WELL

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide and install fiberglass wet well as indicated on the plans. Fiberglass reinforced polyester wet wells 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 the wastewater collection systems.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMTTALS

1. Shop Drawings

1.03 DEFINITIONS

The following define the types of structural fiberglass damage.

A. Tear – Laminate fails when tensile strength is exceeded; typically resulting in fracture existing through the substrate material

B. Hole or Puncture – Damage resulting from impact or cutting, often limited to surface layer.

C. Delamination – Fiberglass layers have separated; typically caused by impact or stress between layers.

1.04 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety:

American Society for Testing and Materials (ASTM) Standards:	
ASTM D3753	Glass-Fiber Reinforced Polyester Manholes and Wet wells

2.00 PRODUCTS

2.01 MANUFACTURERS

Acceptable Manufacturers for Design of Repairs and Wet Well Connections:

A. Flowtite

B. LFM Fiberglass Structures

C. Fiberglass Tank Solutions

D. Approved Equal

2.02 MATERIALS

A. The wet well shall be made of a heavy-wall filament-wound Fiberglass Reinforced Plastic (FRP), as show in the Drawings. Bottom of wetwell shall be sloped per pump manufacturer's recommendation.

B. Wet wells shall be manufactured from commercial grade unsaturated polyester resin or vinyl ester resin, with fiberglass reinforcements. The wet well shall be manufactured in one-piece including body, bottom and top.

C. The resins used shall be a commercial grade unsaturated polyester resin. The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin. If reinforcing materials are 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.

D. Fillers, when used, shall be inert to the environment and wet well construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material shall meet the requirement of this specification.

E. The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate exposed fiber. The exterior surface shall be free of blisters larger than 1/2 inch in diameter, delamination and exposed fiber.

F. The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 square feet if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

G. The bottom to be fabricated using fiberglass material. Bottom to be attached to wet well pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. Reinforcement, if needed, shall be fiberglass channel laminated to wet well bottom per A.S.T.M.-D3299.

H. Bottom: The bottom of the wet well shall be built to withstand full exterior water column with a maximum deflection 3/8".

I. Bottom Square Steel Anti-Floatation Flange: A square steel anti-flotation flange shall be installed in the bottom of the wet well. It shall be one solid piece of 3/16" thick A-36 carbon steel that covers the entire bottom of the tank and extends past the wall of the tank. The steel plate shall be totally encapsulated in resin and glass. The installation of a steel anti-float is in addition to the minimum material required to meet the above-mentioned specification.

J. Influent pipe sleeves shall be PVC Pipe, and shall be installed and tested by the manufacturer. Installation of stubouts to be fiberglass layup to comply with A.S.T.M.-D3299 specifications.

K. Wet well to be designed for the project service conditions, assuming fully saturated soil external loading and buoyant uplift.

L. The FRP wet well shall be installed in strict accordance with the wet well manufacturer's recommendations.

2.03 FABRICATION:

INTERIOR SURFACE: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1**/**2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 per square foot if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

3.00 EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the Manufacturer's instructions. Any modification to the structure as a result of requiring different size access door hatchways is the responsibility of the Contractor.

END OF SECTION

33 31 13.13 FIBERGLASS WET WELL REHABILITATION

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide and install fiberglass wet well piping supports in existing fiberglass wet well structures. Fiberglass reinforced polyester wet wells 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 the wastewater collection systems.

B. Repair damaged sections of fiberglass wet well as identified in the drawings.

C. Pipe support connections to existing fiberglass wet wells must be designed by a qualified engineer registered in the State of Texas.

D. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMTTALS

A. Submit Fiberglass Repair Procedure and Pipe Supports per Section 01 33 00 “Document Management.” Manufacturer's data sheets on each product to be used indicating sizes, profiles, surface finishes, and performance characteristics, and including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Shop drawings for connections and hardware.
5. AIS certifications for any hardware and/or metal components incorporated within the submittal.

1.03 DEFINITIONS

The following define the types of structural fiberglass damage.

A. Tear – Laminate fails when tensile strength is exceeded; typically resulting in fracture existing through the substrate material

B. Hole or Puncture – Damage resulting from impact or cutting, often limited to surface layer.

C. Delamination – Fiberglass layers have separated; typically caused by impact or stress between layers.

1.04 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety:

American Society for Testing and Materials (ASTM) Standards:	
ASTM D3753	Glass-Fiber Reinforced Polyester Manholes and Wet wells

2.00 PRODUCTS

2.01 MANUFACTURERS

Acceptable Manufacturers for Design of Repairs and Wet Well Connections:

A. Flowtite

B. LFM Fiberglass Structures

C. Fiberglass Tank Solutions

D. Approved Equal

2.02 MATERIALS

A. RESIN: The resins used shall be a commercial grade unsaturated polyester resin.

B. REINFORCING MATERIALS: The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

C. SURFACING MATERIALS: If reinforcing materials are 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.

D. FILLERS AND ADDITIVES: Fillers, when used, shall be inert to the environment and wetwell construction. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material must meet the requirement of this specification.

2.03 FABRICATION:

INTERIOR SURFACE: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 per square foot if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

3.00 EXECUTION

3.01 INSTALLATION

A. Delamination Repair - Repair damaged areas of fiberglass wet well as identified in plans per manufacturer recommendation.

1. Remove damaged material
2. Prepare Surface
3. Laminate Repair Patch

B. Fiberglass Support Installation

1. Clean and prepare surface of wet well.
2. Install discharge piping supports without excavation of existing fiberglass wet well. Bond fiberglass tabs to the existing tank wall and bolt steel to the fiberglass tabs for the discharge piping support. All metal appurtenances within the wet will must be 316 SS. Use bonding method recommended by manufacturer and submitted to Engineer for approval. The following methods are acceptable:
    a. Physical laminate bond
    b. Fiberglass angle, bonded to the tank wall with fiberglass compatible adhesive.

C. Sewer Pipe

1. TYPE 1: Make the cutout in the wetwell wall, the outside diameter of pipe, plus 1/2 inch maximum. Slip pipe into position. Apply industrial grade silicone around the pipe next to the wetwell wall cutout on the inside and on the outside. Cover the outside siliconed area with epoxy grout and backfill.
2. TYPE 2: Make the cutout in the wetwell wall, the outside diameter of pipe, plus 1/2 inch maximum. Grind the outside surface of the pipe and both the inside and the outside surfaces of the cutout in the wetwell 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. Apply fiberglass putty to the inside and the outside of the wetwell wall cutout, filling openings between pipe and cutout. Make a good radius for the fiberglass lay-up. After putty has set-up, fiberglass the pipe into place. Use one layer of woven roving sandwiched between two layers of fiberglass mat. Allow fiberglass to completely set-up before backfilling. Fiberglass layup method to comply with A.S.T.M.-D3299 specifications.
3. TYPE 3: Install Insert-A-Tee type fitting per manufacturers instruction.

D. Inspect repair / support installation after bonding agents are fully cured for defects.

END OF SECTION

DY 33 32 16 PACKAGED UTILITY WASTEWATER BACK-UP DIESEL PUMPING STATION

1.00 GENERAL

1.01 SCOPE

A. Pump supplier is responsible for furnishing and testing an automatically starting, skid mounted, diesel driven, back-up (standby) pump for Lift Station No. 4. Pumping units shall include, but not necessarily be limited to, bowl and impeller assembly, check valve, air release valve, line shaft, shaft bearings, column, above floor discharge, motor stand, motor, and sole plate. The product provided shall be a eight inch x six inch portable priming assisted centrifugal pump driven by a liquid cooled diesel engine. Pump unit to include an enclosure for noise abatement and a liquid level control system. Pump unit shall be suitable for permanent mounting. Model of pump shall be Gorman Rupp PAH6C60-6068H FT4 or approved equal.

B. The primary purpose of the pump shall be for wastewater treatment plant use, lift station emergency standby, or pump station bypass.

C. Pumping unit shall be new, unused, and of the current year's production. Unit shall be of the latest design and in current production, completely serviced, ready for work, and shall include all standard equipment as specified herein.

D. Coordination:

1. Coordinate with Owner during installation.
2. Coordinate pumps and motors with electrical work as specified in Technical Specifications and Plans.
3. Pump supplier shall assume the proper responsibility for the proper functioning of the equipment.

1.02 PERFORMANCE CRITERIA

A. Pump must be designed to handle trash or debris up to 3” diameter solids. Pumps shall have 6” suction connection, and 6” discharge connection. Each pump shall be selected to perform under following operating conditions:

1.	Capacity (GPM)	1455
2.	Total Dynamic Head (FT)	210
3.	Total Dynamic Suction Lift (FT)	22.5
4.	Minimum Solids Passage (IN)	3

B. Pump Performance Certifications

1. Solids Handling Capability
   a. All internal passages and impeller vanes shall pass a 3" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted.

b. Upon request from the engineer, manufacturer's certified drawings showing passage size shall be submitted for approval.

2. Dry Run Capability

a. Pump can be run dry at maximum speed with no damage to seals.

b. Seal lubricating oil temperature should be checked to not exceed seal manufacturers maximum continuous rating.

3. Positive Suction Pressure Capability

4. Liquid to be used for this test shall be water.

5. Pump and priming system is to be operated with a positive suction pressure while allowing no water to discharge from the priming system.

C. Priming Performance

1. Consideration shall be given to the service anticipated in which the unit will operate unattended on an open sump. This could result in the liquid level in the sump dropping below the suction pipe entrance causing a loss of prime or reaching the automatic shutdown level. In either case, when the sump level is again restored needing pumping, it will require the pump to prime itself automatically. Such occurrence shall be considered normal.

2. Pump must demonstrate an automatic priming lift of 25 vertical feet at the minimum operating condition point. Priming lift is defined as the static height of the pump suction above the liquid. The pump must prime and deliver full capacity within five minutes after the pump is energized in the priming condition. Additional standards under which reprime tests shall be conducted are:

a. Liquid to be used for priming test shall be water.

b. Discharge check valve shall be installed.

c. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90o elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.

d. Repeatability of performance shall be demonstrated by testing five consecutive priming cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle. No water should be discharged from the priming system to the environment during priming or operation.

1.03 REFERENCE

1. ANSI B16.1- Standard for Cast Iron Pipe Flanges and Flanged Fittings

1.04 SUBMITTALS

A. Submittals shall be in accordance with this Section and General Requirements, Section 01 33 00 "Document Management" and shall include:

1. Submittals for alternate manufacturers not included in the Material Specifications shall include complete fabrication, assembly, and installation drawings, together with detailed specifications, and data covering materials used, devices, and other accessories

forming a part of the equipment furnished, including the following information. These will be required to be submitted as an exception. Submittal shall include:

a. Name of Manufacturer

b. Type of Model

c. Rotative speed

d. Size of discharge and suction flanges

e. Diameter of pump shaft

f. Type of Bearings and bearing life calculations

g. Thickness of Casing

h. Net weight of pump

i. Total weight of pump package

j. Performance curve showing capacity vs. head, NPSH required, efficiency, and HP input

k. Data on shop painting

l. Rated size of motor, in horsepower

2. Supplemental Information:

a. General lifting erection, installation, and adjustment instructions

b. Exact size, placement, and embedment requirements of all anchor bolts

c. Details on materials of construction of all components including applicable ASTM designations

d. Details of shaft sealing system

e. Piping schematics

f. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

g. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

h. A list of spare parts to be provided

i. Any additional information required to show conformance with the equipment specifications

j. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

B. Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the pumps.

C. Prior to start up, the pump supplier shall furnish the Engineer complete operation and maintenance ("O&M") manuals in accordance with Section 01 33 04 “Operation and Maintenance Data”.

1.05 QUALITY ASSURANCE

A. All materials used shall be new, of high grade, and with properties best suited to the work required.

B. Pump shall be designed for continuous operation without cavitation within the specified operating range. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range.

C. The design is based on a specific manufacturer's equipment.

D. Manufacturer’s Qualifications:

1. The pumping unit provided under this section shall be a standard product in regular production by manufacturers whose products have proven reliable in similar service for at least 5 years.

2. Manufacturer shall satisfy the Engineer that it is capable of the following:

a. Providing local factory trained personnel to service the pumps and associated equipment when needed, within a 48-hour period.

b. Providing all needed spare parts for the pumps within a 48-hour period.

3. Acceptance: In the event of failure of the pump to meet any of the specified requirements or efficiencies, the pump supplier shall make all necessary modifications, repairs, or replacements and the pump shall be re-tested at no additional cost, until results are found satisfactory.

4. Field Testing: Pump shall be field tested after installation. The field testing shall be performed in the presence of an experienced field representative of the manufacturer, who shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

5. The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.

6. The pump manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability by the use of best management practices, technological advances, promoting environmental awareness and continual improvement.

7. The pump manufacturer must be a current member of the Contractors Pump Bureau (CPB) with supporting documentation available upon request.

1.06 MANUFACTURER’S SERVICE REPRESENTATIVE

A. Furnish the service of the equipment manufacturer's representative, experienced in installation and operation of the type of systems being provided, to supervise the installation, start-up, and acceptance tests, and final inspection in accordance with this section.

B. Instruction of Owner's Personnel: A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total of 2 hours of normal working time and shall start after the system is functionally complete but prior to

final acceptance tests. Field training shall cover all of the items contained in Section 01 33 04 “Operation and Maintenance Data”.

1.07 SPARE PARTS AND SPECIAL TOOLS

A. The following spare parts shall be provided:

1. None shall be required

1.08 DELIVERY, STORAGE, AND HANDLING

A. Equipment and parts shall be package for shipment so as to prevent breakage and damage to components.

B. Deliver materials to the Site, inspect for damage, and unload and store.

C. Store materials off the ground and under a weather-tight covering.

1.09 EVALUATION AND SELECTION

A. The owner reserves the right to select any equipment which is deemed to be in its best interest.

1.10 IDENTIFICATION PLATES

A. Provide each pump with a stainless steel nameplate securely affixed to the pump with stainless steel hardware. The nameplate shall contain the manufacturer's name, model number, serial number, rating information, and any other pertinent data.

1.11 WARRANTY

A. Manufacturer shall furnish to the Owner a warranty covering workmanship and material in accordance with Purchase Order Standard Terms and Conditions of this RFB. The warranty period shall commence on the day of facility start-up. Warranty shall be in printed form and previously published as the manufacturer's Standard Warranty for all similar units manufactured.

2.00 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Pump package:

1. Gorman Rupp

2. Approved Equal.

B. Listing as an approved or acceptable manufacturer will not relieve the manufacturer from conforming to the Technical Specifications.

C. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company which are deemed most suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The contractor shall prepare his bid based on the specified equipment for purposes of

determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

D. In order to unify responsibility for proper operation, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source) and that source shall be the pump manufacturer. The pumps must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted.

E. Manufacturer must show proof of original product design and testing. Products violating intellectual property regulations shall not be allowed, as they may violate international law and expose the user or engineer to unintended liabilities. "Reverse-engineered" products fabricated to substantially duplicate the design of original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design, which may contribute to product failure.

F. The term "pump manufacturer" shall be defined as the entity which designs, machines, assembles, hydraulically tests and warranties the final product. Any entity that does not meet this definition will not be considered a "pump manufacturer and is not an acceptable supplier. For quality control reasons and future pump and parts availability, all major castings of the pump shall be sourced and machined in North America.

G. After execution of the contract, the contractor may offer substitutions to the specified equipment for consideration. The equipment proposed for substitution must be superior in construction and performance to that specified in the contract, and the higher quality must be demonstrated by a list of current users of the proposed equipment in similar installations.

H. In event the contractor obtains engineer's approval for equipment substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance.

I. It will be assumed that if the cost to the contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

2.02 PUMP DESIGN

A. Pump shall be a horizontal, priming assisted centrifugal type, designed specifically for pumping trash or debris. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 – GENERAL of this section.

B. Pumps that require liquid to be maintained in the pump casing to enable priming will not be considered.

C. Pump shall have a 6" suction, and a 6" discharge connection.

D. Materials and Construction Features

1. Pump casing: Casing shall be made of ductile iron. Casing shall incorporate following features:

a. Dual 6” suction porting allowing for both standard axial and optional radial suction porting. Standard axial suction porting is perpendicular to the discharge porting and the optional radial suction porting is parallel to the discharge porting.

b. Machined location on top of casing to mount priming chamber.

c. Pump casing shall be capable of withstanding 100 psi (7kg/cm2) operating pressure.

2. Coverplate: Cleanout coverplate shall be cast iron. Design must incorporate following maintenance features:

   a. Retained by easy grip hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, priming chamber, seal, and wearplate without removing discharge piping.

   b. A replaceable wearplate secured to the coverplate by capscrews and lockwashers shall be made from ductile iron.

   c. Two O-rings of Buna-N material shall seal coverplate to pump casing.

   d. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.

3. Rotating Assembly: A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate the following features:

   a. Sealplate and bearing housing shall be cast iron. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Two lip seals will prevent leakage of oil.

      1). The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

      2). The seal cavity shall be oversized, providing for a minimum of 1.8 gallons of oil to ensure continuous operational cooling and lubrication of seals. Oil level sight gauge and a fill/vent plug shall be installed. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

   b. Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft.

   c. Shaft shall be stainless steel. Pump shall also have a replaceable shaft sleeve made from stainless steel to protect the shaft from wear.

   d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall have a polished face an external O-ring for sealing to the sealplate. Elastomers shall be viton. Cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.

f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

   a. Clearances shall be maintained by external shimless coverplate adjustment, utilizing collar and adjusting screw design for incremental adjustment of clearances by hand. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings.

   b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above (4a).

   c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

5. Discharge Check Valve: Check valve casing shall be made from cast iron and the flap valve shall be molded Buna N. Removal or installation of the flap valve must be accomplished through a coverplate opening, without disturbing the discharge piping.

6. Priming Chamber: priming chamber shall be made from cast iron and be mounted to the pump casing. Design must incorporate the following features:

   a. Priming system to have a priming valve that will ensure automatic prime and reprime while not allowing any liquid product being pumped to be bypassed to the environment. Performance criteria listed under Part 1 - General.

   b. Priming system should be capable of automatically operating under a flooded or positive suction pressure condition with performance criteria listed under Part 1 – General.

   c. Priming system shall create a vacuum on the suction side of the pump and in the priming chamber using a compressor to force air through a protectively mounted venturi. The valve system in the priming chamber should not allow compressed air into the pumping system should the venturi become plugged.

E. The pump manufacturer shall demonstrate to the engineer's satisfaction that due consideration has been given to reducing setup and maintenance costs by incorporating the following features:

1. No special tools shall be required for replacement of any components within the pump.
2. The unit shall be provided with a pump drain to the outside of the enclosure.
3. Easy externally adjustable wear plate to maintain proper clearances for efficient performance.
4. Replaceable wear plate and shaft sleeve.
5. Oversized oil cooling capacity for seals when pump runs dry.
6. Hard faced shaft seal for long life.
7. Dual suction port feature, allowing for easier setup in space restricted areas.

2.03 ENGINE

A. The engine shall be a Final Tier 4 With a Six (6) cylinder four cycle liquid cooled diesel engine, John Deere model 6068HFC08 “Power Tech”. The engine shall have the following minimum design characteristics:
   1. Displacement shall be 415 cubic inches.
   2. Maximum continuous BHP shall be 250 @ 2500 RPM.
   3. Governor shall be mechanical.
   4. Forced circulation lubrication.
   5. Dry type air cleaner.
   6. Oil reservoir shall be 9 U.S. quarts dry; 8 U.S. quarts refill.
   7. Fuel tank shall be 131 U.S. gallons and shall be furnished with a 12.7-hour minimum operating time at full load. Fuel tank shall have drain line running to outside of the enclosure.
   8. Starter shall be 12 volt.
   9. Compressor to be gear driven directly off the engine. No belts or couplings required. The compressor shall be capable of supplying a minimum of 13 cfm of air to the priming system.

B. Engine Autostart Control Panel to include the following features:
   1. LCD display with backlighting.
   2. Safety shutdown switches / indicators for low oil pressure, engine overcrank, and high coolant temperature.
   3. Displayed values for:
      a. Engine RPM
      b. Run Time
      c. Battery Voltage
      d. Coolant Temperature
      e. Oil Pressure

4. Fault indication for:
    a. Low oil pressure
    b. High temperature
    c. Overcrank
5. Engine MANUAL/STOP/AUTO key switch with key removable in any position.
6. Warning alarm for eight seconds prior to start-up.
7. I.D. tags or equal applied:
    a. Throttle
    b. Float switch input only
    c. Circuit breaker
    d. MANUAL/OFF/AUTO
8. 10 Amp Panel Mounted Fuse
9. Float switch connector in bottom of box adjacent to wiring harness connector.
10. Low Battery Voltage Protection

C. Additional features shall include:
1. Radiator with drain valve on bottom of radiator with hose running to outside of the enclosure.
2. Engine oil drain provisions utilizing ball valve with ½ inch I.D. hose extending to outside of the enclosure.
3. The unit shall be equipped with a residential grade muffler designed to limit noise to a level acceptable in a residential area.

D. Because the engine shall be required to operate during emergency situations, the following minimum performance standards shall be used for engine selection:
1. Engine speed shall be controlled by a manually adjustable, governor-controlled throttle which shall maintain the preset speed over the range of expected pumping loads. This speed shall not be less than 1000 RPM to insure adequate cooling, nor more than 1900 RPM so that internal engine wear is held to a minimum.
2. The engine shall develop approximately 95 percent of manufacturer's published performance after a reasonable run in period.
3. For selection of engine size, engine performance shall be de-rated according to manufacturer's specifications to allow for decreased performance if installed at elevations more than 1000 feet above sea level.
4. For selection of engine size, engine performance shall be de-rated according to manufacturer's specifications to allow for decreased performance in an ambient temperature of 100 degrees F.
5. Engine rating shall be further reduced to conform to engine manufacturer's recommendations for continuous service applications.

6. Engine shall be specifically designed to operate continuously in an enclosed area.

2.04 ENCLOSURE

A. Description

1. The entire pump unit shall be enclosed by a soundproof lightweight aluminum enclosure to reduce operating noise to an average 67 dbA level at 23 feet (7 meters) while pumping under full load.
2. The entire enclosure shall be removable for maintenance of pump or engine.
3. The enclosure shall be equipped with two padlockable side access panels with a minimum opening of 34" x 49" to facilitate pump and engine servicing.
4. The enclosure shall incorporate a removable panel to allow access to the pump clean-out cover plate.
5. The enclosure shall have a lockable access panel for the engine control and level control system.
6. The enclosure shall be secured to an environmentally safe spill containment type base that includes integral drain ports and forklift pockets.
7. A keyed weathertight positive engagement 4-pin socket for float switch connection shall be provided for use with or without the enclosure in place.

2.05 CONTROL SYSTEM

A. Description

1. The engine shall be equipped with all controls and components required for manual and automatic operation when used with the engine controls and DC level control system described herein. Such components shall include, but not limited to, the following:
    a. 12-volt DC electrical system including starter and alternator.
    b. Digital elapsed running time meter.
    c. Shutdown sensors for engine temperature, oil pressure, and overspeed.
    d. Keyed switch for manual, off, or automatic operation of the engine.
2. The electrical control components shall be provided by the pump supplier and shall be provided with the following:
    a. Indicating lights shall be LED type. LED emitting the color Yellow shall indicate “Warning” and LED emitting the color Red shall indicated “Fault”.
    b. A four digit elapsed time display shall be provided to indicate the total running time in "hours".
    c. Controls shall include a micro-processor based controller with 32 character two row LCD backlit display. It shall be housed in a lockable polycarbonate clear cover enclosure visible from the outside of the sound attenuated enclosure.

B. Dual Float Switch Liquid Level Control System

1. The liquid level control system shall utilize individual float switches to start and stop the pump unit in response to changes in wet well level. They shall be mechanical non-mercury type float switches housed in a hermetically sealed polypropylene enclosure designed to extend into the wet well. The transducer's polyurethane jacketed shielded cable shall be of suitable length for proper installation into the wet well without splicing.
2. The level control system shall continuously monitor the wet well level. Upon operator selection of automatic operation, the level controller shall start the pump unit when the liquid level in the wet well rises to the pump start level. When the liquid is lowered to the pump stop level, the level controller shall stop this pump.

C. Engine control system

1. The engine control system shall be designed to accomplish the following tasks:
    a. Permit the operator to select mode of engine operation, providing manual start and stop of the engine to override the level control system.
    b. Crank the engine upon start command from the level control system and stop the engine upon a stop command.
    c. Stop the cranking sequence if the engine fails to start after a reasonable number of attempts, and to provide an audible alarm indication of failure to start.
    d. While the engine is operating, continuously monitor engine speed, temperature and oil pressure.
    e. Stop the engine for excessive speed, excessive coolant temperature, or insufficient oil pressure, and provide an alarm indication of shutdown and its cause. If any of these parameters approach a shutdown condition, an audible alarm will sound and the parameter in question will flash before an actual shutdown occurs.
2. Sequence of operation
    a. Upon operator selection of automatic operation, when the level control system provides a start command, the engine control system shall start the engine cranking motor for a short period of time. If the engine does not start, the system shall stop the cranking motor for a short period of time, then resume cranking. Typically, five 10 second cranking periods, each followed by a 10 second rest period, should be considered a reasonable effort to start the engine. When the engine starts, a sensor shall stop the cranking cycle and reset the cranking circuit for the next start.
    b. If the engine does not start within the preset number of attempts, the cranking circuit shall be de energized, and an overcrank status indication shall be displayed on the LCD panel.
    c. Once the engine has started normally, the engine control system shall monitor and display engine speed, coolant temperature, system voltage, run time, and oil pressure. Upon engine failure from any cause, system shall provide an alarm indication, and illuminate an indicator.
3. Circuit details
    a. Switches or other devices shall be provided and connected to perform as follows:

1). When automatic operation is selected, engine shall start and stop under control of the level control and engine control system.

2). When manual operation is selected, the operator will be prompted to push and hold the “enter” button on the control panel to start the engine. Once started, engine shall run until "OFF" is selected, or the engine failure circuit stops the engine.

3). Operator can stop engine if it is running and prevent it from starting during maintenance or repair.

4). Engine failure circuits shall stop the engine, illuminate an LED, and display on LCD display on the control panel, for each of the following conditions:

a). Engine speed exceeds maximum overspeed setting.

b). Engine temperature exceeds safe operating temperature as specified by the engine manufacturer.

c). Engine oil pressure falls below engine manufacturer's specified recommendations.

d). Engine fails to start after several attempts.

b. Operating power for the engine and level control system shall be provided by the storage battery furnished with the engine.

D. Battery shall be 75 amp hour industrial type with 900 cold cranking amps.

3.00 EXECUTION

3.01 PIPING

A. Take care to avoid undue strain on flanges.

B. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.

C. Install hanged pipe so that adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without over straining the flange.

D. Replace by one of proper dimensions any flanged pipe or fitting whose dimensions do not allow the making of proper flanged joint as specified herein.

E. Provide hangers and supports, where necessary to support piping.

3.02 TESTING

A. General:

1. After pump has been completely installed and working under the direction of the manufacturer, conduct field tests necessary to demonstrate that pump operation conforms to these specifications. Supply water, labor, equipment, and incidentals required to complete field tests. Conduct testing in the presence of the Engineer and the Manufacturer’s service representative.

2. Demonstrate with a "Final Acceptance Test" that these specifications have been met by the equipment as installed. As a minimum perform the following tests to determine:
    a. That unit has been properly installed and is in correct alignment.
    b. That units operate without overheating or overloading any parts and without objectionable vibration or strain.
    c. That there are no mechanical defects in any of the parts.
    d. That the controls perform satisfactorily as to sequence control, correct start and stop elevations, and proper high level alarm functions.
    e. That the units meet the specified operating conditions.

B. If the pump performance does not comply with the specifications, take corrective measures or remove and replace pump(s) with pump(s) which satisfy the conditions specified, in connection with the Contract.

END OF SECTION

33 39 13 SANITARY UTILITY SEWAGE MANHOLES, FRAMES AND COVERS

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to construct standard and special manholes and cleanouts complete with covers, fittings, and other appurtenances, in accordance with the details and/or called out on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Design and fabrication details for fiberglass manholes and components shall be submitted as Record Data.

1.03 REFERENCE SPECIFICATIONS

A. Section 01 33 00 “Document Management.”

B. Section 01 40 00 “Quality Requirements.”

C. Section 03 30 00 “Cast-in-Place Concrete.”

D. Section 33 39 13.10 “Non Metallic Manhole Ring and Cover.”

1.04 STANDARDS

A. Applicable provisions of the following standards shall apply as if written here in their entirety:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM A48	Specification for Gray Iron Castings
ASTM D2240	Test Method for Rubber Property - Durometer Hardness
ASTM D3753	Glass-Fiber Reinforced Polyester Manholes and Wet wells

2. American National Standards Institute (ANSI) Standards:

ANSI A21.10	American National Standard for Gray Iron and Ductile Iron Fittings, 3 through 48 Inches for Water and Other Liquids

1.05 DELIVERY AND STORAGE

A. Inspect prefabricated fiberglass manholes upon delivery, and reject any visibly defective units.

2.00 PRODUCTS

2.01 MATERIALS

A. Concrete: Concrete for all cast-in-place bases shall be as specified in Section 03 30 00 “Cast-In-Place Concrete” and at a minimum shall be 3000-psi concrete. Mortar shall be as specified in Section 03 30 00 “Cast-In Place Concrete.”

B. Fiberglass Manholes:

1. Fiberglass manholes shall conform to all ASTM standards governing plastic laminations and the latest Glass-Fiber Reinforced Polyester Manholes standard, ASTM D3753.
2. Provide wall section thickness in accordance with ASTM D3753, but not less than 0.48 inches of thickness.
3. Mark date of manufacture and name or trademark of manufacturer in 1-inch tall stenciled letters on the inside of the manhole.
4. The manhole shall be of watertight construction to prevent infiltration and exfiltration.
5. The barrel and cone shall each be produced in a continuous manufacturing process which ensures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a reinforced glass-resin joint resulting in a one-piece unit. Field made joints shall not be acceptable.
6. The manhole shall be a circular cylinder with an inside diameter in conformance with 1.01.A.
7. The cone of the manhole shall have a bearing surface wide enough to facilitate the placement of concrete adjustment rings and have sufficient strength to safely support HS-20 loading in accordance with AASHTO.
    a. The ring and cover shall not be placed directly on the fiberglass manhole.
8. The manway cone shall be concentric with respect to the barrel of the manhole.
    a. Eccentric manway cones shall not be permitted.

C. Manhole Rings and Covers:

1. Manhole rings and covers shall be per Section 33 39 13.10.

D. Cleanout Fittings:

1. Pipe fittings shall be ductile iron and shall conform to ANSI A21.10 with a minimum pressure rating of 250 psi.
2. The cleanout casting shall conform to ASTM A48, Class 30.
3. Ductile Iron fittings shall be lined with factory installed Protecto 401 Ceramic Epoxy Lining by Enduron or American Polybond Plus (fusion bonded epoxy and fusion bonded polyethylene) or an approved equal, lining primers, applications and thicknesses shall be in accordance with manufacturer’s recommendations for sanitary sewer applications.

2.02 MANUFACTURED PRODUCTS

A. Fiberglass Manholes: Prefabricated fiberglass manholes shall be in accordance with ASTM D3753. Dimension, shape and size shall conform to the details shown in the Drawings.

B. Manhole Rings and Covers: Per Section 33 39 13.10.

C. Chimney Seals: Frame seals shall consist of a flexible internal rubber sleeve, interlocking extensions and stainless steel expansion band as manufactured by Cretex Specialty Products, or approved equal, conforming to the following requirements. The seal shall remain flexible throughout a 25-year design life, allowing repeated vertical movement of the frame of not less than 2 inches and/or repeated horizontal movements of not less than 1/2 inch. The sleeve portion of the seal shall be either double or triple pleated with a minimum unexpanded vertical height of either 8 or 10 inches respectively. The sleeve and extension shall have a minimum thickness of 3/16 inch and shall be made from a high quality rubber compound conforming to the applicable requirements of ASTM C923, with a minimum 1500-psi tensile strength, a maximum 18 percent compression set and a hardness (durometer) or 48 plus or minus 5. The bands shall be integrally formed from 16 gauge stainless steel conforming to ASTM A240, Type 304, with no welded attachments, and shall have a minimum adjustment range of 2 diameter inches and a positive locking mechanism. Any screws, bolts, or nuts used for this mechanism shall be stainless steel conforming to ASTM F593 and F594, Type 304.

3.00 EXECUTION

3.01 INSTALLATION

A. Manhole Base:

1. Cast-in-place Manhole Foundation: The applicable details as indicated in the Drawings shall apply.

2. The first section of pipe extending out a minimum of 24 inches from each side of the manhole base shall be supported by lean concrete as part of the manhole base. No additional payment shall be made for this concrete cradle; the sum shall be included in the bid price for the manhole.

B. Fiberglass Manholes: Lower manhole barrel on to manhole base. Seal with manufacturer's gasket or approved sealant. Wrap joint with external sealing material, minimum 12-inch width.

C. Pipe connection for Fiberglass Manholes: Connections between the pipe and manhole may be accomplished by methods listed below.

1. Cut manhole barrel for pipe penetrations following curvature of the pipe with a maximum of 1-inch clearance. Seal cut edges with resin. Hole may be circular or cutout with a semi-circular top, which extends to the bottom of the barrel.

2. Construct pipe stub outs as part of the prefabricated manhole. Install required sealant or gasket in stub out to ensure a watertight bond is achieved at the connection between the pipe and manhole.

D. Inverts: Construct invert channels to provide a smooth waterway with no disruption of flow at the connection between the pipe and manhole.

E. Manhole Rings and Covers: Securely anchor the base of the manhole ring into a 6-inch minimum thickness precast concrete ring as indicated, and set on top of concentric manhole cone as a unit.

F. Cleanouts: Provide a cleanout at the ends of all sewer lines unless a manhole is provided at that point. Construct cleanouts in accordance with the details shown on the Drawings.

G. Drop Manholes: Install a drop manhole piping assembly in all cases where the distance between the incoming pipe and the floor of the manhole is 2 feet or more. External drop assemblies shall be encased in concrete as indicated in the Drawings.

3.02 FIELD QUALITY CONTROL

A. Manholes shall be tested by hydrostatic exfiltration or vacuum testing in accordance with Section 01 40 00 “Quality Requirements.” Manholes shall be tested after installation with all connections (existing and /or proposed) in place. Drop connections and gas sealing connections shall be installed prior to testing.

END OF SECTION

33 39 14 SANITARY UTILITY GLASS FIBER REINFORCED POLYESTER (FRP) MANHOLES, FRAMES AND COVERS

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and incidentals necessary to construct fiberglass manholes and cleanouts complete with covers, fittings, and other appurtenances, in accordance with the details and/or called out on the Drawings.

1.02 QUALITY ASSURANCE

A. Examination: Each manhole component part shall be examined for dimensional requirements.

B. Composition Control: Controls on glass and resin content shall be maintained for all manufacturing processes and for each portion of manhole fabrication. Records shall be maintained of 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, paragraph 8.8.1.

C. Certification: A certification shall be provided by the manufacturer that the manholes have been sampled, tested, and inspected in accordance with the provisions of ASTM D3753 and this Specification, and meets all requirements. An authorized agent of the manufacturer shall sign each certificate so furnished.

1.03 SUBMITTALS

A. Submittals must be in accordance with Section 01 33 00 “Document Management” and must include:

1. Shop Drawings

a. FRP Manholes: Manufacturer’s data and details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.

b. Cast-in-place Concrete Base: Details of construction.

c. Include detailed diagrams of manholes showing typical components and dimensions.

d. Connection detail to existing manholes: stubouts, manhole interior configuration showing fiberglass bench and flow channel, coring method, elevations of new pipe connection, pipe end treatment, and other pertinent information.

e. Itemize, on separate schedule, sectional breakdown of each manhole with all components and refer to drawing identification number or notation.

f. Indicate knockout elevations for all piping entering each manhole.

g. Calculations prior to manhole fabrication:

1). Show compliance with load cases defined in ASTM F1759

2). Buoyancy calculations

3). Lateral earth pressures

4). Wall thickness calculations considering depth, soil and groundwater conditions, and loading conditions.

5). Calculations shall be signed and sealed by professional engineer

h. Testing results showing conformance and manufacturer's written certification that FRP manholes meet ASTM D3753. Required tests include:

1). Load Rated Test

2). Cylinder Stiffness

3). Soundness

4). Flexural strength

5). Flexural modulus

6). Compressive Strength

7). Barcol hardness

i. Manufacturer's recommended installation instructions

2. Product Data

a. Ring and covers, watertight inserts, grade rings, gaskets and sealants, stub outs, vents, etc.

b. Warranty documentation

1.04 STANDARDS

Applicable provisions of the following standards shall apply as if written here in their entirety:

A. American Association of State Highway and Transportation Officials (AASHTO):

AASHTO H-20	Axial Loading
AASHTO M306	Specification for Drainage, Sewer, Utility and Related Castings

B. American Society for Testing and Materials (ASTM) Standards:

ASTM A48	Specification for Gray Iron Castings
ASTM C478	Specification for Precast Reinforced Concrete
ASTM C581	Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D695	Test Method for Compressive Properties of Rigid Plastics
ASTM D790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2412	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

ASTM D2583	Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D2584	Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D2996	Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3753	Glass-Fiber-Reinforced Polyester Manholes and Wet wells
ASTM D4796	Test Method for Bond Strength of Thermoplastic Pavement Marking Materials

1.05 DELIVERY AND STORAGE

A. Handling and storage shall be in strict accordance with the manufacturer’s written instructions. Fiberglass manholes must be delivered to the site in one piece.

B. Inspect prefabricated fiberglass manholes upon delivery and reject any cracked or otherwise visibly defective units.

1.06 WARRANTY

A. The manufacturer must warrant the FRP manhole as follows:

Will not leak for twenty (20) years from substantial completion due to internal or external corrosion, or structural failure when used within a municipal wastewater system.

2.00 PRODUCTS

2.01 FRP MANHOLES:

A. Fiberglass manholes must conform to all ASTM standards governing plastic laminations and the latest Glass-Fiber Reinforced Polyester Manholes standard, ASTM D3753.

B. Marking and Identification:

All manholes must be marked with the following information in minimum 1-inch tall, stenciled letters on the inside of the manhole.

1. Manufacturer’s name or trademark
2. Factory location
3. Serial Number
4. Manhole length
5. ASTM Designation
6. Installation assistance marking (vertical lines 90-degrees apart at base of manhole)

C. The manhole must be of watertight construction to prevent infiltration and exfiltration.

D. The manhole must be a circular cylinder with an inside diameter in conformance with the plans and this specification.

E. Provide wall section thickness in accordance with ASTM D3753, but not less than 0.50 inches of thickness.

F. The manhole must be manufactured in one class of load rating. Complete manhole must have a minimum dynamic load rating of 16,000 lbs. when tested in accordance with ASTM D3743. The complete manhole must not leak, crack or suffer other damage when load tested to 40,000 lbs. and must not deflect vertically downward more than 0.25" at the point of load application when loaded to 24,000 lbs.

G. The cylindrical portion of the manhole is to be tested per ASTM D2412. The manhole cylinder must have the following minimum pipe stiffness values in accordance with ASTM D3753, Section 8.5, (note 1). For manhole depths greater than 35-feet, pipe stiffness will be in accordance with the manufacturer's recommendations.

Manhole Length (ft)	Pipe Stiffness (PSI)
3 – 6	0.72
7 – 12	1.26
13 – 20	2.01
21 – 25	3.02
26 - 35	5.24

H. Inside diameter tolerance - ±1%.

I. Minimum Physical Properties:

1. Flexural Strength (cone):
    a. Hoop: 15.4 x 10^3 PSI
    b. Axial: 17.2 x 10^3 PSI
2. Flexural Strength (pipe):
    a. Hoop: 22.5 x 10^3 PSI
    b. Axial: 14.3 x 10^3 PSI
3. Compressive Strength: 8.9 x 10^3 PSI

J. Manhole Cone

1. The barrel and cone shall each be produced in a continuous manufacturing process which insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a reinforced glass-resin joint resulting in a one-piece unit. Field made joints are not acceptable.
2. The cone of the manhole must have a bearing surface wide enough to facilitate the placement of concrete adjustment rings and have sufficient strength to safely support HS-20 loading in accordance with AASHTO.
3. The ring and cover must not be placed directly on the fiberglass manhole.
4. The manway cone must be concentric with respect to the barrel of the manhole. Eccentric manway cones are not permitted.

5. Provide UV inhibitors added directly to resins to prevent photodegradation.

K. Manhole Base

1. Manholes must have resin fiber-reinforced base.
2. Provide stiffening ribs, completely enclosed with resin fiber-reinforcement as required by the Manufacturer's design.
3. All fiberglass manholes with a fiberglass bottom must have a minimum 3-inch anti-flotation ring.
4. Manhole bottoms must be a minimum of 0.50-inch thick.

L. Approved Manufacturers:

1. Containment Solutions, Inc.
2. L.F. Manufacturing, Inc.
3. Approved Equal

2.02 CAST-IN-PLACE CONCRETE BASE

A. Reinforcing Steel: Furnish as specified in Section 03 21 00 "Reinforcing Steel" and as shown on Drawings.

B. Concrete: Furnish as specified in Section 03 30 00 "Cast-in-Place Concrete" and as shown on the Drawings.

The minimum compressive strength for concrete is 3,500 psi.

2.03 NON-METALLIC MANHOLE RINGS AND COVERS:

A. All rings and covers must be made from high strength nonmetallic fiber reinforced polymer/composite materials. The material must be a resin thermoset matrix that can be reinforced with continuous filament engineered fabrics, fiber rovings, short fiber filaments, or equivalent nonmetallic reinforcing structure(s). Sealing gaskets must be bonded to the frame continuously at the interface with the cover to reduce wear, shock, noise, malodors and infiltration.

B. Rings and covers intended for traffic service must be capable of withstanding AASHTO M306: Proof Testing (includes items such as frames, covers, etc.)

C. Fabricate rings and covers to conform to shapes, dimensions, and with wording or logos shown on the Drawings.

D. Molding Process

1. Before the moldings are removed from the molding operation, they must be thoroughly de-flashed and cleaned at the parting lines, holes, notches and all exposed edges.
2. If using a lock or latch, these must be independent of the method used to open the cover to ensure the cover can be opened in the event of lock or latch failure.
3. Covers and frames must be compression molded under high pressures (>0.5 tons/sq. inch of x-y surface area) and high temperatures (>200 degrees F).

4. Metal reinforcements or metal hinges molded within the composite shall not be permitted. Small non-stress bearing pieces of metal may be encapsulated or attached.

E. All rings and covers shall be molded and assembled in the United States in accordance with the requirements of AASHTO M306.

F. Covers must be provided with a positive sealing mechanism utilizing 316 stainless steel hardware with nuts molded in or attached at pre-molded designated points of the frame and shall be Teflon coated. Other equivalent locking mechanisms must be approved by the Engineer.

G. Composite covers must be detectable by metal detectors.

H. Composite covers must be furnished with two concealed pick holes molded with 316 stainless steel inserts. An additional 316 stainless steel lifting clip must be molded into the top of the cover to facilitate removal and replacement.

I. Composite covers must have provisions for 316 stainless steel threaded inserts molded into the bottom surface to accommodate monitoring and remote transmission sensors and antenna utilized by the utility. Antenna placed on the bottom side must have the capability to transmit through the cover without the need to drill and install antenna on the upper surface.

J. Markings: Covers and Frames shall have the following molded into the substrate of the cover

1. Name (or abbreviation) of molder
2. Country of Origin
3. Molding Date
4. Indication that material is non-metallic

K. Approved Manufacturers:

1. Composite Access Products, L.P.
2. Approved equal.

2.04 MANHOLE GRADE ADJUSTMENT RINGS

A. Concrete Manhole Grade Rings

1. Grade adjustment rings must be pre-cast, reinforced concrete in conformance to ASTM C478.
2. Mortar concrete grade rings using one (1) part Portland Cement and two (2) parts sand and sufficient potable water to produce a working mixture.
3. Coat all exposed concrete surfaces per 09 96 01 “Concrete Protective Coatings”.

2.05 WASTEWATER MANHOLE INTERNAL DROP

A. Internal drop for wastewater manholes must consist of a fiberglass reinforced resin bowl in combination with a PVC drop pipe.

B. Bowl and pipe must be attached to manhole using manufacturer provided 316 stainless steel hardware with epoxy anchors.

C. Drop pipe must be ASTM D3034, SDR35 PVC pipe.

D. Provide 316 stainless steel bracket extensions as required for manhole ID changes.

E. Approved manufacturers:

1. Duran, Inc. – Reliner Drop Bowl

2. Approved Equal

2.06 CLEANOUT FITTINGS

A. Pipe fittings shall be ductile iron and shall conform to ANSI A21.10 with a minimum pressure rating of 250 psi.

B. The cleanout casting shall conform to ASTM A48, Class 30.

C. Ductile iron fittings shall be lined with factory installed Protecto 401 Ceramic Epoxy Lining by Induron or American Polybond Plus (fusion bonded epoxy and fusion bonded polyethylene) or an approved equal. Lining primers, applications and thicknesses shall be in accordance with manufacturer's recommendations for sanitary sewer applications.

2.07 PIPE CONNECTIONS

A. Field connections to FRP manholes to pipe penetration must use a compression fit into the cored wall of the RFP liner and use stainless steel bands to secure the gasketed connection to the pipe.

B. Approved Manufacturers:

1. ADS – Insert-a-Tee

2. Trelleborg – Kor-N-Seal

3. Approved Equal

2.08 MANHOLE SCRUBBER INSERT

A. Components must be manufactured from corrosion proof material suitable for atmospheres containing hydrogen sulphide and dilute sulphuric acid as well as other gases associated with wastewater collection systems and be filled with dry media capable of effective control of odors associated with such gases.

B. The body must be made from Acrylonitrile Butadiene Styrene plastic that meets the Federal Standards of LP 1183 and can pass the following ASTM test requirements: D 256, D 638, D 790, D 792, D 785, D648. The thickness must not be less than 3/32" nor greater than 6/32". The body must be manufactured to the dimensions as shown on the contract drawings to allow easy installation in the manhole frame.

C. The gasket must be made of closed-cell Neoprene. The gasket must have a pressure sensitive adhesive on one side and be placed under the insert rim by the manufacturer. The adhesive must be compatible with the body material so as to form a long-lasting bond in either wet or dry conditions of use.

D. The insert must have two lift straps attached to its body. Lift straps must be made of 1” width polyester nylon and shall be seared on all cut ends to prevent unraveling or deterioration. Lift straps must be attached to insert body by means of a 3/16” stainless steel rivet.

E. The insert media must remove H2S and malodorous compounds from the air stream via H2S Converting/Oxidizing/Polishing media. The H2S converting/Oxidizing/Polishing media capacities must not be diminished by ambient humidity.

F. The manhole scrubber must be manufactured to fit the manhole frame rim from which it hangs.

G. Approved Manufacturers:

1. Syneco Systems Incorporated – Peacemaker Manhole Scrubber

2. Approved Equal

2.09 CHIMNEY SEALS

A. Chimney seals consist of a flexible internal or external rubber sleeve, interlocking extensions and stainless steel expansion bands.

B. The seal must remain flexible, allowing repeated vertical movement of the frame of not less than 2 inches and/or repeated horizontal movements of not less than ½ inch.

C. The sleeve portion of the seal must be either double or triple pleated with a minimum unexpanded vertical height of either 8 or 10 inches respectively. The sleeve and extension shall have a minimum thickness of 3/16 inch and shall be made from a high quality rubber compound conforming to the applicable requirements of ASTM C923, with a minimum 1500-psi tensile strength, a maximum 18 percent compression set and a hardness (durometer) or 48 plus or minus 5.

D. The bands must be integrally formed from 16 gauge stainless steel conforming to ASTM A240, Type 316, with no welded attachments, and shall have a minimum adjustment range of 2 diameter inches and a positive locking mechanism.

E. All hardware used for this mechanism must be 316 stainless steel.

F. Product must have a minimum 25-year manufacturer’s warranty.

G. Approved Manufacturers:

1. Cretex Specialty Products

2. Approved Equal

3.00 EXECUTION

3.01 GENERAL

A. Remove and keep all water clear from the excavation during construction and testing operations.

B. Place imported pipe base material on subbase; thoroughly compact with a mechanical vibrating or power tamper.

C. Build and install each manhole to dimensions shown on plans and at such elevations that manhole will be true extensions of lines of pipe.

D. Fiberglass manholes must be installed in accordance with the manufacturer's installation instructions.

E. The Contractor is responsible for handling groundwater to provide firm, dry subgrade for the structure, and must prevent water from rising on newly poured in place concrete until concrete obtains sufficient strength and must guard against floatation or other damages resulting from groundwater or flooding.

F. Construct manhole ring concrete encasement as indicated on the drawings.

3.02 DEFECTS NOT PERMITTED

A. The exterior surface must be relatively smooth with no sharp projections. The exterior surface must be free of blisters larger than 0.5-inch in diameter, delamination or fiber show. Gel-coat, paint or other coatings on the exterior surfaces are not allowed.

B. The interior surfaces must be resin rich, and smooth with no exposed fibers. Surface must be free of crazing, delamination, blisters larger than 0.5-inches in diameter and wrinkles of 0.25-inches or greater in depth. Voids that cannot be broken with finger pressure and that are entirely below the resin surface are permitted up to 4 each per square foot, if they are less than 0.5-inches in diameter and less than 0.0625-inches thick. Gel-coat, paint or other coatings on the interior surfaces are not allowed.

C. Manhole lengths must be in whole or ½-foot increments, ±2-inches.

D. Coat all concrete surfaces exposed on the interior of the manhole as specified.

3.03 INSTALLATION

A. Manhole Sizing

Manhole diameters are to be as indicated on the plans and as indicated below. If there is a conflict between the plans and these requirements, the larger manhole will be required.

1. Pipe diameters 18" and smaller – Provide 48-inch inside diameter manholes.
2. Pipe diameters 24" to 27" – Provide 60-inch inside diameter manholes.
3. Pipe diameters 30" and larger – Provide 72-inch inside diameter manholes.

B. Manhole Base:

1. Cast-in-place Manhole Base: The applicable details as indicated in the Drawings shall apply. Form and place the manhole base at an elevation that allows the inverts to match the pipe flowlines.
2. Concrete base must be a minimum of 6-inches thick for up to 48-inch diameter manholes (minimum 8-inch thick for larger diameters). Concrete base must extend a minimum of 12-inches beyond the outside wall of manholes up to 20-feet in depth (minimum of 24-inches for up to 35-feet in depth).
3. Manhole must be embedded into concrete base for a minimum of 4-inches, with a minimum 2-inch thick concrete bearing surface beneath the bottom edge of the manhole.

4. Inverts

    a. Give the concrete portion of all inverts within the manholes a smooth steel trowel finish.

    b. Cast in place concrete U-shaped invert channels must connect the entering and existing pipes. The invert channels must be constructed so that the connecting pipes will not protrude beyond the inside surface of the manhole wall.

    c. Construct invert channels to provide a smooth waterway with no disruption of flow at the connection between the pipe and manhole.

5. The first section of pipe extending out a minimum of 24 inches from each side of the manhole base must be supported by lean concrete as part of the manhole base. No additional payment shall be made for this concrete cradle; the sum shall be included in the bid price for the manhole.

C. Pipe Connection: Connections between the pipe and manhole may be accomplished by the methods listed below.

1. All cut-outs should be performed by the manufacturer at the factory. Contractor should not make any cut-out in the field. If any cut-out or coring is required, Contractor must notify the Engineer prior to proceeding.

2. Cut manhole barrel for pipe penetrations following curvature of the pipe with a maximum of 1-inch clearance. Seal cut edges with resin. Hole may be circular or cutout with a semi-circular top, which extends to the bottom of the barrel.

3. Construct pipe stub outs as part of the prefabricated manhole. Install required sealant or gasket in stub out to ensure a watertight bond is achieved at the connection between the pipe and the manhole.

4. Connections must be made with a watertight compression connection conforming to the performance requirements of ASTM C923.

D. Manhole Rings and Covers: Securely anchor the base of the manhole ring into a 6-inch minimum thickness precast concrete ring and set on top of concentric manhole cone as a unit. Provide sealant between the rings. Set frame on top of manhole or grade rings using continuous water sealant. Remove debris, stone and dirt to ensure a water tight seal. Do not use shims, wood, stones, or other unspecified materials to obtain the final surface elevation of the manhole frame.

E. Contractor may use grade rings to reach final plan elevation. Grade ring total height must not exceed 24-inches.

F. Cleanouts: Provide a cleanout at the ends of all sewer lines unless a manhole is provided at that point. Construct cleanouts in accordance with the details shown on the Drawings.

G. Drop Manholes: Install a drop manhole piping assembly in all cases where the distance between the incoming pipe and the floor of the manhole is 2 feet or more.

3.04 FIELD QUALITY CONTROL

A. 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 the TCEQ. Test manholes after installation with all connections (existing and/or proposed) in place. Pug lift holes with an approved non-shrink grout prior to testing. Install drop-connections and gas sealing connections prior to testing.

1. Vacuum Test: Temporarily plug lines entering the manhole with the plugs braced to prevent them from being drawn into the manhole. Install plugs in the lines beyond drop-connections, gas sealing connections, etc. Place the test head inside the frame at the top of the manhole and inflate in accordance with the manufacturer's recommendations. Draw a vacuum of 10 inches of mercury, then turn off the vacuum pump. Read the level of the vacuum after the required test time with the valve closed. The manhole will pass the test if the drop in the level is less than 1 inch of mercury (final vacuum greater than 9 inches of mercury). The required test time for 48-, 60-. And 72-inch manholes with depths up to 30 feet is 2 minutes. Test times for manholes of greater size and depths will be determined by the Engineer.
2. Manhole Repairs: Manholes will be accepted in accordance with the criteria above. Repairs to manholes must be performed by the manufacturer. Engineer in consultation with the manufacturer will determine if extent of repairs warrants manhole replacement. Contractor will bear all costs of manhole replacement. Retest the manhole as described above until a successful test is achieved. Remove all temporary plugs and grout after a successful test.

END OF SECTION

33 37 13.10 NON METALLIC MANHOLE RING AND COVER

1.00 GENERAL

1.01 SECTION INCLUDES:

A. Molded composite manhole frames and covers for application in wastewater collection system and facilities.

B. All composite moldings shall consist of a thermosetting resin matrix blended and/or combined with reinforcing fiber rovings, short fiber filaments, or equivalent nonmetallic reinforcing structure(s). The thermosetting resin matrix shall be a polyester, vinylester, or a blend of these. The moldings shall be true to pattern in form and dimension and free from cracks, pores, knit-lines, or other defects in locations affecting their strength and value for the service intended.

1.02 REFERENCES

A. AASHTO - American Association of State Highway and Transportation Officials

1. M306-10: Drainage, Sewer, Utility, and Related Castings

a. Manufacture

b. Proof Testing

c. Inspection

d. Certification

e. Marking

2. Standard Specification for Highway Bridges

B. ASTM G154 – Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

C. ASTM C 1028 – Standard Test Method for Determining the Static Coefficient of Friction

D. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

E. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

F. TCEQ Chapter 217 Design Criteria for Waste Water Systems Section 217.55 Manhole Covers

G. Texas Department of Transportation Approval

1.03 SUBMITTALS

A. Conform to requirements of Section 01 33 00 “Document Management” and Section 01 33 02 “Shop Drawings.”

B. Submit copies of manufacturer's specifications, testing data, certifications, load tables, dimension diagrams, anchor details, and installation instructions.

C. Submit shop drawings for fabrication and installation of casting assemblies that are not included in Drawings or standard Utility details. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

2.00 PRODUCTS

2.01 MANHOLE RING AND COVER

A. All rings and covers units shall be made from high strength nonmetallic fiber reinforced polymer/composite materials. The material shall be a resin thermoset matrix that can be reinforced with continuous filament engineered fabrics, fiber rovings, short fiber filaments, or equivalent nonmetallic reinforcing structure(s). Sealing gaskets shall be bonded to the frame continuously at the interface with the cover to reduce wear, shock, noise, malodors and infiltration.

B. Rings and covers intended for traffic service shall be capable of withstanding AASHTO M306: Proof Testing (includes items such as frames, covers etc.)

C. Fabricate rings and covers to conform to shapes, dimensions, and with wording or logos shown on Utility Drawings as required.

D. Molding Process

1. Before the moldings are removed from the molding operation, they shall be thoroughly deflashed and cleaned at the parting lines, holes, notches and all exposed edges.

2. If using a lock, or latch, these must be independent of the method used to open the cover to ensure the cover can be opened in the event of lock or latch failure.

3. Covers and frames shall be compression molded under high pressures (>0.5 tons/sq. inch of x-y surface area) and high temperatures (>200 degrees F).

4. Metal reinforcements or metal hinges molded within the composite shall not be permitted. Small non-stress bearing pieces of metal may be encapsulated or attached.

E. All rings and covers shall be molded and assembled in the United States in accordance with the requirements of AASHTO M306.

F. Covers shall be provided with a positive sealing mechanism by means of four (4) austenitic 316 stainless steel one half inch (1/2”) nuts and bolts # 11 National Coarse Thread. Nuts shall be molded in or attached at pre-molded designated points of the frame and shall be Teflon Coated. For bolted manhole covers a thin film of an “Anti-Seize” lubricant, approved by the Engineer, or his designated representative shall be applied to all bolts. Bolts shall be threaded by hand prior to the use of wrenches. Other equivalent locking mechanisms must be approved by the Utility.

G. Composite covers shall be detectable by metal detectors.

H. Composite Covers shall be furnished with 2 concealed pick holes molded with 316 stainless steel inserts. An additional 316 stainless steel lifting clip shall be molded into the top of the cover to facilitate removal and replacement.

I. Composite covers shall have provisions for 316 stainless steel threaded inserts molded into the bottom surface to accommodate monitoring and remote transmission sensors and

antenna utilized by the utility. Antenna placed on the bottom side shall have the capability to transmit through the cover without the need to drill and install antenna on the upper surface.

J. Markings: Covers and Frames shall have the following molded into the substrate of the cover

1. Name (or abbreviation) of molder
2. Country of Origin
3. Molding Date
4. Indication that material is non-metallic

K. Composite frame and covers shall be Composite Access Products, L.P., McAllen, Texas or approved equal.

2.02 MANHOLE SCRUBBER INSERT

A. Materials and Design

1. Components shall be manufactured from corrosion proof material suitable for atmospheres containing hydrogen sulphide and dilute sulphuric acid as well as other gases associated with wastewater collection systems and be filled with dry media capable of effective control of odors associated with such gases.
2. The body shall be made from Acrylonitrile Butadiene Styrene plastic that meets the Federal Standards of LP 1183 and can pass the following ASTM test requirements: D 256, D 638, D 790, D 792, D 785, D 648. The thickness shall not be less than 3/32" nor greater than 6/32". The body shall be manufactured to the dimensions as shown on the contract drawings to allow easy installation in the manhole frame.
3. The gasket shall be made of closed-cell Neoprene. The gasket shall have a pressure sensitive adhesive on one side and be placed under the insert rim by the manufacturer. The adhesive shall be compatible with the body material so as to form a long-lasting bond in either wet or dry conditions of use.
4. The insert shall have two lift straps attached to its body. Lift straps shall be made of 1” width polyester nylon and shall be seared on all cut ends to prevent unraveling or deterioration. Lift straps shall be attached to insert body by means of a 3/16" stainless steel rivet.
5. The insert media shall remove H2S and malodorous compounds from the air stream via H2S Converting/Oxidizing/Polishing media. The H2S Converting/Oxidizing/Polishing media capacities shall not be diminished by ambient humidity.
6. The manhole scrubber shall be manufactured to fit the manhole frame rim from which it hangs.

B. Manufacturers

1. Syneco Systems Incorporated – Peacemaker Manhole Scrubber
2. Approved Equal

2.03 TESTING AND PERFORMANCE REQUIREMENTS

A. Testing shall be performed in accordance with the following inspection criteria unless otherwise specified in the contract or purchase order. The manufacturer/supplier shall be responsible for carrying out all of the required tests and inspections. All testing shall be conducted in the United States using purchaser approved reliable facilities. The manufacturer/supplier shall maintain complete records of all such tests and inspections. All testing shall be paid for by the manufacturer/supplier.

B. Frames and Covers shall be “Proof Tested” in accordance with AASHTO M306.

C. Heavy Duty: A load of 50,000 lbs shall be concentrated on a 9” x 9” block with rubber or fiber backing pad for one minute. During the load testing process visible cracks or delamination will be cause for rejection. When load is removed, Permanent Set (Deflection) of more than 1/8” (.125”) measured at center of load area will be cause for rejection. All testing shall be conducted on a NIST calibrated and Certified load test machine.

D. Ultraviolet resistance: ASTM G154 Cycle 1 for 1000 hrs. Specimens shall be tested for ultimate flexural strength, retaining at least 75% of control values for load and deflection at failure.

E. Coefficient of Friction: Shall be greater than 0.6 when tested in accordance to ASTM C1028.

F. At the request of the Project Manager, the quality process manual shall be available for review. Manufacturing facility shall also be available for inspection to ensure quality standards are met along with EPA and OSHA standards.

G. Where manhole scrubbers are installed, measure atmospheric H2S in ppm after removing cover but prior to installing insert. Measure again after installing insert and calculate removal percentage.

3.00 EXECUTION

3.01 INSTALLATION

A. Install composite frames and covers according to approved shop drawings, instructions in related specifications and details, and written installation instructions from manufacturer.

B. Set units accurately at required locations to proper alignment and elevation. Keep units plumb, level, true, and free of trash. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.

END OF SECTION

DIVISION 40

PROCESS INTEGRATION

40 05 53 IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

1.00 GENERAL

1.01 WORK INCLUDED

A. Provide identifying devices for the following:

1. Piping.
2. Equipment.
3. Electrical Equipment.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

1. Product data sheets for identifying devices.
2. A list of where devices are to be installed, and the data to be included on each identifying device.

1.03 STANDARDS

The applicable provisions of the following standards shall apply as if written here in their entirety:

American National Standards Institute (ANSI) Standards:

ANSI A13.1	Pipe Marking Specifications

1.04 DELIVERY AND STORAGE

Store products inside storage sheds until installed.

1.05 GUARANTEES

Guarantee Identifying devices installed in wet locations or areas subject to moisture to be weather resistant for a period of 3 years after installation.

2.00 PRODUCTS

2.01 MATERIALS

A. Piping Identification: Pressure sensitive, adhesive-backed vinyl plastic label having the lettering indicated on background color as scheduled. Provide labels manufactured by the Seton Name Plate Corp. or Brady “Perma Code”. Provide labels having an arrow to indicate the direction of flow. Provide 1-1/4-inch high letters.

B. Outdoor Pipe Markers: Seton “Weather Code” Fade resistant, vinyl markers, 2-1/4 by 9 inches.

C. Equipment Nameplate: Seton Style 2060 “Seton-ply” engraved plastic plaque, approximately 3/4 by 2-1/2 inches in size. Plaque shall be 1/16 inch thick having beveled edges and drilled with two mounting holes when attached by screws. Mounting screws shall be stainless steel. Lettering shall be approximately 3/16 inch high. Text to include equipment mark and equipment description (Example: EXHAUST FAN EF-5). Identification label on nameplate shall correspond to a typewritten legend included in the O & M Manual which includes the following:

1. Equipment identifier.
2. Location inside building (or on project site).
3. Manufacturer’s model number.
4. Brief description of function.
5. Reference to shop drawings, parts lists, or other data included in the O & M Manual.

3.00 EXECUTION

3.01 PREPARATION

Install piping complete with insulation and valves in place prior to installing identification devices. Mount electrical components, including electrical control devices. Piping shall be dry and free of oil, grease, or other contaminants. Insulation shall be completely dry.

3.02 INSTALLATION

A. Install pipe labels on piping exposed to view, in any location inside buildings or structures, or in underground vaults, pump stations, basements, or other exposed locations.

B. Install a minimum of one label in each area or room and additional labels at spacings not to exceed 5 feet. Position labels so that lettering is visible from the front of piping at floor level. Provide labels of a size that is legible from floor level. Install labels in rows with uniform spacings where several pipes run parallel to each other.

C. Name the fluid flowing inside the pipe on color coded labels with text per the schedule below. Labels shall also include an arrow indicating the direction of flow.

3.03 EQUIPMENT IDENTIFICATION

A. Provide an equipment identifier on each separate piece of equipment, including process equipment and electrical equipment. Provide a nameplate for each separate piece of electrical equipment, including but not limited to panelboards, switchgear, starters, disconnects, control devices and control panels. Provide name tags for each separate switch, starter, contactor, or other compartment on electrical switchgear.

B. Engrave lettering on nameplates corresponding to the identification marks. Install nameplates prominently on equipment not occurring in occupied spaces. Install nameplates on the inside covers of lighting panelboards. Install nameplates on all other equipment centered and at top of equipment. Nameplates shall not be installed in a location that interferes with the equipment’s ability to operate.

C. Attach nameplates to exterior equipment with two 3/8-inch stainless steel screws. Interior plaque may be attached by screws, or by the adhesion method when approved by the Engineer.

3.04 SCHEDULES

A. Prepare a typed schedule showing piping label requirements and equipment tags. Include each piping type and the appropriate identification on the schedule. Submit the schedule to the Engineer for approval.

B. Mark pipe labels to conform with the following legend, or with requirements of standards noted. Include the full name, as appearing under the column heading "Description", and the abbreviation under the column heading "Abbrev. Legend."

Description	Valve Prefix	Abbrev. Legend	Label Color (Letter on Background)
Plumbing			
Waste, Drain	W	DP	Black on Green
Process Piping			
Raw Sewage	PP	SR	White on Green
Electrical			
Panelboards	LP-1		White on Black
Starters for Exhaust Fan	S/EF-1		White on Black
Control Panels for Exhaust Fan	CP/EF-1		White on Black
Disconnects for Exhaust Fan	DS/EF-1		White on Black
Junction Boxes	JB/101		White on Black
Controllers for Exhaust Fan	CI/EF-1		White on Black

END OF SECTION

40 05 61 GATE VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install gate valves and appurtenances, including valve boxes, operators, bolts, nuts and gaskets.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

Acceptable Manufacturers:

A. Mueller Company

B. J&S

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and must include:

A. Record Data:

1. Manufacturer’s product data sheets.
2. Manufacturer’s product data sheets for coatings and linings.
3. AIS Certifications.

B. Operation and Maintenance Manuals:

1. Manufacturer’s product data sheets and operation manuals.
2. Manufacturer’s product data sheets for coatings and linings.
3. Valve warranty information.

1.04 STANDARDS

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

1. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

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

ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Standard Specification for Ductile Iron Castings

3. American Water Works Association (AWWA) Standards:

AWWA C111	Rubber-Gasket Joints
AWWA C500	Gate Valves for Water and Sewage Systems
AWWA C509	Resilient Seated Gate Valves for Water and Sewage Systems

2.00 PRODUCTS

2.01 GATE VALVES

A. General:

1. Unless otherwise specified, gate valves 3 through 24 inches in size shall be in accordance with AWWA C509, Resilient Wedge. Valves 16 inches and larger shall be provided with gearing to reduce the maximum required opening and closing torque to 80 ft-lb.

2. Gate valves 2-1/2 inches and smaller shall be bronze, non-rising stem with wedge disc and screwed ends for 300-psi W.O.G. working pressure. Bronze gate valves shall be Crane No. 437, Mueller No. H 10914, or approved equal.

3. Gate valves shall meet 300 psi test pressure, 200 psi working pressure, mechanical joint, with inside stem meeting AWWA C-509 specifications. Valves shall be wrapped with 8-mil polyethylene film with all edges and laps securely taped to provide a continuous wrap.

B. Gate: Gate for double disc valves shall be cast iron with bronze mounted wedges and seats. Gate for resilient seated valves shall be cast iron with rubber-seat compound bonded to the valve gate.

C. Operators

1. Operators must turn counterclockwise to open the valve.

2. Above grade valves must have handwheel operators, unless otherwise designated. A directional arrow and the word “open” must be cast on the handwheel. Handwheels are to be painted ‘red’.

3. Valves for buried service must have a 2-inch square nut operator and be installed with extension stems where required to extend operating nut to within 12 inches of the finished grade.

   Provide a cast iron valve box to enclose the operating stem. Valve box must be per Owner standards with concrete collars.

D. Stem and Seal: The non-rising stem shall be bronze with inside screw. Shaft seal shall employ O-rings or V-type packing.

E. Bell Ends: Where designated, valves shall be mechanical joint or rubber gasketed push on joints in accordance with the applicable requirements of AWWA C111.

F. Coating: Provide factory applied epoxy coating per AWWA C509 suitable for buried service.

G. Lining: The interior of the valve shall be lined by the manufacturer in accordance with manufacturer's recommendations for sanitary sewer applications.

3.00 EXECUTION

3.01 INSTALLATION

Carefully handle and lower buried valves into position to prevent damage to any part of the valves. Place the valve in the proper position with stem truly vertical and securely hold until connections have been made. Furnish bolts, nuts, and gaskets. The Contractor shall be responsible for adjusting the valve boxes to the proper length to conform with the ground surface.

3.02 BLOCKING UNDER GATE VALVE

Gate valves 18 inches and larger which are buried shall rest on a concrete pad. Pad shall extend for the full width of the trench and from back of hub to back of hub (or flange). Care shall be taken to not interfere with the jointing.

3.03 FIELD QUALITY CONTROL

Upon completion of installation of the equipment, an acceptance test to verify the satisfactory operation of each unit shall be conducted. The test shall be conducted in a manner approved by and in the presence of the Engineer. The unit shall be checked for general operation and leakage. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

END OF SECTION

40 05 65.23 SWING CHECK VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install Surgebuster Check Valves at the locations and size as indicated. Valves shall be designed, manufactured and tested in accordance with American Water Works Association Standards ANSI/AWWA C508.

A. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Surgebuster (Val-Matic)
2. Approved Equal.

B. Experience Requirements: The Manufacturer shall have had successful experience in manufacturing valves for this type service in the sizes indicated. The Manufacturer shall have at least 10 years' experience in the manufacture of the valves.

C. Manufacturer's Representative for Startup and Training: The Manufacturer shall provide the services of a competent manufacturer's representative for an indefinite period of time as required to insure proper adjustment, installation and operation of the valve.

D. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the Manufacturer shall provide test certification and required documentation. The valve coating system shall be NSF61 approved.

E. WARRANTY: Manufacturer shall warrant the Surgebuster Valves furnished under this specification for a period of three (3) years against defects in materials and workmanship and operational failure. The first three (3) years of service shall be interpreted as the thirty six (36) month period following the installation of the Surgebuster Valves, or forty eight (48) months after delivery to the Owner, whichever occurs first.

In the event of failure of any part or parts of the Surgebuster Valves during the first three (3) years of service, provided that the valves have been operated and maintained in accordance with good practice, the Manufacturer shall furnish, deliver and install the defective part or parts at his own expense.

NOTE: The flex portion of the disc shall be warranted for twenty-five (25) years. This time period shall be interpreted as the twenty-five (25) year period following the installation of the Surgebuster Valves, or twenty-six (26) years after delivery to the Owner, whichever occurs first.

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Submittal Procedures" and shall include:

1. Shop Drawings.
2. Equipment Installation Reports.
3. Operation and Maintenance Manuals.

1.04 STANDARDS

A. The following standards shall apply as if they are included in these documents:

1. American Society for Testing and Materials (ASTM) Standards:

ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A276	Standard Specifications for Stainless Steel Bars
ASTM A582 T303	Standard Specification for Free-Machining Stainless Steel Bars

2. American Water Works Association (AWWA) Standards:

AWWA C508	Swing-Check Valves for Waterworks Service, 2- through 24-inch NPS

2.00 PRODUCTS

2.01 SWING CHECK VALVES

A. The Check Valve shall be of the full body type, with a domed access cover and only two moving parts, the flexible disc and the disc accelerator.

B. The valve body and cover shall be constructed of ASTM A-536 Ductile Iron.

C. The valve disc shall absolutely prevent the return of water or sewage back through the valve when the inlet pressure decreases below the delivery pressure, on pump shutoff or power failure. The valve shall be tight-seating.

D. The closing and opening rate of the valve shall be field adjustable.

E. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, without special tools or removing the valve from the line.

F. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

G. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator.

H. The disc accelerator shall be of one piece 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.

I. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.

J. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG. 5.3 The disc accelerator shall be type 302 stainless steel.

K. A mechanical indicator shall be provided to provide disc position indication on valves 4" and larger. The indicator shall have continuous contact with the disc under all operating conditions to assure accurate disc position indication.

L. A screw-type backflow actuator shall be provided to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation.

M. Swing check valves shall be furnished with ANSI 125 pound flat faced flanges. Valve exterior and interior to be painted with Fusion Epoxy Paint per AWWA C550.

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and lower the valves into position so to prevent damage to any part of the valves.

3.02 CLEAN AND ADJUST

A. Adjust weight position and air cushion operation in accordance with manufacturer recommendations.

END OF SECTION

40 05 78 AIR RELEASE AND AIR AND VACUUM VALVES

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install air and vacuum valves of the sizes and types indicated and shall be suitable for wastewater service. All air release valves shall be combination air release, air vacuum valves. Furnish the necessary isolating valves and piping.

B. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and must include:

A. Record Data: Manufacturer’s product data sheets.

B. Record Data: AIS Certifications.

C. O&M: Manufacturer’s operating instructions and product data sheets.

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

A. Air Release Valve (ARV) for Wastewater:

1. Combination air valves must be heavy duty and contained and operating within a single body or assembled unit. Valve must automatically release small volumes of air while the pipe is operating under normal conditions.
2. Valves must be designed for use with raw wastewater containing solids.
3. Valves must be rated for at least 150 psi service pressure.
4. Material Requirements:
    a. Valve exterior bodies, base and covers must be 316 stainless steel or reinforced nylon.
    b. Internal bushings, hinge pins, float guide and retaining screws, pins, etc., must be 316 stainless steel or bronze.
    c. All exterior hardware and components must be stainless steel.
    d. Orifice seats must be Buna-N rubber.
    e. Floats must be polypropylene.
5. Approved Manufacturers:

a. A.R.I. Model S-020

b. Approved equal

B. Combination Air Valve (CAV) for Wastewater:

1. Combination air valves must be heavy duty air release and vacuum valves contained and operating within a single body or assembled unit.

a. Valve must automatically release small volumes of air while the pipe is operating under normal conditions.

b. Valve must automatically exhaust large volumes of air while the pipe is being filled and permit immediate re-entry of air while being drained.

2. Valves must be designed for use with raw wastewater containing solids.

3. Valves must be rated for at least 150 psi service pressure.

4. Material Requirements:

a. Valve exterior bodies, base and covers must be reinforced nylon.

b. Internal bushings, hinge pins, float guide and retaining screws, pins, etc., must be 316 stainless steel or bronze.

c. Orifice seats must be Buna-N rubber.

d. All exterior hardware and components must be polypropylene or reinforced nylon.

e. Floats must be foamed polypropylene.

5. Approved Manufacturers:

a. A.R.I. Model D-025

b. Approved equal

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and install valves vertically in such a manner as to prevent damage to any part of the valves. Installation shall be in accordance with the Manufacturer's instructions. Provide nuts, bolts, and gaskets where applicable.

B. Provide additional field applied coatings to factory applied epoxy coatings per section 09 96 00.01 "High Performance Coatings".

END OF SECTION

40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS

1.00 GENERAL

1.01 GENERAL

A. The General Conditions and Requirements, Special Provisions, and Electrical specifications are hereby made a part of this section.

B. The Instrumentation and Control Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the office of the Owner's representative and shall be examined by all bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

C. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable Instrumentation and Control system as defined by the contract documents.

D. The Contractor is responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly.

E. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition. The Contractor shall warranty all Parts and Labor for 18 months from the date of Substantial Completion.

F. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition. Further, It is the intent of these plans and specifications that the I & C contractor shall provide an Open Architecture SCADA/Control system, where as the Owner can maintain, change/alter, or expand the system as the Owner deems necessary after the warranty period at no additional cost to the Owner. Further all programming keys, ladder logic, and Owner’s manuals shall be submitted to the Owner as needed to meet this intent.

G. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

H. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association

5. National Electrical code
6. National Fire Protection Association

I. The use of the word “furnish” or “Install” or “provide”, shall be taken to mean that the item or facility is to be both furnished and installed under this section unless specifically stated to the contrary that the item or facility is to be furnished under another section and installed under this section; furnished under this section and installed under another section; or furnished and installed under another section.

J. The use of the term “as or where Indicated”; “as or where shown”; “as or where specified”; or “as or where scheduled” shall be taken to mean that the reference is made to the contract documents either under the drawings and/or the specifications.

1.02 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the Instrumentation and Control system installation shall conform to the latest edition of the National Electrical Code as well as all other State and Local codes and applicable standards.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these prior to bid time.

1.03 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. All materials and equipment shall be or the highest quality in order to provide the most reliable end product possible. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)

B. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturer’s Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code

6. National Fire Protection Association

C. Submit copies of applicable standards with each submittal

D. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

E. All products shall bear UL labels where standards have been set for listing.

1.04 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings shall be taken mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

C. Submit for review in sextuplet within sixty (60) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and submittals are not received in sixty (60) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne by the contractor.

D. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.

E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's representative and such procedures will not be cause for delay. After final review, supply up to six (6) copies, if requested.

G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each Submittal and/or shop drawing.

H. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.

I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent.

J. Materials to be submitted are as follows:

1. Sensors

2. Logic Ladder Diagrams

3. Control Panels
4. Wiring Devices
5. TOUCHPAD Screen Shots
6. Level/Pressure Transmitters
7. Flow Meters
8. PLC
9. Cellular Monitoring Device
10. Software, etc.

K. Each submittal shall be accompanied with a written statement certifying that the submitted equipment and/or material meets the plans and specifications.

1.05 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The Submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

1.06 EXCAVATION AND BACKFILLING

A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.

C. All backfilling shall be made with selected soil; free of rock and debris and shall be pneumatically tamped in six (6") inch layers to secure a field density ratio of 90%.

D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

1.07 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

F. No cutting of structural elements shall be done without permission of the Engineer.

1.08 WATERPROOFING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

B. Flashing for conduit penetrations through built-up roofs shall be made with pitch pans filled with pitch. Conduit penetrations through poured concrete roofs shall be made with sleeves and annulus caulked.

C. Penetrations through walls at below ground elevations shall be waterproofed by conduit sealing fittings or other methods as indicated.

D. Interiors of raceways that are likely to have water ingress such as runs from handholes into below-grade installations shall have waterstops installed to prevent water from entering into installations.

E. It is the responsibility of the Contractor to follow all applicable codes and standards for installation of electrical equipment in all hazardous locations, whether these locations are indicated on the plans and specifications. All electrical penetrations to junction boxes, control panels, shall be sealed with an acceptable sealed connector to avoid the entrance of harmful gasses or corrosive liquids that electrical raceway or electrical equipment may be exposed to. The Contractor must submit on the connectors for approval before use.

1.09 CONSTRUCTION REQUIREMENTS

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the engineer in advance of construction. Confirmed locations shall be made for the following:

1. 1. Poles
2. 2. Rough-ins and connections for equipment furnished under other sections
3. 3. Control Panels, etc.

B. Where equipment is being furnished under another section, request from the Engineer an accepted drawing that will show exact dimensions of required locations of connections. Install the required facilities to the exact requirements of the approved drawings

C. All work shall be done in the best and most workmanlike manner by qualified careful electricians/technicians who are skilled in their trade. The standards of work required throughout shall be of the first class only and work that is unsatisfactory to the Engineer shall be instantly dismissed from the work upon written notice from the Engineer. All work must meet the approval of the Engineer.

D. Unless shown in detail, the drawings are diagrammatic and do not give exact details as to the elevations and routing of conduits, nor do they show all offsets and fittings. Nevertheless, the installation must be made to fit conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are shown, confirm locations and routing prior to installation with Engineer.

E. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole punch. Cutting openings with a torch or other device that produces a jagged edge, rough cut will not be acceptable. Top penetrations shall not be acceptable under any means.

F. Raceway entry into equipment shall be carefully planned. Cutting of enclosure framework to accommodate poorly planned raceway placement will not be acceptable. No hole punch penetrations shall be made on top of any equipment, panel, or Junction box. All hole punch penetrations shall be properly sealed so as to prevent moisture and gasses from entering the equipment, panel, of Junction Box etc....

G. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be acceptable.

H. Equipment, inclusive of supporting devices, shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid tight fitting manner.

1.10 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

E. Interiors of Control Panels, shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200 watt Lamp located the bottom of each section, or panel. Energizing integral condensation heaters shall be acceptable in place of lamps.

1.11 COOPERATION WITH WORK UNDER OTHER SECTIONS

A. Cooperate with all other trades so as to facilitate the general progress of the work. Allow other trades every reasonable opportunity for then installation of their work and the storage of their materials.

B. The work under this section shall follow the general construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before any concrete is placed or masonry is installed.

C. Work with other trades in determining exact locations of outlets, conduits, fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime as required to accomplish these requirements if directed to do so.

E. The I&C Contractor shall coordinate all work with the General Contractor. The equipment provided by the I&C Contractor shall work with all of the features included in the equipment provided by others. It is the responsibility of the I&C Contractor to coordinate with all other parties so as to ascertain the required information in order to provide a fully functional workable system and to adjust his bid accordingly to meet this goal. Any deviations from the plans and specs shall be reported to the Engineer before bid time.

1.12 INSTALLATION AND CONNECTION OF WORK UNDER ANOTHER SECTION

A. Ascertain all requirements for proper installation of any Electrical/Control equipment either provided by this section and required for installation by this section or provided by any other section and required for installation by this section.

B. Verify the electrical capacities of all electrical equipment furnished under other sections, or furnished by the Owner, and request wiring information from the Engineer if wiring requirements are different from that specified under this section. Do not make rough-ins until equipment verification has been received.

C. All controllers, terminal boxes, pilot devices, and miscellaneous items of electrical equipment that are not integrally mounted with the equipment shall be securely mounted and adequately supported in a neat workmanlike manner.

1.13 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.14 RECORD DRAWINGS

A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.

B. Show conduit routing and wiring runs as constructed and identify each.

C. Record all deviations from the Contract Documents.

D. Submit set of marked-up drawings for review.

1.15 OPERATIONS AND MAINTENANCE MANUALS

A. Six (6) weeks prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.

B. Submit six (6) copies for review.

2.00 PRODUCTS

2.01 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.

B. Numbered marking labels shall be colored vinyl markers, T&B, Brady, or equal.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.

D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking "BURIED CONDUIT", or similar language, along its length.

E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with white engraving. Attachment means shall be self-tapping stainless steel screws.

2.02 GROUNDING DEVICES

A. Exothermally welded joints shall be made with Enrico "cadweld", Burndy "Thermweld", or equal kits.

B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.

C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.

2.03 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be grade 316 stainless steel; 1-5/8" wide x 3-1/4" deep. Clamp nuts and mounting hardware for use with slotted channels shall be grade 316 stainless steel.

C. Conduit straps for use with slotted channels shall be stainless steel with stainless steel hardware.

D. Concrete and Masonry Anchors shall be stainless steel type. Furnish Hilti, or equal.

E. Poles for supporting outdoor control panels shall be Hot Dipped Galvanized, with footings encased in concrete. Tops of poles shall be covered with a Hot Dipped Galvanized conduit cap.

F. "U" bolts shall be stainless steel galvanized steel with galvanized hex-head bolts.

G. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.04 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.

H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

3.00 INSTALLATION

3.01 WIRING

A. All control wiring, 120/240V wiring and insulated equipment grounding conductors shall be type THHN/THWN insulated stranded copper conductors.

B. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

C. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

D. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

E. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment as required. Number selected shall correspond to number on terminal strip.

F. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

G. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

3.02 GROUNDING

A. Each item of equipment shall be adequately and thoroughly grounded. Comply with Article 250 of N.E.C., except where higher standards of grounding have been specified.

B. Equipment grounding conductors (EGC) shall be installed where indicated. These wires shall be green colored in sizes #6 AWG and smaller and green banded in larger sizes.

C. EGC runs into equipment and shall be grounded to equipment bus where available, or to equipment ground lugs.

D. Where grounding type bushings are installed, bond EGC thereto and furthermore ground each bushing lug to equipment ground bus or ground lug, or ground rod.

E. In each motor terminal box, install equipment ground lug and connect EGC thereto.

F. In each floodlight pole, install ground connector to pole and bond to conduit bushing and to EGC in branch circuit.

3.03 LABELING

A. In addition to requirements for labeling as specified throughout this section, install as follows:

1. Phase bank each power wire and cable with colored banding tape. Do this at each termination.

2. Apply numbered wire marking labels to control wires; power wiring in panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.
3. Apply write-on identification labels to wiring sets in each hand-hole to identify function. Use waterproof labels.
4. Apply write-on identification labels to empty conduits to identify each with information as to terminus of other end and also trade size of conduit.
5. Install micarta nameplates with engraving to identify function and/or load served for the following:
    a. Pump Control Panels, Panelboards, Overcurrent Devices, Motor Control Center, any newly installed work including Micarta nameplates shall be attached with stainless steel screws, use two (2) per each nameplate. Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.
6. Type circuit directory information on circuit directory cards on all panelboards.

4.00 CONTROL & INSTRUMENTATION

4.01 SCOPE

A. Furnish and install control panels in the locations shown on the plans.

B. Furnish and install control panels and remote control system as indicated on the plans.

C. Products and installations shall comply with the electrical section specifications including all applicable codes and standards.

D. The Contractor shall obtain the required electrical and telephone service as applicable at each location. The Contractor must coordinate his construction activities with the local utilities where applicable.

4.02 EQUIPMENT FIELD SERVICE

A. Provide the services of factory trained personnel to assist in the installation and start- up of the control system.

B. Provide at least four (4) hours on site time of factory trained personnel for training plant personnel on the operation and maintenance of the equipment.

5.00 PRODUCTS

5.01 PANEL CONSTRUCTION

A. Panel wiring shall be NEMA Class B.

B. Control panel shall be Stainless Steel NEMA 4X gasketed enclosure with heat barriers and shall be as follows:

1. Enclosures shall be fabricated of Stainless Steel and adequately braced and reinforced as required with a NEMA 4X rating. Enclosure shall be manufactured with mounting

provisions so that it can be properly braced by unistrut and/or supporting poles without the need to penetrate the enclosure for supporting means. Enclosures shall be Hoffman or equivalent.

2. The control panels shall include mounting of hand-off-auto switches, indicating lights, and elapsed time meters, etc, as required suitable for outdoor use. The installation of this equipment shall not lessen the required NEMA 4X rating.
3. Enclosures shall have stainless steel with butterfly type quick-release latches and one stainless steel hasp latch for padlocking.
4. A 15A 120V convenience receptacle shall be installed in every panel
5. Disconnect device operating handles shall have on-off positions clearly marked with provisions for pad-locking provisions. This device will be installed so that it can be operated without the need to open the enclosure where applicable.
6. All control wiring shall be functionally color coded using factory pigmented insulation. Repeated colors shall be identified with Brady "sleeve type" numbered wire markers at each termination. Colors and numbers used shall correspond with colors and numbers shown on shop drawings control diagram. The use of only red for the color of control wire functions will not be acceptable. Use pigmented colored insulation for power (as per NEC); green shall be used for equipment grounding conductors; white or gray shall be used for grounding conductors; each rung of the ladder diagram shall have one of the remaining colors listed and shall be numbered as required above. Red shall be used from the transformer secondary fuse to the first device(s). Minimum wire size shall be #12 AWG.
7. All control relays shall be industrial type each with 10-amp, 120V rated contacts. Each contact shall be field convertible. Each relay shall have open-close position indication. Relay coils shall be rated 120V A.C. continuous duty, including the latch type relay coils.
8. All alternator relays shall be industrial type with 10-amp, 120V rated contacts. Furnish Furnas Class 47 or approved equal alternators. Where applicable
9. Each control panel shall be equipped with a lightning arrester connected to the 120VAC breaker. Furnish Square D #J9200-9A lightning arrester or approved equal.
10. All analog signals shall be supplied with Lighting Surge suppression. The contractor shall submit on LSA arrestor intended for use.
11. All RTU panels shall be provided with a 120V, 20A Circuit Breaker from a nearby distribution panel. The contractor shall verify that all loading is acceptable and make accommodations to provide additional power circuits as required. Each panel shall be equipped with a fused control power transformer (CPT) as required. VA capacity of CPT shall be sized to handle its controller load plus external connected loads. Radio control panels (Local and Remote) shall have local power brought into each panel by contractor from spare circuit breakers.

5.02 SENSORS/METERS

A. Level Sensor – Submersible level sensors for wet well and sewer water applications. The Submersible Level Transmitters shall be manufactured for years of trouble-free service in the harshest applications. This sensor shall be required to measure the height of liquid

above the position in the tank referenced to atmospheric pressure. The transmitter shall consist of a piezoresistive sensing element, encased in a 316 SS housing with cage and large diameter 316 SS diaphragm seal.

B. This section describes the requirements for a submersible level senor.

C. The contractor shall furnish and install the level sensor and accompanying display equipment and accessories as indicated on the plans and as herein specified.

D. Acceptable Manufacturers:

1. Endress and Hauser
2. Dwyer
3. Engineer approved equal

5.03 SUBMITTALS

A. The following information shall be included in the submittal for this section:

1. Data sheets and catalog literature for the level sensors and displays and the microprocessor-based signal converter.
2. Connection diagrams for equipment wiring.
3. List of spare parts and optional equipment.

5.04 LEVEL SENOR SPECIFICATIONS

A. The level sensor shall consist of a submersible stainless steel 316 body with a water tight seal around the transition to a Polyehter, poly urethane or ETFE cable that will house the signal cable to the transmitter.

B. Application: sensor shall be rated for the following conditions:

1. Waste Water
2. Sludge Pits
3. Alum Tanks
4. Chemical Storage
5. Oil Tanks
6. Lime Slurry
7. Sumps
8. Reservoirs

C. Sensor:

1. Operating principle: The transmitter shall consist of a piezoresistive sensing element, encased in a 316 SS housing with cage and large diameter 316 SS diaphragm seal that will deliver a 4-20mA signal in proportion to the level of the liquid in the tank. This analog signal will be transmitted to a NEMA 4X enclosure in the control panel that will indicate the level of the liquid in the wet well. The sensor shall be loop power and shall be configured to work with the accompanying display.

2. Construction:
    a. Durable cage design with large diameter 316 SS diaphragm seal that is non-clogging and damage resistant to floating solids. Large diameter 316 SS diaphragm seal that is non-clogging and damage resistant to floating solids
    b. UL approved intrinsically safe on PBLTX models for use in hazardous locations when used with proper barrier
    c. The Cable shall be made of Polyether polyurethane or ETFE;
    d. The Seals: Fluoroelastomer and suitable for the applications detailed herein.
    e. Lightning and surge protection shall be integral to the unit with dual arrestor technology, grounded to case, to eliminate both power supply surges and lightning ground strike transients
    f. Unit shall be maintenance free with filter to keep particulate or water droplets from entering and damaging the transducer.
    g. NPT connection to allow installation in a pipe/conduit, or the addition of a A-625 hanging loop for attaching a chain for pulling out of the installation
3. Installation:
    a. Sensor Display.
4. Enclosure: NEMA 4X enclosure
5. Display: Background illumination with alphanumeric 4-line, 20-character display to indicate flow rate, totalized values, settings, and faults
6. Power supply: 115/230 VAC or 11-24VDC.
7. Operating temperature: -5 to +120 degrees F.
8. Outputs: 0-20 mA or 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1 A. Digital (frequency or pulse) for external display of flow rate or totalizer.

D. Sensor
1. Accuracy shall be + 0.25%
2. Temperature Limits: -4° to 176°F
3. Output Signal 4-20mA DC two wire
4. Loop powered
5. Response time: 50ms
6. Loop Resistance900Ω
7. Installed suspended in tank. Contractor shall supply all necessary hardware and stress relivers to meet this requirement.
8. Suitable for installation in Class 1 Div II

E. SPARE PARTS
1. Spare parts for the equipment shall include the following, unless otherwise noted:

2. One set of manufacturer's recommended spare parts.
3. Extra operation manuals as required.

F. OPERATOR FUNCTIONS

1. CALIBRATION

a. Each sensor shall be calibrated and certificate of calibration shall accompany each sensor.

2. SIGNAL CONVERTER FUNCTION DETAILS

a. The following functions shall be provided:

b. All programming shall be accomplished through an integral keypad and all programming shall be protected by a user-defined password.

c. The signal converter shall be integrally mounted or remotely mounted using a remote-mount kit provided by the manufacturer.

d. The signal converter shall provide a 0/4-20 mA DC signal proportional to flow rate into 800 ohms max. Output shall be selectable as unidirectional or bi-directional.

e. The relay shall be programmable as error indicator, limit alarm or pulsed output.

f. The signal converter system shall be equipped with an error and status log

G. EXECUTION

1. INSTALLATION

a. Follow manufacturer's recommendation for installation of units in liftstation and Control panel environments

b. Wiring between sensors and remote mounted signal converters shall use cable type and procedures as per the manufacturers' recommendations.

H. MANUFACTURER'S ASSISTANCE

1. WARRANTY

a. The manufacturer of the level sensor shall guarantee for one year of operation that the equipment shall be free from defects in design, workmanship, or materials.

b. In the event a component fails to perform as specified, or is proven defective in service during the guarantee period, the manufacturer shall promptly repair or replace the defective part at no cost to the owner.

5.05 CELLULAR MONITORING SYSTEM

A. The contractor shall allow for space in the Lift station Site for addition of a Cellular Monitoring system. Station communication from the Control panel shall occur via a cellular signal. The contactor shall provide all required hardware, peripheral devices, and features required to meet the intent of this operation.

B. This section describes the requirements for the Monitoring System:

1. The unit is intended to be a complete wireless monitoring and remote control system. It shall include the hardware necessary for installation, such as a cellular radio,

enclosure, backup battery, transformer, antenna with cable and mounting hardware. This unit is intended to provide Real-time alarms delivered via phone, text message, email, fax, pager and even to your existing HMI software via data link. Alarms shall be logged with a timestamp. All information shall be available on a web portal for tracking and reporting.

2. The contractor shall furnish and install the level sensor and accompanying display equipment and accessories as indicated on the plans and as herein specified.

C. Acceptable Manufacturers:

1. Mission Communications
2. Evoqua
3. Engineer approved equal

D. SUBMITTALS

1. The following information shall be included in the submittal for this section:
    a. Data sheets and catalog literature for the level sensors and displays and the microprocessor-based signal converter.
    b. Connection diagrams for equipment wiring.
    c. List of spare parts and optional equipment

E. Monitoring system Hardware

1. The system hardware shall meet the following at a minimum:
    a. 8 supervised digital inputs; 8 configurable to runtime/starts accumulators.
    b. Option board expands digital inputs to 16.
    c. 2 analog inputs: 4-20 mA or 0-5 V, 10-bit resolution, 4 real-time alarmset points per input. Option board expands analogs to 6.
    d. 4 built-in alarms (AC, low battery, temperature, and communications fail).
    e. 2 pulse counter inputs (optional) for rainfall tipping bucket or flow meter.
    f. 1 electronic key reader for site activity tracking and service mode.
    g. 3 remotely controllable, form C dry contact relay outputs
    h. (1 amp @ 12 VDC), SPDT, N.O./N.C.
    i. Supervised 120 VAC to 12 VAC, 1.2 amp power supply with UL
    j. Recognized Class II / Class III transformer.
    k. 5 AH battery provides up to 40 hours of back up power.
    l. Includes Antenna Kit (PN R8005) with mounting bracket and 11' of cable.
    m. Omnidirectional outdoor antenna can be wall or pole mounted.
    n. 8 vertical LEDs for diagnostics.
    o. 8 digital input LEDs display input status and wiring faults.

p. RJ45 connection for optional Wet Well Module (PN 651).

F. The system hardware shall meet the following at a minimum:

1. Units automatically self enroll with no startup delays. Radios make
2. live, continuous, encrypted socket connections with all data and alarms being “end-to-end” acknowledged. Mission does not use SMS “text” messaging to transmit RTU data.
3. Unit shall be compatible with AT&T, Verizon and Sprint radios have 128-bit encryption. All use TCP data transmission protocol.
4. GSM: HSPA+ (ATT 3.5G and lower) Penta band (850, 900, 1700, 1900,
5. 2100 MHz).
6. CDMA: 1XRTT.
7. 0.6 to 2 watt maximum transmit power and -112 dBm sensitivity.

G. The unit shall have the following characteristics at a minimum for Data Frequency:

1. Digital runtime and alarm inputs and analog alarm set points: real-time.
2. Analog inputs: Every 2 minutes or real-time if 5%+ change occurs.
3. Built-in telemetry inputs: reported hourly.
4. The unit shall be able to function properly in -20° to 160°F

H. Provide all hardware necessary for proper functionality in a wet well environment as detailed in these plans and specifications.

I. Software: - The intent of these plans and specifications is to provide an open architecture SCADA type system where the Owner can log into a website via a cell phone; tablet; or computer to monitor the signals as detailed in pertinent sections and sheets of these plans and specifications. To this end all software licensing, keys, etc., shall be owned and operated by the Owner with all updates and access provided in this scope of work for a period of 3 years.

J. Warranty – the Contractor and manufacture shall provide a 1year warranty for all parts and labor.

5.06 PROGRMMABLE LOGIC CONTROLLER

A. The contractor shall refer the PLC and Software/Hardware sections of these plans and specifications.

6.00 LOOP DESCRIPTIONS:

6.01 SUMMARY (NOTE SEE SECTION 40 94 00B FOR LS #4 OPERATION DESCRIPTION)

A. This section will provide a general description of anticipated control loops that are necessary to provide control functions as shown on the Drawings and as specified including any other equipment, accessories, and appurtenances as required for a complete and operable system. The I&C Contractor shall provide instrumentation hardware as necessary to perform the following functions.

6.02 RTU PANEL DESCRIPTION

A. The I&C Contractor shall provide the Pump Control Panel, for mounting on a rack or self-supported at the Lift Station Site. The provided panel shall be a 316 Stainless Steel NEMA 4X rated enclosure. This cabinet shall receive all Signal Cables from the field and have the ability to process all signals via the internal PLC. These signals shall be able to communicate from this RTU to the TOUCHPAD. The panel manufacturer shall provide a space for future radio installation and integration as a part of another scope of work. The Contractor shall provide all hardware required to achieve the required tasks detailed in these plans and specifications. This scope of work shall include a touchpad controller that shall display all desired screens as detailed herein. Further the Contractor shall provide all hardware/software necessary to give the Owner the ability to record, report, and visually show the variables as required to make reports for Management and Governmental entities as required.

B. Liftstation Pump Control Panel Description - The I&C Contractor shall provide Liftstaion PLC integrated in the proposed Pump Control Panel, as indicated on these plans and specifications. The provided panel shall be a 316 Stainless Steel NEMA 4X rated enclosure. This cabinet shall receive a Level signal from a Dwyer PBLTX Submersible level indicating transmitter. From this Liftstation RTU Panel, all signals shall be able to be communicated to the RTU via field wires from the instruments to this Control Panel. The Contractor shall provide all hardware including, but not limited to wiring, fuses, pilot devices, transformers, relays, terminal strips, etc. to achieve the required tasks. The power supply to this RTU shall be 120VAC +/- 15% @ 50/60 Hz from a nearby distribution panel. It shall communicate all field instrumentation via a Twisted Pair Shielded Cable, fiber optic Cables, or Signal Wire. In addition, these signals shall be programmed as graphics on a touch pad located on the Control Panel Deadfront door.

C. Loop 100, 200

1. Liftsation Pump Control

a. The I&C Contractor shall F&I a series of Float Switches (LSLL 0627); (LSP1 0628); (LSP2 0629); (LSHH 0630) these float switches shall act as a Low Level Lockout; Call Pump 1; Call Pump 2; and High High that will operate the lift station pumps accordingly via the Pump Control Panel. Low Level Lockout shall turn pumps off and not allow them to run. High High level will call for all pumps to run, and the Pump Call Floats will call for the next pump in line to run under normal circumstances. Said control shall protect the pumps; call them to operate, and provide alarms as needed. These Float Switches shall be wired in an individual conduit from the Pump Control Panel to floats in the wetwell. The Float Switches shall be powered from 120V inside the control panel. The intent of these plans and specifications is that the Float Switches shall be secondary or backup control for the pumps in the case of an issue with the PLC control scheme. Alternating sequencing can be programmed into the PLC or by an external Alternating Relay so long as the Liftstation can function in the event that the PLC is unavailable or not functioning.

b. The I&C Contractor shall provide all conduit and wiring for control and status wires from field to the PLC and control panel. This wiring shall provide the necessary DI

and DO for proper operation and indication of these of the system. The I&C Contractor shall coordinate all requirements with other Contractors to meet this requirement. The PLC in the RTU shall be designed to process these signals and ultimately produce an indication on the touchpad for each pump. The Touchpad shall be capable of displaying a graphic that shows a real-time Level indication in the wetwell (LI E600). The TOUCHPAD shall indicate a Low Level alarm (LALL E601); PUMP CALL (LAH E602); and High High Level (LAHH E603). Finally, these level controls shall provide permissive for the Liftstation Pumps as required.

1). Each pump in this panel shall have the following functionality in the Control Panel/RTU:

a). The Control panel shall have a Pump Motor Protective relay provided by the Pump Manufacturer. This relay shall protect the pump motor as needed and as required by the Pump and Motor Manufactuers. Control wires and conduits for this relay shall be included as part of this scope of work. Said relay shall be integral to the Control Panel and shall provide permissive as required for proper operation of the pump motor.

b). The Pump Control panel shall have a pump Alternating capability. This feature shall alternate the pumps so as to make the run time as even as possible. Either the PLC or an Alternating relay shall be programmed to alternate which pump will start and then allow the next pump to start the next time. It shall be required that the Panel will continue to control the pumps in the event that the PLC needs to be removed or replaced. All hardware and wiring shall be built into the cabinet. A graphic on the TOUCHPAD and HMI will indicate which pump is running.

c). A Manufacturer Pump Protection Relay shall also be provided to provide manufacturer approved protection for each pump. These relays shall, at a minimum, provide a seal failure; motor over temperature. These indications shall indicate on Local Touchpad in the front of the Control Panel. Further these alarms, shall also engage (Y2 X07) after time delay.

d). (HAD X00) shall be a contact from the Pump Control Panel. to indicate that the motor is in Hand or Automatic Mode. The switch shall be a manual hand switch located on the Pump Starter.

e). In Auto Mode the PLC/Alternator and the float switches/Level Transmitter shall have control of the LS Pumps. A contact (HAD X00) shall indicate that the switch is in this mode. In Automatic mode a contact from the VFD shall indicate that the VFD is running the pump (YR X05).

f). In Hand Mode all Automatic Control shall be bypassed and an indication on the TOUCHPAD shall indicate that the pumps is running in this mode. Local control shall be indicated by a contact in (Y1 X00). Low Level Lockout shall still cut pumps off in the event the level gets too low for the pumps.

g). Pump Run Time shall be Provided on the Panel Door with a runtime meter.

h). In the event that the Pump is called to run but does not send a run status with a 10 second period, the TOUCHPAD will indicate a Pump Fault Failed to Start alarm (Y2 X07)

i). Other indications from contacts in the field and indicated on the TOUCHPAD shall be as follows:

- Alarm O/L Trip (Y2 X06)
- Alarm Fail to Start (Y2 X07)
- Running status that will be a contact provided from the VFD to the PLC to indicate the motor is running (YR X06)
- The PLC shall count and indicate operating hours of the pumps and provide a display of operating hours.

D. Loop 600

1. The Contractor shall furnish and install a Level Transducer as indicated in the plans and specs that will indicate the real-time Level (LIT E600) of water in the Liftstation Wet Well. The Level Transducer shall be a DWYER PBLTX Submersible Level Transducer or approved equal. The sensor shall be a loop powered instrument. The signal wires shall be run in a conduit from the Meter in in the Wet Well to the nearby Pump Control Panel. The Level Transducers shall generate an independent a 4-20mA signal to be manipulated by the Liftstation PLC. This signal shall ultimately display at the Touchpad. Transducer shall convey a level signal in realtime to the Touchpad display and the PLC shall have the capability to manipulate this signal for its intended uses. (LI E600).
2. Run Sequence for Pumps:
    a. Upon receiving the start command from the floats and/or the level transducer, the PLC shall give the command for the next scheduled pump to run as allowed by the alternator sequence. Upon receiving the first start command the pump being started will ramp up to 100% or 60 Hz. The purpose of starting in this manner is to allow for the pump to flush the forcemain downstream. The required pump will run at 100% or 60Hz for an adjustable amount of time as pre-determined by the Engineer. This time shall be made adjustable by the programming of an Engineer's screen that will allow such adjustments. Once the allotted time is reached the PLC will lower the speed of the VFD to allow the VFD to control the level of the water in the wet well. In the event that the level in the wetwell continues to rise a second pump will be started and allowed to run in such a manner as to supplement the level control of the wet well. The second pump running will not be required to ramp up to 100% or 60Hz when running in unison with the first pump. Upon reaching the Low Level of the wetwell, both pumps will stop running. With the alternating sequence the second pump will now start first and the sequence shall be repeated with the pumps alternating.
    b. The intent of these plans and specifications is to allow the pumps to be primarily controlled by the PLC contingent on the level of the water in the wet well according to the Level Transducer. In the event that the Level Transducer fails, the float switches shall be used as the secondary level control. Alternation shall be required when either the float switchers or the Level Transducer are controlling the pumps.

END OF SECTION

40 61 13.01 CONTROL SYSTEMS: PCS SOFTWARE

1.00 GENERAL

1.01 SUMMARY

A. This section of the specifications shall apply to Liftstation 4 only

B. Section includes:

1. PCS system software to be used for application software development and real time operation of the PCS system.

C. Related sections:

1. Section 01 33 00 – Document Management
2. Section 40 61 13 – Process Control System General Provisions
3. Section 40 63 00 – Programmable Logic Controllers (PLCs)
4. Section 40 94 33 – Local Operator Interface (LOI)

D. General requirements:

1. Software provided under this Contract represents a complete and operating control software system. Achieve the functionality specified in this and other sections through a combination of standard control system software and application software developed specifically for this Project.
2. The standard control software listed in this Section does not represent a comprehensive list of software necessary to implement the functional requirements of the Contract Documents. Provide all necessary supplemental drivers, utility software and application software, as required, to meet the functional requirements of the Contract Documents.
3. Applications software requirements are described in this Section.
4. License all software for proper operation as described in the Contract Documents.
5. License all software provided under this Contract to the Owner.

E. Provide copies of all software on CD, or equivalent media.

1.02 REFERENCES

A. As specified in Section 40 61 13.

1.03 DEFINITIONS

A. As specified in Section 40 61 13.

1.04 SYSTEM DESCRIPTION

A. PCS system node descriptors:

1. PCS client workstation: Client workstations shall be provided with all graphic display and related software for interacting with the PCS system data. PCS client's displays shall

operate on data maintained by the PCS server. Display capabilities shall include, but not be limited to:

a. Process mimic displays.

b. Real time and historical trend displays.

c. Alarm summary and sub-summary displays.

d. System utilities.

2. PCS terminal server: Provide the PCS terminal server with the required software and licenses to deploy instances of PCS client workstation to PCS terminal services clients.

3. PCS terminal services client: Provide the PCS system terminal services client with the required software and licenses required to access and display all graphic displays deployed from the PCS terminal server.

4. PCS development node: Provide the PCS system development node with software and licenses required to edit the programs and configuration files as part of the system application development. Unless otherwise indicated, the development node shall be complete with run time software for fully testing the application programs. Functions required at the development node include:

   a. Edit the PCS database.

   b. Edit graphic displays.

   c. Modify alarm files.

   d. Modify PLC programs.

   e. Modify programs and scripts executing at any of the workstations.

   f. Set up trends and historical displays.

   g. Edit user authorizations.

   h. Other functions as may be required to modify the PCS system application software.

5. PCS I/O server: Provide server nodes with software and licenses as needed to communicate with the PLCs and other data providers and maintain a real time database of system values. Unless otherwise indicated, server nodes shall be equipped with client software for the viewing of the real time data. The PCS server will include input/output drivers for interfacing with field devices, and buffer historical data, and provide data for the historian node(s). On systems not containing a historian node, the PCS servers will maintain permanent data files containing the historical data. Provide redundant PCS servers complete with software required for synchronization and auto-fail over. PCS server will include separate network interface cards (NIC) for the PCS to PLC network, PCS to PCS network, and PCS server network when redundant fail over PCS servers are provided.

6. PCS Application Server node: The Application server is a development node with software and licenses as needed to edit and deploy the PCS application to all PCS nodes. In the event the application server is unavailable when another node requests the application, a local cached copy of the application runs on the client node.

7. Historian server: The historian server collects real time data and compresses the values into historical records for trending and reporting. Unless otherwise indicated, the historian server shall archive data provided by the PCS server. The server shall be provided with software for interfacing with standard report software packages via MS-SQL, ODBC and other standard interfaces as described in this Section. Provide software required for collector redundancy when auto-fail over PCS servers are supplied.

8. Alarm node: Each client workstation is equipped with an alarm window on the operator display with local annunciation. Where a separate alarm node has been indicated, this node shall handle the interface to telephone, paging and radio alarming systems.

B. General:

1. Contractor shall provide PCS software, as required for a complete and functional PCS system as indicated on the Drawings and as specified in this Section:

a. Provide software on the system nodes as follows:

1). 2 – PCS servers with Auto Fail-Over.

a). Primary server in Control Room 19” rack.

b). Secondary server in Control Room 19” rack.

2). 1 – 1000 point minimum historian with collector redundancy.

a). Historian server in Control Room 19” rack.

3). 2 – PCS client workstations.

a). Operator workstation in Control Room.

b). Engineering workstation in Control Room.

4). 1 – PCS terminal server w/ three PCS terminal services client licenses.

a). a) Terminal server in Control Room 19” rack.

5). 2 – PCS terminal services clients.

a). Process control operations laptop.

b). Plant Supervisor's Office workstation.

b. System configuration:

1). The system consists of a primary and backup data servers configured for hot failover operation. Server nodes shall be equipped with I/O drivers from communicating with networked PLCs.

2). Client machines obtain real time data from the I/O servers. The client machines shall monitor the status of the servers and re-establish data connections with a new server in case the primary server fails.

C. Security:

1. User Groups:

a. The system will use User Groups to assign screen access and control action permissions within the system dependent on the login credentials of the user.

b. A user group with minimal permissions will always be logged in if no other user group is logged in. This user group will be limited to view only and basic screen navigation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01 33 00 and 40 61 13.

B. Remote alarm database:

1. After development of the PCS system database but before system start-up, provide a list of points configured for alarming and submit to the Owner and the Engineer. The Owner/Engineer will identify critical alarms for use in the extended alarming system (e.g. dialer system, paging) and provide response descriptions.

C. Alarm descriptions shall be of sufficient detail for an accurate review by the Owner.

D. After all shop drawings submittals required herein have been favorably reviewed by the Engineer, the ICSC shall submit the following items, which must also be favorably reviewed and implemented prior to the start of system testing, the entire control system including all required software packages must be operational prior to the required factory acceptance test:

1. All operator interface display submittals shall be in full color as they will appear on the display screen:

a. This submittal shall be prepared after the requisite graphics meetings.

b. The submittal shall include:

1). Graphic displays.

2). Trend displays.

3). Alpha numeric displays.

4). Alarm displays.

2. Each display shall be uniquely titled:

a. Locations for process data shall be clearly identified either through the use of simulated data or by showing variables on the displays and providing a reference list describing those variables.

b. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets:

1). Color change.

2). Symbol change.

c. Three sets of submittals, with screen prints in color on a white background, are required for review by the Owner and Engineer.

d. One set will be returned with comments.

3. All periodic and custom reports for the entire control system:

a. Locations for process data shall be clearly identified, either through the use of simulated data or by showing variables on the report and providing a reference list describing those variables.

b. Three sets of reports shall be submitted for review by the Engineer.

c. One set will be returned with comments.

E. Pre-acceptance test documentation as specified in the Sequencing article of this Section.

F. Operator's reference manual:

1. The ICSC shall prepare and submit a user reference manual for the operator interface system for use by the operators. This manual shall be bound in a 3-ring binder and meet the following minimum requirements:

a. An index to the manual.

b. A list of operator interface:

1). Display screens.

2). Trends.

3). Reports.

4). With display name and description.

c. A summary of all possible commands and operator inputs to these screens including setpoints:

1). All control actions shall be included.

d. A control system block diagram with names and locations of major components.

e. Instructions for manually printing screens or reports.

1). Real time.

2). Historical.

f. A summary of security levels and their privileges and limitations.

g. Spaces for operators to make notes.

2. A copy of this manual shall be provided to each operator during training on the operator interface operations:

a. The training class shall include a review of this manual with the operators in addition to more detailed instruction on the operator interface configuration and its use.

G. Review meeting minutes submittals:

1. Graphics review meeting:

a. Minutes of Graphic Review Meeting No. 1.

b. Minutes of Graphic Review Meeting No. 2.

2. Report review meeting:

a. Minutes of Report Review Meeting No. 1.

b. Minutes of Report Review Meeting No. 2.

3. Alarm review meeting:

a. Minutes of Alarm Review Meeting No. 1.

b. Minutes of Alarm Review Meeting No. 2.

1.06 QUALITY ASSURANCE

A. As specified in Section 40 61 13.

B. The manufacturer must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software:

1. The presence of a formal quality assurance department is required.

C. Software provided under this Section shall be included in the testing specified in Section 40 61 13.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

A. The following items shall be submitted with the final sets of technical manuals required as specified in the Submittals article of this Section, 15 working days before the pre-commissioning test as specified in Section 40 61 13:

1. All program manuals supplied by the manufacturers with the standard software packages.

2. All original program disks supplied by the manufacturers with the standard software packages, including any program revisions or updates issued by the manufacturers during the construction period.

3. All PLC program and operator interface application program files stored on labeled disks:

a. The PLC program and operator interface application program file disks shall also be updated as required if any changes or corrections are required in this programming before Project completion.

B. Operator interface graphics generation:

1. The ICSC through the Contractor shall schedule the operator interface graphics meetings.

2. Topics shall include graphics for:

a. HMI graphics.

b. Data acquisition and graphics display system.

3. The Owner and Engineer shall attend these meetings.

4. Graphics Meeting No. 1: Held in conjunction with the Preliminary Meeting as specified in Section 40 61 13:

    a. The ICSC shall chair and develop an agenda 3 weeks in advance of the meeting, which shall address the basic criteria to be adhered to in the configuration and development of graphic displays:

        1). At this meeting, the ICSC shall distribute sample display formats for illustration purposes.

        2). As a minimum, this meeting shall address the following issues:

            a). All in plant and remote site areas and conventions for identifying tag names and descriptors.

            b). Designation of groups within each plant area along with tag names and descriptors.

            c). The assignment of individual control loops and inputs to specific groups.

            d). Organization of the systems universal display hierarchy.

            e). Paging schemes to be used to enable the movement from one display to another.

            f). An itemization of the type of display to be used at each level in the graphic hierarchy, i.e., pre-formatted displays, templates, custom graphics, etc.

            g). Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms based on alarm priority, background colors, static field colors and dynamic field colors.

            h). The utilization of blinking and conditional text.

            i). Definition of graphic symbolism to be used on the Project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves:

                (1). All symbolism must be specific as opposed to generic in that shapes must define both function and type, i.e., specific symbols for each valve design, each pump design, each type of flowmeter, etc.

                (2). If the ICSC's library of shapes does not adequately describe plant or field conditions, the ICSC shall develop additional shapes to meet the plant or field requirements.

                (3). Shapes and symbols used on the P&IDs shall be used as a guideline.

            j). Definition of all display select commands that enable the operator to move within the display hierarchy.

            k). The utilization of cursor movement commands which enable the operator to move within a display.

            l). Definition of control input commands which enable the operator to interact with face plates control stations and custom graphic displays to implement control functions.

m). Definition of data input commands which enable the operator to enter numeric values into the control system.

n). Definition of the utilization of "poke" points or fields that are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.

o). A review of graphic generation procedures.

b. Subsequent to the adjournment of Graphics Meeting No. 1, the ICSC shall prepare and formalize a document titled "Graphics Criteria" which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to:

1). This report shall be supplemented by graphic examples which illustrate the incorporation and application of each graphic criteria.

2). The report shall be submitted within 30 calendar days of the meeting's adjournment.

5. Graphics Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 61 13:

a. Subsequent to the finalization of the overall system-wide graphics criteria, the ICSC shall develop graphic packages for the entire operator interfaces being furnished under this Project.

b. At this meeting the ICSC shall submit 5 copies including:

1). A review of the graphic package developed for the process areas for content and completeness.

2). A review of all data fields that display automatically updated process information.

3). A review of all required input commands associated with the graphic access and control manipulation.

c. Subsequent to the adjournment of Graphics Meeting No. 2, the ICSC shall prepare a formalized submittal of the graphic package for review along with the detailed meeting minutes:

1). The report shall be submitted within 30 calendar days of the meeting adjournment.

6. 10 additional displays shall be configured on-line during the pre- commissioning test period.

C. Report generation:

1. The ICSC through the Contractor shall schedule the report generation meetings.

2. The Owner and Engineer shall attend these meetings.

3. Reports Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 40 61 13:

a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the configuration and development of the reports:

1). At this meeting, the ICSC shall distribute sample formats for illustration purposes.

2). As a minimum, this meeting shall address the following issues:

a). All in plant and remote site data and conventions for identifying tag names and descriptors.

b). Designation of groups within each plant area along with tag names and descriptors.

c). The assignment of inputs to specific categories.

d). Organization of the systems universal report categories.

e). An itemization of the type of report available.

f). Definition of terms to be used on the reports.

g). Definition of all report commands that enable the operator to move within the report editor.

h). The utilization of cursor movement commands which enable the operator to move within a report.

i). Definition of data input commands which enable the operator to enter numeric values into the system.

j). A review of report generation procedures.

3). Subsequent to the adjournment of the Report Meeting No. 1, the ICSC shall prepare and formalize a document titled "Report Criteria" which shall contain detailed meeting minutes and a definition of all report guidelines to be adhered to:

a). This report shall be supplemented by report examples.

b). The report shall be submitted within 30 calendar days of the meeting's adjournment.

4. Reports Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 61 13:

a. Subsequent to the finalization of the overall report format criteria, the ICSC shall develop report packages for review.

b. At this meeting the ICSC shall submit 5 copies including:

1). A review of the report package developed for the process area(s) for content and completeness.

2). A review of all data fields for process information.

3). A review of all required input commands associated with the report access and control manipulation.

c. Subsequent to the adjournment of Report Meeting No. 2, the ICSC shall prepare a formalized submittal of the report package for review along with the detailed meeting minutes:

1). The report shall be submitted within 30 calendar days of the meetings adjournment.

5. 10 additional reports shall be configured on-line during the pre-commissioning test period.

D. Alarming priority:

1. The ICSC through the Contractor shall schedule the alarming priority meetings.

2. The Owner and Engineer shall attend these meetings.

3. Alarming Priority Meeting No. 1: Held in conjunction with the preliminary meeting as specified in Section 40 61 13:

a. The ICSC shall chair and develop an agenda 3 weeks in advance for a meeting, which shall address the basic criteria to be adhered to in the prioritization of alarms:

1). At this meeting, the ICSC shall distribute a listing of all plant alarms identified by tag names and descriptors.

2). As a minimum, this meeting shall address the following issues:

a). Criteria for prioritizing alarms including alarming priority levels. (i.e. Priority 3 - alarm at PCS; Priority 2 – alarm at PCS and autodialer; Priority 1 – alarm at PCS, autodialer, and plant shutdown.)

b). Alarm display banner basic criteria.

3). Subsequent to the adjournment of the Alarming Priority Meeting No. 1, the ICSC shall prepare and formalize a document titled "Alarm Criteria" which shall contain detailed meeting minutes and a definition of all alarming guidelines to be adhered to:

a). The report shall be submitted within 30 calendar days of the meeting's adjournment.

4. Alarming Priority Meeting No. 2: Held in conjunction with the intermediate review meeting as specified in Section 40 61 13:

a. Subsequent to the finalization of the overall alarm criteria, the ICSC shall develop an alarming priority spreadsheet that will be populated at this meeting.

b. At this meeting the ICSC shall provide a spreadsheet including:

1). A listing of all plant alarms identified by tag names and descriptors.

2). For each alarm listed include a location to enter the alarm priority assignment.

3). For each alarm listed include a location to enter specific comments related to that alarm.

c. Subsequent to the adjournment of Alarming Priority Meeting No. 2, the ICSC shall prepare a formalized submittal of the alarming priority spreadsheet for review along with the detailed meeting minutes:

1). The spreadsheet and meeting minutes shall be submitted within 30 calendar days of the meetings adjournment.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 40 61 13.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

A. Provide 3-year extended manufacturer’s warranty as follows:

1. Dedicated technical support department or handled by programming staff or distributor.
2. Telephone support available 24 hours per day.
3. Email and web support addresses.
4. FTP download area.
5. Knowledge base.
6. Bulletin board service.
7. Field service.

B. Provide system upgrades and maintenance fixes for a period of 2 years from Substantial Completion.

2.00 PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Rockwell Automation Factory Talk View Site Edition.

B. The software revision of the package used should be of the latest version which has been released for a minimum of 1 year.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:

1. Unless otherwise indicated, provide all run time and development software licensed for:

a. Unlimited screens.

b. No direct limits on the number of connections to a server machine.

c. Provide the number of client licenses as indicated by the number of machines shown or specified, the addition of a new client shall not require an upgrade to the server license.

d. Historian tags: Provide at least 50 percent of the number of I/O SCADA tags.

2. Provide software and licenses as required to implement the system architecture and functionality as indicated on the Drawings and as described in the System Description article of this Section.

3. License/registered all software in the Owner's name.

4. Turn all software installed on the workstation, over to the Owner with disks, keys and manuals.

5. The system software specified as part of this Section support PCS system functions including, but not limited to:

a. Human machine interface (HMI) process graphics development and display.

b. Real time point database development and display.

c. Historical database generation, collection, and display.

d. Alarming subsystem.

e. Trending and report subsystems.

f. Drivers and interfaces.

6. PLC programming software is specified in Section 40 63 00.

B. Operating system software:

1. Provide all workstations and servers with operating system software compatible with the software provided under this Section:

a. Client nodes: Microsoft Windows 7 Professional, 64-Bit.

b. Server nodes: Windows 2012 Server is the preferred operating system, if legacy 32-bit software is to be run on the server, Windows 2008 Server (32-bit) is acceptable. Include 2 Client Access Licenses (CALs).

2. Provide all operating system software as a clean install. Where workstations have been loaded with OEM versions of software containing trial software or other advertisements, remove the OEM software and reinstall the operating system and all drivers from the original installation disks.

3. Provide all workstations with recovery disks.

C. Virtualized Operating Systems:

1. When a virtual environment is used for the operating system, it is the responsibility to the ICSC to verify compatibility of the PCS software package with the Virtual Operating System software.

2. Provide host machine hardware to meet the minimum requirements of the Virtualized Operating System(s).
    a. If multiple virtual environments are used on the same host or in a cluster, a hypervisor should be used to manage resource pool and memory allocation such that each virtual operating system has the recommended minimum hardware resources.
3. Synchronize all virtual timekeeping with a single real external time source.

D. PCS HMI run time software:
1. Provide run time software and licenses for all control system workstations provided.
2. Include client licenses for I/O server machines.
3. License all software in the Owner's name.

E. PCS I/O server software:
1. Provide software and licenses for a full PCS system node including I/O drivers.
2. Provide drivers for all control system devices as indicated on the Drawings.
3. Configure historical data collectors to provide data for the historical database on all I/O servers.
4. License all software in the Owner's name.

F. PCS Application Server:
1. Provide run time software and licenses for full PCS system node.
2. License all software in the Owner's name.

G. Development workstations:
1. For development workstations provide all software for the generation and modification of the graphic screens, PCS system databases, access control files and supervisory control programs.
2. The development node contains all client software and licenses for use as an additional operator display.
3. The development node shall be equipped with I/O drivers for live testing of screens and control programs.
4. License all software in the Owner's name.

H. Historian server:
1. Provide the latest version of the historian software.
2. Use data collectors to buffer historical data in the event of a loss of communication with the history server.
3. Provide Microsoft SQL client access licenses for all nodes in the system plus an allowance for 50 percent expansion.

I. Licensing:
1. Provide hardware keys will utilize the USB form factor.

J. Alarm dialer software:

1. Install the alarm dialer software on the workstation identified as the alarm node.
2. The alarm software shall interface with the PCS system via the PCS system client software and provide an interface to the appropriate external alarming system.
3. Provide 1 copy of the alarm dialing software:
    a. Win911 Event Notification Software by Specter Instruments.
    b. Or equal.

K. Miscellaneous software:

1. Provide the following support software for use on the PCS system computers. Install all software on the appropriate system node. Provide all software CD/DVD media. License all software to the Owner:
    a. Provide Symantac's Norton Ghost software for the backup of all system nodes DVD.
    b. Provide 2 copies Microsoft Office 2010 for generating and editing of reports.
        1). Install one copy on Engineers Workstation and the other copy on the Operator Workstation.
    c. Provide 1 copy of Sytech xl Reporter Suite for the development of report templates and the event scheduling of automatically generated reports.
        1). Install on Engineers Workstation.
    d. Provide all nodes with virus protection software.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

3.00 PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 40 61 13.

B. Install all required software improvement modules (SIMs). At the completion of the Project, and provide installation disk(s) containing all SIMs used on the Project to the Owner.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. Test all software provided as part of this Section as part of the system tests specified in Section 40 61 13.

B. Contractor shall cover the costs of tuition, training materials, and related fees.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 40 61 13.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

40 61 16 CONTROL PANELS

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:

a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.

b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.

c. Control components.

d. Control panel installation.

2. Related sections:

a. Submittal Procedures.

b. Section 26 00 00 – General Electrical Requirements

c. Section 26 05 53 – Electrical Identification.

d. Section 26 43 13 – Surge Protective Devices.

e. Section 26 05 73 – Electrical System Studies.

f. Section 40 61 13 – Process Control System General Provisions

g. Other Pertinent Sections

B. Provide all control panels identified in Contract Documents.

1.02 1.02 REFERENCES

A. As specified in Section 26 00 00 and 40 61 13.

B. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.

C. Underwriters Laboratories Inc. (UL):

1. 508 - Standard for Industrial Control Equipment.

2. 508A - Standard for Industrial Control Panel.

3. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.

4. 1283 - Standard for Electromagnetic Interference Filters.

5. 1449 - Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 26 00 00 and 40 61 13.

B. Specific definitions:

1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 SYSTEM DESCRIPTION

A. Panel dimensions:

1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer’s non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:

a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.

b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.

c. Maximum panel depth: 30 inches, unless otherwise indicated.

B. Structural design:

1. Completed and installed panel work shall safely withstand seismic requirements as indicated. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

1.05 SUBMITTALS

A. Qualification Statement

1. Contractor shall submit qualification statement detailing the qualifications of Panel Shop intended to be used with this project. the Qualification Statement shall include as a minimum the following information:

a. Name; Address/Location of Manufacturing Facility

b. List of Personnel that will work on this project

c. List of Certifications held by Company i.e.

1). UL listed Certification

2). Other pertinent certifications

d. List of Similar Projects completed in the last five years with current Contact information of each customer.

B. Provide submittals as specified in Sections 26 00 00; 40 61 13, and submittal section of the plans and specifications.

C. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:

1. Product data:

a. Enclosure construction details and NEMA type.

b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.

2. Shop drawings:

a. a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:

1). Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.

b. Complete nameplate engraving schedule.

c. Structural details of fabricated panels.

3. Calculations:

a. Provide installation details based on calculated shear and tension forces:

1). Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:

1). Weight including panel internal components.

2). Seismic forces and overturning moments.

3). Shear and tension forces in connections.

c. Cooling calculations, including but not limited to:

1). Highest expected ambient temperature for the enclosure's location.

2). Internal heat load.

3). Exposure to direct sunlight.

4). Dimensions of the enclosure in inches.

5). Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

D. Seismic design (As Required):

1. Seismic panel construction:

a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all panels, enclosures, consoles, etc. to meet seismic requirements in Section 26 00 00 and 40 61 13:

1). Stamped by a Professional Engineer registered in the state where the project is being constructed.

b. For floor-mounted freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other information to substantiate that panel, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01612. Calculations

shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

E. Qualifications

1. Panel Supplier shall provide

1.06 QUALITY ASSURANCE

A. As specified in Section 26 00 00 and 40 61 13.

B. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:

1. Provide all components and equipment with UL 508 listing.

2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:

a. Non-listed, complex, and unique equipment may be evaluated and approved by a third-party testing agency, with prior approval by the Owner. Provide report documenting the testing standard, specification, method of testing, and that the equipment and materials meet appropriate designated standards or have been tested and found suitable for use in a specified manner.

3. Provide fuses for all equipment that is not UL or UR listed.

4. Panel Builder shall have 5 or more years of building UL listed and recognized panels.

5. The Panel Builder shall supply a list of successful projects spanning the last 5 years along with contact and reference information.

a. Qualification Statement

1). Contractor shall submit qualification statement detailing the qualifications of Panel Shop intended to be used with this project. the Qualification Statement shall include as a minimum the following information:

a). Name; Address/Location of Manufacturing Facility

b). List of Personnel that will work on this project

c). List of Certifications held by Company i.e.

(1). UL listed Certification

(2). Other pertinent certifications

d). List of Similar Projects completed in the last five years with current Contact information of each customer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Project environmental conditions as specified in Section 26 00 00 and 40 61 13.

1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 00 00 and 40 61 13.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. For the purposes of this project, the Control Panel Manufacturer shall at a minimum provide a Five (5) Year warranty on all parts and labor for the Pump Control Panel. This warranty shall cover all Major components such as but not limited to VFD's; PLC's'; A/C Cooling Units; etc. and all minor components such as but not limited to Pilot Devices; terminal blocks; door latches; etc.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

2.00 PRODUCTS

2.01 MANUFACTURERS

A. The intent of this project is to provide a Panel from a Pump Control Panel Manufacturer. Said shop shall meet the requirements as listed in these plans and specifications. It shall be noted that the pump scheme requested with this pump control panel is complicated and will require close coordination with the pump supplier and Control panel manufacturer. The Contractors and Suppliers shall be required to take all responsibility in providing a working Control Panel and Pump system. This responsibility rests solely on the Contractors and Equipment Suppliers.

B. Acceptable Panel Manufactures:

1. **Pump Suppliers**

a. It shall be noted that pump suppliers shall be allowed to provide Pump Control Panels for this project under the following conditions:

1). There is a 5 year history of construction of pump panels similar to the pump scheme.

2). A list of successful projects shall similar in scope to this project shall be included with bid along with contact information of each project.

3). A qualification statement as described in Section 1 General; 1.05 Submittals; subsection A. shall be required.

2. **Engineer Approved Equal**

C. Component Manufactures:

1. As listed below in the individual component paragraphs.

2. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:

1. Enclosures shall have the following properties:

a. NEMA Type 1: Steel.

b. NEMA Type 4: Steel with gasketed door, rain- tight.

c. NEMA Type 4X: Type 316 stainless steel

d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.

e. NEMA Type 12: Steel with gasketed door, dust-tight.

f. NEMA Type 7: Cast aluminum.

B. Bolting material:

1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.

2. Carriage bolts for attaching end plates.

3. All other bolted joints shall have S.A.E. standard lock washers.

2.04 MANUFACTURED UNITS

A. Panels/enclosures:

1. Manufacturer: One of the following or equal:

a. Rittal.

b. Pentair (formerly Hoffman Engineering).

c. Saginaw Control & Engineering.

2. Panel assembly:

a. General guidelines for panel fabrication include:

1). Continuous welds ground smooth.

2). Exposed surfaces free of burrs and sharp edges.

3). Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.

b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

1). Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.

c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.

e. Door construction:

1). Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.

2). Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.

3). Heavy-gauge piano-type continuous stainless steel hinges.

4). For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.

5). Gasket installed to seal against roll lip on the enclosure opening.

f. Latches:

1). For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.

a). Provide padlock for each enclosure with padlock provisions.

2). Include an oil-tight key-locking, 3-point latching mechanism on each door:

a). Provide 2 keys per panel.

b). All locks keyed alike.

3). For large NEMA Type 4 and NEMA Type 4X cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.

g. Panel cut-outs:

1). Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.

2). Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.

3). Reinforce around cut-outs with steel angles or flat bars for the following:

a). Large panel cutouts; for example, openings for local operator interfaces.

b). Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:

a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.

b. Door hardware: 316 Stainless steel.

c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.

d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Arrangement of components:

1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.

2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.

3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.

4. All control-panel-mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:

1. Main overcurrent device:

a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a

molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:

1). Door-mounted disconnect handles are not acceptable.

2). Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.

3). Provide means to defeat the interlock.

4). Lockable in the off position.

b. Control panels supplied with 120 VAC:

1). Provide an internal breaker with the line side terminals covered by a barrier.

2). Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.

2. Provide circuit breakers as specified in Section pertinent sections of these plans and specifications.

3. Selection and ratings of protective devices:

a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.

b. Voltage rating: Not less than the voltage of the application.

c. Select current rating and trip characteristics to be suitable for:

1). Maximum normal operating current.

2). Inrush characteristics.

3). Coordination of the protective devices to each other and to the source breaker feeding the panel.

4. Provide a separate protective device for each powered electrical device:

a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.

b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:

1). Size external fuse to open before any I/O-card-mounted fuses.

2). Individual discrete inputs shall use a 0.5-ampre fuse.

c. Control loops can use individual 5-ampere fuse for the loop.

d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.

5. Fuses for 4 to 20 milliamperes signals:

a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:

1). Label shall not cover or interfere with equipment manufacturer's instructions.

b. An individual 1/2-ampere fuse for each 4 to 20 milliamperes analog loop powered from the control panel.

c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.

d. Manufacturer: One of the following or equal:

1). Ferraz Shawmut.

2). Littelfuse.

3). Bussmann.

6. Fuse holders:

a. Modular type:

1). DIN rail mounting on 35-millimeter rail.

2). Touch-safe design: All connection terminals to be protected against accidental touch.

3). Incorporates blown-fuse indicator.

b. Provide nameplate identifying each fuse:

1). As specified in Section 26 05 53.

c. Manufacturer: One of the following or equal:

1). Phoenix Contact.

2). Allen-Bradley 1492-FB Series B.

7. Control circuit breakers:

a. DIN rail mounting on 35-millimeter rail.

b. Manual OPEN-CLOSE toggle switch.

c. Rated for 250 VAC.

d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.

e. Current ratings: As indicated on the Drawings or as required for the application.

f. Provide nameplate identifying each circuit breaker:

1). As specified in Section 26 05 53.

g. Manufacturer: One of the following or equal:

1). Phoenix Contact.

2). ABB.

3). Allen-Bradley.

4). Square D.

D. Conductors and cables:

1. Power and control wiring:

a. Materials: Stranded, soft annealed copper.

b. Insulation: 600 volts type MTW.

c. Minimum sizes:

1). Primary power distribution: 12 AWG.

2). Secondary power distribution: 14 AWG.

3). Control: 16 AWG.

d. d. Color:

1). AC power (line and load): Black.

2). AC power (neutral): White.

3). AC control: Red.

4). AC control: Orange for foreign voltages.

5). DC power and control (ungrounded): Blue.

6). DC power and control (grounded): White with Blue stripe.

7). Ground: Green.

2. Signal cables:

a. Materials: Stranded, soft annealed copper.

b. Insulation: 600 volts, PVC outer jacket.

c. Minimum size: 18 AWG paired triad.

d. Overall aluminum shield (tape).

e. Copper drain wire.

f. Color:

1). 2-Conductor:

a). Positive (+): Black.

b). Negative (-): White and red.

2). 3-Conductor:

a). Positive (+): Black.

b). Negative (-): Red.

c). Signal: White.

g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:

1. Identify each conductor and cable with unique wire numbers as specified in Section 26 05 53.
2. Readily identified without twisting the conductor.

F. General wiring requirements:

1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
    a. Provide wiring separation plan.
    b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
    c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
        1). 120 VAC: Grey colored ducts.
        2). 24 VDC: White colored ducts.
8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
    a. Screw-on cable tie mounts.
    b. Hammer-on cable-tie mounting clips.
    c. Fingers of the nonmetallic duct.
9. Wire Ties:
    a. No wire ties inside wire duct.
    b. Use Panduit Cable tie installation tool, with tension control/cutoff.
    c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.

12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
    a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
    a. Solenoid valves.
    b. Instruments both mounted in the control panel and remotely connected to the control panel.

G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with typical detail NE303.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Thermal management:
1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified.
2. Heating:
    a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
        1). The panel is not supplied with 120 VAC power.
        2). There are no electronics or moisture-sensitive devices in the enclosure.
        3). The panel is smaller than 38 inches high.
3. Enclosure temperature switch:
    a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    b. Sensor and electronic enclosure.
    c. Accuracy: Within 2 degrees Fahrenheit.
    d. Manufacturer: The following or equal:
        1). Hoffman ATEMNC.
        2). Pfannenberg FLZ.
4. Fan ventilation:
    a. Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.

b. Provide finger-guard kit.

c. Filter kit with 2 spare filters for each intake fan

d. Provide bezel and gasket kit.

e. 120 VAC, 60 Hertz.

f. NEMA Type 5-15R cord connections.

5. Air Conditioning Unit

   a. Any Control Panels provided with Variable Frequency Drives shall be provided with Air Condition Units. This A/C unit shall be properly sized for the South Texas Environment; for the Size of the Cabinet; and the expected heat load in the cabinet. A safety factor shall be factored in to the size of this unit to provide reliable cooling for the panel. In the event that a larger service or Panel main is needed, the Pump Control Panel Manufacture shall coordinate the Electrical Contractor, the General Contractor; and the Owner and Engineer to provide accommodations as needed. It shall be the sole responsibility of the Contractor and the Suppliers to provide a workable control panel in conjunction with a properly sized electrical system.

6. Digital process indicators:

   a. General:

      1). Integral provisions for scaling.

      2). Scale to process engineering units.

      3). Switch-programmable decimal points.

      4). NEMA Type 4/IP65 sealed front bezel.

   b. Current and voltage indicators:

      1). 3-1/2-digit minimum.

      2). Minimum character height: 0.5 inches.

      3). Accuracy:

         a). AC/DC volts: Within 0.1 percent of reading plus 2 digits.

         b). DC current: 4 to 20 milliamperes; within 0.1 percent of reading plus 1 digit.

         c). DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1digit.

   c. Operating voltage: 120 VAC.

   d. Operating temperature: 0 to 60 degrees Celsius.

      1). Manufacturer: One of the following or equal:

         a). Red Lion.

         b). Action Instruments Visipak.

7. Counters:

   a. 6 digits.

   b. Switch-selectable inputs:

1). Switch contacts.

2). CMOS.

3). TTL.

4). Magnetic pickup.

5). RLC sensors.

c. Selectable up/down control via external signal.

d. Remote reset.

e. Remote inhibit to prevent accumulating counts.

f. Programmable to enable or disable front panel reset.

g. Non-volatile memory to retain all data upon loss of supply power.

h. Sunlight readable.

i. Operating temperature: 0 to 50 degrees Celsius.

j. Manufacturer: The following or equal:

1). Red Lion PAX Series.

B. Pilot devices:

1. General:

a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.

b. Size:

1). 30.5 millimeters.

c. Heavy duty.

d. Pushbuttons:

1). Contacts rated:

a). NEMA Type A600.

2). Furnish 1 spare normally open contact and normally closed contact with each switch.

e. Selector switches:

1). Contacts rated:

a). NEMA Type A600.

b). Knob type.

2). Furnish 1 spare normally open contact and normally closed contact with each switch.

3). Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.

f. Pilot lights:

1). Type:

a). LED for interior installations.

2). Push to test.

3). Lamp color:

a). On/Running/Start/Open: Green

b). Off/Stop/Closed: Red.

c). Power On (within panel): White.

d). Fault: Amber.

2. Indoor and outdoor areas:

a. NEMA Type 4/13.

b. Manufacturer: One of the following or equal:

1). Allen-Bradley Type 800T.

2). Square D Class 9001, Type K.

3). General Electric Type CR104P.

4). IDEC TWTD Series.

3. Corrosive areas:

a. NEMA Type 4X.

b. Corrosion resistant.

c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.

d. Manufacturer: One of the following or equal:

1). Cutler Hammer Type E34.

2). Square D Class 9001, Type SK.

3). Allen-Bradley Type 800H.

4). IDEC TWTD Series.

4. Hazardous (Classified) Areas/Class I Division 2:

a. NEMA Type 4X.

b. Corrosion resistant.

c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:

1). All contacts contained within a hermetically sealed chamber:

a). Pushbuttons.

b). Selector switches.

c). Push-to-test contacts on pilot lights.

2). UL listed and labeled for Class I Division 2 areas.

d. Manufacturer: One of the following or equal:

1). Cutler Hammer Type E34.

2). Allen-Bradley Type 800H.

C. Signal isolators and converters:

1. Furnish signal isolators that provide complete isolation of input, output, and power input:

a. Minimum isolation level: 1.5 kilovolts AC/50 Hertz for at least 1 minute.

b. Adjustable span and zero.

c. Accuracy: Within 1.0 percent of span.

d. Ambient temperature range: -20 to +65 degrees Celsius.

2. Manufacturer: One of the following or equal:

a. Phoenix Contact MCR Series.

b. Acromag 1500, 600T, 800T, Flat Pack, or ACR Series.

c. Action Instruments Q500 Series or Ultra SlimPakII.

d. AGM Electronics Model TA-4000.

D. Relays:

1. General:

a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.

b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.

E. General purpose:

a. Magnetic control relays.

b. NEMA Type A300 rated:

1). 300 volts.

2). 8 Amps continuous (minimum).

3). 7,200 volt-amperes make.

4). 720 volt-amperes break.

c. Plug-in type.

d. LED indication for energization status.

e. Coil voltages: As required for the application.

f. Minimum poles: DPDT.

g. Touch-safe design: All connection terminals to be protected against accidental touch.

h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.

i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.

j. Relays with screw-type socket terminals.

k. Provide additional (slave/interposing) relays when the following occurs:

1). The number or type of contacts shown exceeds the contact capacity of the specified relays.

2). Higher contact rating is required in order to interface with starter circuits or other equipment.

l. DIN rail mounting on 35-millimeter rail.

m. Ice-cube-type relays with retainer clips to secure relay in socket.

n. Integrated label holder for device labeling.

o. Manufacturer: One of the following or equal:

1). Phoenix Contact PLC Series.

2). Potter and Brumfield Type KRP or KUP.

3). IDEC R* Series (* = H, J, R, S, U).

4). Allen-Bradley Type 700 HC.

5). Square D Type K.

F. Terminal blocks:

1. DIN rail mounting on 35-millimeter rail.

2. Suitable for specified AWG wire.

3. Rated for 15 amperes at 600 volts.

4. Screw terminal type.

5. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.

6. Finger-safe protection for all terminals for conductors.

7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 to 105 degrees Celsius.

8. Terminals: Plainly identified to correspond with markings on the diagrams:

a. Permanent machine-printed terminal identification.

9. Disconnect-type field signal conductor terminals with socket/screw for testing.

10. Identify terminals suitable for use with more than 1 conductor.

11. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
12. Provide minimum 25-percent spare terminals.
13. Manufacturer: One of the following or equal:
    a. Phoenix Contact UK5 Series.
    b. Allen-Bradley 1492 Series.

G. Wire Duct
1. Provide flame retardant plastic wiring duct, slotted with dust cover
2. Type:
    a. Wide Slot
    b. Narrow slot.
    c. Round hole.
3. Manufacturer: The following or equal:
    a. Panduit.

H. Din Rail
1. Perforated Steel.
2. 35mm width.
3. 15mm deep.
4. Provide 2 inch offset using one of the following:
    a. Offset brackets
    b. Preformed standoff Din Rail Channel

I. Surge protection devices:
1. Control panel power:
    a. 120-volt control power source: Non-UPS powered:
        1). Provide surge protection device (SPD) for panel power entrances:
            a). Nominal 120-VAC with a nominal clamping voltage of 200 volts.
            b). Non-faulting and non-interrupting design.
            c). A response time of not more than 5 nanoseconds.
        2). Control panel power system level protection, non-UPS powered
            a). Designed to withstand a maximum 10-kA test current of a 8/20 µs waveform according to IEEE C62.41.1 Category C Area.
            b). For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.

c). Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.

d). DIN rail mounting.

e). Attach wiring to the SPD by means of a screw-type cable- clamping terminal block:

(1). Gas-tight connections.

(2). The terminal block: Fabricated of non-ferrous, non-corrosive materials.

f). Visual status indication of MOV status on the input and output circuits.

g). Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.

h). Meeting the following requirements:

(1). Response time: Less than or equal to 100 ns.

(2). Attenuation: Greater than or equal to -40 dB at 100 kilovolt-Hertz as determined by a standard 50-ohm insertion test.

(3). Safety approvals:

(a). UL 1283 (EMI/RFI Filter).

(b). UL 1449 2nd Edition.

i). Manufacturer: One of the following or equal:

(1). Phoenix Contact Type SFP TVSS/Filter.

(2). Liebert Accuvar Series.

(3). Islatrol.

b. 120-volt control power source: UPS powered.

1). Provide surge protection on the control power source at each panel containing power supplies, or electronic components including PLCs, I/O, HMI, and digital meters.

2). Location:

a). For panels with a UPS, install surge protection ahead of UPS and maintenance bypass switch.

(1). Surge protection is not required for 120-VAC circuits that are only used for panel lights and receptacles.

b). For panels receiving power at 480 VAC, provide surge protection on the 120-VAC control power transformer secondary.

3). MCOV: 150 VAC.

4). Surge capability (8/20 µs wave): 10 kA.

5). Peak let-through: 620V L-N, 850V L-G.

6). Manufacturer: One of the following or equal:

a). Phoenix Contact Plugtrab PT Series.

b). MTL Surge Technologies MA15 Series.

2. Instrument, data, and signal line protectors (traditional I/O) – panel mounted:
    a. Surge protection minimum requirements: Withstand a 10-kA test current of a 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
    b. DIN rail mounting on 35-millimeter rail (except field-mounted SPDs).
    c. SPDs consisting of 2 parts:
        1). A base terminal block.
        2). A plug protection module:
            a). Replacing a plug shall not require the removal of any wires nor interrupt the signal.
            b). Base and plug coded to accept only the correct voltage plug.
            c). SPD manufacturer: One of the following or equal:
                (1). Phoenix Contact Plugtrab Series.
                (2). Bournes Series 1800.
3. Instrument, data, and signal line protectors (traditional I/O) – field mounted:
    a. Surge protection minimum requirements: Withstand a minimum 10-kA test current of a 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
    b. Manufacturer: One of the following or equal:
        1). Plugtrab PT Series.
        2). MTL TP48 Series.

J. Horns and beacons:
1. Beacons/horn combination units:
    a. Manufacturer: One of the following or equal:
        1). Federal Signal Multi-Status LED 108i with tone module.
        2). LED Colors: Red, Green, Amber.
        3). Power: 120VAC.
        4). Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
    b. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
    a. Manufacturer: One of the following or equal:
        1). Federal Signal Corp Starfire Series.
        2). Allen-Bradley 855 B *-* 10 Series.
        3). Edwards 102 Series.

3. Dedicated horn unit:
    a. Electromechanical:
        1). Manufacturer: One of the following or equal:
            a). Federal Signal 350 or 31X Series.
            b). Edwards 878EX or 879EX Series.
    b. Electronic:
        1). Manufacturer: One of the following or equal:
            a). Federal Signal 300GCX or 300X Series.
            b). Allen-Bradley 855H or 855XH Series.
            c). Edwards 5530M or 5533MD Series C Rated for 80 dB minimum at 10 feet.

K. Power supplies:
    1. Design power supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the system operation.
    2. Convert 120 VAC to 24 volt DC or other DC voltages required or as required for the application.
    3. Provide backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
    4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure:
        a. Provide automatic switchover upon module failure.
        b. Alarm contacts monitored by the PLC.
    5. Sized to provide 40-percent excess rated capacity.
    6. UL 508C listed to allow full rated output without de-rating.
    7. Provide fuse or short-circuit protection.
    8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.
    9. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change:
        a. With remote voltage sensing.
    10. Operating temperature range: 0 to 50 degrees Celsius.
    11. Touch-safe design: All connection terminals to be protected against accidental touch.
    12. DIN rail mounting on 35-millimeter rail.
    13. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
    14. Manufacturer: One of the following or equal:

a. Fully redundant:

1). Phoenix Contact Quint Power Supply with SFB technology

a). Phoenix Contact Quint - O-ring redundancy module

2). IDEC PS5R Series.

a). With redundancy Diode

b). Sola.

c). Acopian.

d). PULS.

L. Intrinsic safety barriers:

1. Transformer isolated barrier:

a. Containing a transformer to provide complete:

1). Isolation between the safe and hazardous areas for loop-powered devices.

2). 3-way isolation between the safe area, hazardous area, and power supply powered devices.

b. Resistor for current limitation.

c. Fuses for short-circuit protection.

d. Provide barriers with pluggable connectors that are coded for easy replacement.

e. Transmission error shall be less than or equal to 0.1 percent of full scale.

f. DIN rail mounting on 35-millimeter rail.

g. Approvals:

1). FM.

2). UL 913.

2. Types:

a. Switch isolators:

1). Designed and approved for use with discrete inputs.

2). Supply power: 20 to 30 VDC.

3). Output to track input.

4). LED in the cover to indicate the status of the input.

5). Selector switch to change the logic of the input.

6). Input: Dry contact.

7). Output: SPDT relay.

b. Transmitter and converters for use with 4- to 20-milliampere signals without Hart® communications capability:

1). Designed and approved for use with 4- to 20-milliampere analog signals.

2). Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.

3). Supply voltage: 20 to 30 VDC.

c. Transmitter and converters for use with 4- to 20–milliampere signals with Hart® communications capability:

1). Designed and approved for use with 4- to 20-milliampere analog signals.

2). Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.

3). Transfer digital signals from the hazardous area to the safe area.

4). Complete bi-directional communication between a mart transmitter located in the field and the suitable equipment located in the safe area.

5). Supply voltage: 20 to 30 VDC.

3. Manufacturer: One of the following or equal:

a. Phoenix Contact ME Series.

b. Pepperl + Fuchs.

M. Limit switches:

1. NEMA Type 4X.
2. AC contact rating 120 volts, 10 A.
3. DC contact rating 125 volts, 0.4 A.
4. Provide robust actuation mechanism not prone to degradation.
5. Provide complete actuator mechanism with all required hardware.
6. Allows for contact opening even during contact weld condition.
7. UL approved.
8. Operating temperature range: -18 to +110 degrees Celsius (0 to 230 degrees Fahrenheit).
9. Manufacturer: One of the following or equal:

a. Allen-Bradley 802 Series.

b. Honeywell HDLS Series.

c. Omron D4 Series.

d. Eaton E47, E49, E50.

e. ABB.

N. The panel for LIFTSTATION No 4, shall be provide with a Variable Frequency Drive. The VFD shall be required to operate and be controlled as detailed in Section 40 94 00B. The variable frequency drive shall be capable of operation under any combination of the following conditions without mechanical or electrical damage. Ambient Temperature: 0 to + 40 degrees C

a. Relative Humidity: Less than 95% non-condensing

b. Altitude: Less than 1,000M (3300 ft) above sea level

c. Vibration: .006 inches displacement, 1G peak

d. Shock: 15G peak for 11mS (+/- 1.0mS)

e. Control Specification

f. Control System: Sinusoidal pulse width modulated voltage waveform

g. Frequency Accuracy: +/- 0.4% of max. frequency

h. Volts/Hertz Ratio: V/Hz user programmable

i. Operation Frequency: 0 to 400 Hz

j. Overload Capacity: 110% Overload capability for up to 1 minute, 150% Overload capability for up to 3 seconds

1. Digital Readout and Monitor

2. Interface to the drive is provided via a module with integral LCD display. Unit is a 7 line by 21 character backlit LCD display with graphics capability. It is used to display drive operating conditions, fault / alarm indications and programming information with full text support in multiple languages, including but not limited to English, German, French, Italian, Spanish, Portuguese and Dutch. The unit will display standby status (power on, not running), output frequency (drive run), set-up parameters and fault. With keypad, user can monitor current, voltage, frequency, acceleration and deceleration time, minimum frequency and maximum frequency. Readout also provides inverter status and protective circuit status.

3. Protection

   a. The variable speed drive system shall include a diode or fully gated bridge rectifier, capacitor filter, and transistorized inverter section. Base driver signals to control firing of the power transistors will be designed with optically coupled isolators for maximum protection of the control circuits from high voltage and noise. The output will be a sinusoidal, pulse width modulated, voltage waveform for reduced harmonic heating in the motor.

4. The system protection will provide the following:

   a. Intermittent overload - 50 to 150%

   b. Current limit - 50 to 115%

   c. Overcurrent - 220-300% of rated output current

   d. Inverse time overload - 50 to 100%

   e. Short circuit - Phase to phase or phase to ground

   f. Overvoltage - 10% above input line or DC bus voltage

   g. Undervoltage - 10% below line voltage

   h. Power loss ride-through - 500mS

5. When the inverter trips out on a fault, the fault relay shall activate and the display shall indicate the reason for the trip as follows:
    a. Overcurrent
    b. Short circuit
    c. Overload
    d. Overvoltage
    e. Undervoltage
    f. Overheat
    g. Ground fault
    h. Motor stalled
    i. Power supply fault
6. Auto restart shall occur when the inverter faults. Auto restart shall be adjustable up to 9 attempts with a 0.5 to 30 second interval. Auto restart will not be attempted for ground fault, output shorted, transistor shorted or internal microprocessor fault but will trip out immediately, activate the fault relay and make the appropriate indication on the display.
7. In the event of a fault trip, the microprocessor shall save the status of the inverter at the time of the fault and make that information available on the digital display. Information regarding the last 4 faults is maintained in event of a power loss.
8. Operational Functions:
    a. Acceleration and deceleration time independently adjustable from 0.1 to 3600.0 seconds (selectable ranges).
    b. Volts/Hertz patterns user selectable.
    c. Maximum and minimum frequency limit adjustments.

2.07 ACCESSORIES

A. As specified in Sections 26 00 00 and 40 61 13.

B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

C. Provide 15-inch floor stands or legs where needed or as indicated on the Drawings.

D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

E. Provide nameplate to each panel as indicated on the Drawings:
    1. Provide as specified in Section 26 05 53 on all internal and external instruments and devices.

2. Provide a nameplate with the following markings that is plainly visible after installation:
    a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
    b. Supply voltage, phase, frequency, and full-load current.
    c. Power source or circuit ID.
    d. Short-circuit current rating of the panel based on one of the following:
        1). Short-circuit current rating of a listed and labeled assembly.
        2). Short-circuit current rating established utilizing an approved method.

F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
    1. Safety plate glass.
    2. Secured by rubber locking seal.
    3. Allow full viewing of devices issuing visual process data or diagnostics.

G. Lighting:
    1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
        a. Covered or guarded.
        b. Provide On-Off door-activated switches where indicated on the Drawings.
        c. 120-volt, single-phase, 15-amp style plug.
        d. Provide 4000K, 900 Lumens – LED fixture.
            1). Provide additional fixtures for every 36 inches of width.

H. Receptacles:
    1. Provide 1 duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.
    2. GFCI, 120-volt, single-phase, 15-amp style plug.
    3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

I. Grounding:
    1. Provide the following:
        a. Grounding strap between enclosure doors and the enclosure.
        b. Equipment grounding conductor terminals.
        c. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
        d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus.

2. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND,” the letter “G,” or the color green.
3. Signal (24 VDC) grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.
4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
8. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
10. Bond together all remote and local control panels, processor racks, and conductive enclosures of power supplies and connect to the equipment- grounding circuit to provide a common ground reference.

J. Provide sunshades and insulation for all outdoor installations.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finishes:

1. Metallic (non-stainless):
    a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer’s recommendations to achieve a smooth, well-finished surface.
    b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer’s recommended dry-film thickness and allowed to dry before applying the finish coat.
    c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
    d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
    a. All Stainless Steel Cabinets shall be 316 SS

b. Stainless enclosures shall be provided with a Number 4 brushed finish with a white painted finish.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.

2. Exterior of panels mounted outdoors shall be manufacturer's standard white.

3. Panel interiors shall be manufacturer's standard white.

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 26 00 00 and 40 61 13.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8 inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

D. Provide 3-1/2-inch high concrete housekeeping pads for freestanding enclosures.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:

1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or mis-cut holes shall require that the entire enclosure be replaced.

H. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule, but shall be shown on the Loop Drawings prepared by the Contractor.

I. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

J. Side Panels:

1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 00 00 and 40 61 13.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 26 00 00 and 40 61 13.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 00 00 and 40 61 13.

3.12 SCHEDULES (NOT USED)

END OF SECTION

40 63 00 PROGRAMABLE LOGIC CONTROLLERS (PLCS)

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Programmable logic controller (PLC) based control systems hardware.
2. Development software to be used with the specified PLC hardware.

B. Related sections:

1. Section 01 33 00 – Document Management.
2. Section 46 61 13 – Process Control System General Provisions
3. Section 40 61 13.01 - Control Systems: PCS Software.

1.02 REFERENCES

A. As specified in Section 40 61 13.

B. Institute of Electrical and Electronics Engineers (IEEE).

1.03 DEFINITIONS

A. As specified in Section 40 61 13.

B. Specific definitions:

1. CPU: Central processing unit.
2. I/O: Input/Output.

C. Specific definitions:

1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
2. Application software: The software that is programmed specifically for the Project.

1.04 SYSTEM DESCRIPTION

A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01 33 00 and 40 61 13.

B. Product data:

1. CPU:

a. Processor type.

b. Processor speed.

c. Memory.

d. Internal processor battery back-up time.

2. I/O modules:

a. Type.

b. Standard wiring diagram.

C. Calculations:

1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.

2. Submit calculations to verify that spare I/O requirements of this Section are met.

3. Submit calculations to verify that PLC power supply requirements of this Section are met.

D. Product data:

1. Programming languages.

2. Operating system requirements.

E. Control logic:

1. Fully annotated copy of programmed PLC logic.

2. Cross-referenced index of all PLC registers or points.

F. Provide application software for the specific Project process requirements.

1. Fully annotated copy of programmed PLC logic in its native format.

2. Cross-referenced index of all PLC registers or points.

1.06 QUALITY ASSURANCE

A. As specified in Section 40 61 13.

B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.

C. Additional requirements:

1. Provide PLC system components by a single manufacturer:

a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.

2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.

3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40 61 13.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 40 61 13.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 40 61 13.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

A. As specified in Section 40 61 13.

B. In addition to the spare parts requirements specified in Section 40 61 13

1. CPU: 1 spare for each type of CPU in the system.
2. I/O cards: 3 spares for each type of I/O card in the system.
3. Power supplies; 2 spares for every power supply in the system.
4. Network/communications cards: 1 spare for every network or communications card in the system.
5. Remote adapter: 1 spare for every remote adaptor in the system.
6. Chassis: 1 spare for each chassis size in the system.

C. Installed spare requirements:

1. I/O points:
   a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC and remote inputs and outputs (RIO).
   b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
2. PLC backplane capacity:
   a. Provide 25-percent or 3 spare backplane slots, whichever is greater in all racks containing I/O.
3. PLC memory:
   a. Provide 50-percent spare program volatile memory.

2.00 PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers:
    1. Rockwell Automation:
        a. 1756 ControlLogix.
            1). PCM-HW
            2). PCM-AD
        b. 1768 CompactLogix
            1). VCP-04.5100
            2). VCP-04.5150
            3). VCP-04.5200
            4). VCP-04.5250
            5). VCP-04.6160
            6). VCP-04.6250
            7). VCP-08.1010

B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
    1. Rockwell Software:
        a. Studio 5000.
            1). Latest major release that has been out for at least a year.
            2). Provide one licensed copy of PLC programming software to the Owner.

C. The LOI programming software system shall be manufactured by PLC hardware manufacturer:
    1. Rockwell Software:
        a. FactoryTalk View Machine Edition.
            1). Latest major release that has been out for at least a year.
            2). Provide one licensed copy of LOI programming software to the Owner.

D. The HMI programming software system shall be manufactured by PLC hardware manufacturer:
    1. Rockwell Software:
        a. FactoryTalk View Site Edition.
            1). Latest major release that has been out for at least a year.
            2). Provide one licensed copy of HMI programming software to the Owner.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Programmable logic controller:

1. Construction:

a. Furnish plug-in modular system.

b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:

1). Temperature: 0 to 60 degrees Celsius.

2). RFI: 80 to 1,000 MHz.

3). Vibration: 10 to 500 Hertz.

4). Humidity: 0 to 95 percent.

c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.

d. Design the PLC system to function as a stand-alone unit that performs all of the control functions described herein completely independent from the functions of the SCADA system PC-based operator interfaces:

1). Failure of the SCADA system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.

2. CPU:

a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.

b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.

c. Capable of supporting and implementing closed loop floating-point math and PID control that is directly integrated into the CPU control program.

3. Memory:

a. Non-volatile memory: On-board complementary metal oxide semi conductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.

b. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:

1). Reserve capacity:

a). Totally free from any system use.

2). Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.

4. Programming:
   a. Provide a system where processors are programmed by:
      1). Portable laptop computer both locally and via the PLC control network.
5. PLC power supply:
   a. Input: 120 VAC.
   b. Mounted in the PLC housing or as indicated in the Drawings.
   c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
   d. Provide redundant power supply.
6. PLC input/output, I/O modules:
   a. General:
      1). Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
      2). Provide I/O modules that:
         a). Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
         b). Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
         c). Accept dual-ended inputs.
      3). The use of common grounds between I/O points is not acceptable.
      4). Provide modules that are removable without having to disconnect wiring terminals:
         a). Utilize a swing-arm or plug-in wiring connector.
      5). Provide at each PLC the I/O modules for the following:
         a). Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
         b). Installed spare capacity in accordance with the requirements of this Section.
         c). Wire all spares provided to the field terminal strip.
      6). Condition, filter, and check input signals for instrument limit conditions.
      7). Filter, scale, and linearize the raw signal into an engineering-units- based measurement.
      8). Alarm measurements for high, low, rate-of-change limits, and alarm trends.
      9). Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.

10). When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.

b. Discrete input modules:

1). Defined as contact closure inputs from devices external to the input module.

2). Provide inputs that are optically isolated from low-energy common- mode transients to 1,500 volts peak from users wiring or other I/O modules.

3). Individually isolated inputs.

4). With LED's to indicate status of each discrete input.

5). Input signal level: As indicated in the schematics and as required to interface with the equipment and instruments. It is most desirable to stick with a signal voltage level where possible.

6). Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:

a). Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.

c. c. Discrete output modules:

1). Defined as contact closure outputs for ON/OFF operation of devices external to the output module:

a). Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.

2). Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.

3). LEDs to indicate status of each output point.

4). Each output point: Individually isolated.

d. d. Analog input modules:

1). Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.

2). Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.

3). The analog-to-digital conversion updated with each scan of the processor. Individually isolated each input. Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.

e. Analog output modules:

1). Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.

2). Individual isolated output points each rated for loads of up to 1,200 ohms.

3). HART analog input module:

a). Channels per module: 8 minimum.

b). Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).

c). Each channel can individually have HART enabled or disabled.

d). Flash-upgradeable firmware.

e). Slot in PLC backplane.

f). Uses standard PLC terminal blocks to allow use of pre-wired I/O cable system.

g). Modules shall be configured using the specified PLC programming software.

7. Communications modules:

a. Network communications modules:

1). General:

a). Install communications modules in the PLC backplane.

2). Ethernet:

a). Ports: 1 RJ-45.

b). Communication rate: 10/100 Mbit/s.

3). Modbus:

a). Ports: 1.

b). Each port individually configurable as Modbus Master or Slave. c) Manufacturer:

(1). ControlLogix PLC:

(a). Prosoft Model MVI56E-MCM or equivalent product.

4). Optical Communication:

a). Manufacturer:

(1). Phoenix Digital.

(a). 1756 Plug-In Module Model OCX-ETF-85-D-SC or approved equal for ControlLogix PLC.

(b). 1768 Plug-In Module Model OCP-ETG-85-D-SC or approved equal for CompactLogix PLC.

5). Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.

8. PLC backplane housing:

a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.

b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.

c. Provide a blank slot filler module for each spare slot.

B. SCADA system interface:

1. As specified in Section 40 61 13 and Section 40 61 13.01.

C. PLC programming software:

1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:

a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.

b. Monitor devices at each drop on the PLC data network for proper communications.

c. Provide the ability to program all PLCs on the PLC data network from the Engineer's console.

2. PLC Programming Laptop/Desktop Operating system :

a. Microsoft Windows 7.

3. The PLC programming software shall be suitable for the PLCs specified above.

4. PLC programming software for all programming, monitoring, searching, and editing:

a. Usable both on-line, while connected to the PLC, and off-line.

b. The operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.

c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic, forced elements shall be identifiable by means of color change.

d. Include a search capability to locate any address or element and its program location.

e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.

5. The PLC programming software shall support the following programming languages:

a. Ladder Diagram.

b. Function Block Diagram.

6. Generate a PLC program printout, which is fully documented, through the PLC programming software:

a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.

b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.

c. Use a mnemonic associated with each contact, coil, etc. that describes its function.

d. Utilize the tag and loop identification as contained in the P&IDs:

1). If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.

e. Provide a cross-reference report of program addresses.

7. Software functions automatically without operator intervention, except as required to establish file names and similar information:

a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:

1). Respond to demands from a program request.

2). Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.

3). Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.

4). Queuing of requests in order of priority if one or more requested resources are unavailable.

5). Resolution of contending requests for the same resource in accordance with priority.

6). Service requests for execution of one program by another.

7). Transfer data between programs as requested.

8). Management of all information transfers to and from peripheral devices.

9). Control and recovery from all program fault conditions.

10). Diagnose and report real-time hardware device errors.

8. Program execution:

a. Application software - program execution scheduled on a priority basis:

1). A multilevel priority interrupt structure is required.

2). Enter into a list of pending programs a program interrupted by a higher priority program:

a). Resume its execution once it becomes the currently highest priority program.

3). Schedule periodic programs.

4). Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.

9. Start-up and restart:

a. Provide software that initializes and brings a PLC or any microprocessor- based hardware unit from an inactive condition to a state of operational readiness.

b. Initialization:

1). Determination of system status before start-up of initializing operating system software and initializing application software.

2). Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.

10. Shutdown:

a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.

b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.

c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.

d. Alarm PLC failure at the operator interface level.

11. Diagnostics:

a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.

b. Use the manufacturer's standard diagnostic routines as much as possible.

c. Furnish diagnostic software and test programs for each significant component in the control system.

d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.

12. Calendar/time program:

a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system level and application software.

b. Variations in the number of days in each month and in leap years must be handled automatically by the program.

c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.

13. Algorithms:

a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.

b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.

c. Algorithms must include alarm checks where appropriate.

d. Provide, as a minimum, the following types of algorithms:

1). Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.

2). A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.

3). A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supporting both direct and reverse-acting modes.

4). Lead, lag, dead time, and ratio compensators.

5). Integration and totalization of analog process variables.

14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:

a. In addition, provide spare database points for future expansion.

15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case the database for each point must include all specified aspects.

16. All portions of the database must be available for use by the display, report, and other specified software modules.

17. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:

a. Analog input signal types:

1). Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.

b. Input accuracy:

1). Inputs must be read with an accuracy of within 0.05-percent full scale or better.

2). Data conversion errors must be less than 0.05-percent full scale.

3). Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once a minute.

4). Maintain for a minimum of 1 year the system accuracy stated above without adjustments.

c. Blocking:

1). Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.

2). For any input so blocked, the operator may manually enter a value to be used as the input value.

d. Filtering:

1). For each analog input, provide a first order lag digital filter with an adjustable filter factor.

e. Linearizing:

1). Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.

f. Calculated values:

1). Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc.

2). These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.

g. Scaling and zero suppression:

1). Provide a conversion program to convert input values into engineering units in a floating-point format.

h. Alarms:

1). Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.

2). When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.

3). Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.

4). Report return to normal shall also be reported.

5). Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.

i. Averages:

1). Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.

2). Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.

3). Update hourly averages each minute or at the polling interval for the selected variable.

4). Update daily averages at least once each hour and calculate using the results of the hourly averages.

5). Update monthly averages at least once each day and calculate using the results of the daily averages.

6). At the end of each averaging period, store the average values for the period on the hard disk for historical record keeping and reset the present period average register to the present value of the variable.

7). The active database must include the present period average nd previous period average for each variable and averaging period.

j. Totals:

1). Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.

2). Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.

3). Assign a separate factor for each totalizing interval.

4). Variables for which totalization is inappropriate must have scaling factors of zero.

5). At the end of each totalizing period, store the totalized values or the period on the hard disk for historical record keeping and reset the present period totalization register to zero.

6). The active database must include the present period total and previous period total for each variable and totalizing period.

k. Engineering units:

1). Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.

2). The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.

3). Pre-program the conversion of the engineering units, and if not re-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.

4). The programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.

5). New conversions must not require the services of a special programmer and/or special, high-level, programming training.

l. Control modules:

1). For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.

2). Input and output assignments, setpoints, and constants just be adjustable by the operator through the operator interface.

3). Provide control algorithms for manual control with output values adjustable by the operator.

m. Analog outputs:

1). Analog outputs must be maintained as part of the database.

2). These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.

18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. General control functions:

1. Analog control functions:

a. PID, lead/lag, signal select, alarm, limit, delay, and time base.

b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.

c. All math utilities must be linkable to process data points or manual inputs via control block configuration.

d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.

2. Discrete control functions:

a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.

3. Software support:

a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.

b. Call each function as required by the configured controls to perform the intended function.

4. Control and status discrepancies:

a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.

1). For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.

b. Involuntary change in the device's status must also generate an alarm:

1). For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

c. Each command, status, and alarm must cause the color of the symbol to change.

d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:

1). Delay periods for each final control element must be adjustable at the operator interface.

2). List all time delays in the final documentation.

5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

E. Control configuration:

1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.

2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints and tuning constants, etc.

3. Provide a mechanism to link separate control functions together into an integrated control strategy.

4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.

5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU and to upload them to the operator interface for operational record keeping.

6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

F. Remote inputs and outputs (RIOs):

1. Compatible with all of the PLCs being furnished under this Contract and shall be by the same manufacturer as the PLCs, and as a minimum, includes:

a. Power supply.

b. Rack.

c. Backplane.

d. Communications module.

e. I/O modules.

f. Enclosure.

2. Provide all cables and software needed for a complete and operational RIO system as specified in the Contract Documents.

3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.

4. The control system must continue operation should a fault occur on a single RIO drop:

a. Upon clearing the fault, restart communications to that drop automatically.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 40 61 13.

3.00 PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 40 61 13.

B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:

1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.

C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

D. General:

1. The control system logic program shall reside at the PLC level.

E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.

F. Program the PLC logic using the following language(s):

1. Ladder Diagram.

2. Function Block Diagram.

3.04 3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

A. Provide a minimum of 4 CD/DVD copies of the following:

1. Application software:

a. Finalized fully annotated copy of programmed PLC logic in its native format.

b. Cross-referenced index of all PLC registers or points.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 40 61 13.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 40 61 13.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 40 61 13.

B. Tailor training specifically for this Project that reflects the entire control system installation and configuration.

C. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:

1. representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.

2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.11 PROTECTION

A. As specified in Section 40 61 13.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40 94 00B INSTRUMENTATION

1.00 LOOP DESCRIPTIONS

This section will provide a general description of anticipated control loops that are necessary to provide control functions as shown on the Drawings and as specified including any other equipment, accessories, and appurtenances as required for a complete and operable system. **This section of the specifications shall apply to Liftstation #4 Only.** The I&C Contractor shall provide instrumentation hardware as necessary to perform the following functions.

1.01 RTU PANEL DESCRIPTION

The I&C Contractor shall provide the Pump Control Panel, for mounting on a rack or self-supported at the Lift Station Site. The provided panel shall be a 316 Stainless Steel NEMA 4X rated enclosure. This cabinet shall receive all Signal Cables from the field and have the ability to process all signals via the internal PLC. These signals shall be able to communicate from this RTU to the TOUCHPAD. The radio capability from this PLC shall **NOT** be made part of this scope of work. The panel manufacturer shall provide a space for future radio installation and integration as a part of another scope of work. The Contractor shall provide all hardware required to achieve the required tasks detailed in these plans and specifications. This scope of work shall include a touchpad controller that shall display all desired screens as detailed herein. Further the Contractor shall provide all hardware/software necessary to give the Owner the ability to record, report, and visually show the variables as required to make reports for Management and Governmental entities as required.

As described in section

- Liftstation Pump Control Panel Description - The I&C Contractor shall provide Liftstaion PLC integrated in the proposed Pump Control Panel, as indicated on these plans and specifications. The provided panel shall be a 316 Stainless Steel NEMA 4X rated enclosure. This cabinet shall receive a Level signal from a Dwyer PBLTX Submersible level indicating transmitter. From this Liftstation RTU Panel, all signals shall be able to be communicated to the RTU via field wires from the instruments to this Control Panel. The Contractor shall provide all hardware including, but not limited to wiring, fuses, indicating lights, transformers, relays, terminal strips, etc. to achieve the required tasks. The power supply to this RTU shall be 120VAC +/- 15% @ 50/60 Hz from a nearby distribution panel. It shall communicate all field instrumentation via a Twisted Pair Shielded Cable, fiber optic Cables, or Signal Wire. In addition, these signals shall be programmed as graphics on a touch pad located on the Control Panel Deadfront door.

A. Loop 100, 200

1. Liftstation Pump Control

a. The I&C Contractor shall F&I a series of Float Switches (LSLL 0627); (LSP1 0628); (LSP2 0629); (LSHH 0630) these float switches shall act as a Low Level Lockout; Call Pump 1; Call Pump 2; and High High that will operate the lift station pumps accordingly via the Pump Control Panel. Only one pump shall be required to run at any one time and the PLC will be programmed to rotate the usage of the pumps. The Liftstation was designed to only need one pump and to have the accompanying pumps as redundancy. As such the Pump 1 call and High High Alarms are intended to notify the Operator of current conditions, but 1ea. Pump is designed as sufficient to operate the Liftsation. Low Level Lockout shall turn pumps off and not allow

them to run. During High High level the same pump called for in Call Pump 1 shall be required to run, under normal circumstances to the LLL Level. Said control shall protect the pumps; call them to operate, and provide alarms as needed. These Float Switches shall be wired in an individual conduit from the Pump Control Panel to floats in the wetwell. The Float Switches shall be powered from 120V inside the control panel. The intent of these plans and specifications is that the Float Switches shall be secondary or backup control for the pumps in the case of an issue with the PLC control scheme.

b. The I&C Contractor shall provide all conduit and wiring for control and status wires from field to the PLC and control panel. This wiring shall provide the necessary DI and DO for proper operation and indication of these of the system. The I&C Contractor shall coordinate all requirements with other Contractors to meet this requirement. The PLC in the RTU shall be designed to process these signals and ultimately produce an indication on the touchpad for each pump. The Touchpad shall be capable of displaying a graphic that shows a real-time Level indication in the wetwell (LI E600). The TOUCHPAD shall indicate a Low Level alarm (LALL E601); PUMP CALL (LAH E602); and High High Level (LAHH E603). Finally, these level controls shall provide permissive for the Liftstation Pumps as required.

c. Each pump in this panel shall have the following functionality in the Control Panel/RTU:

   1). The Control panel shall have a Pump Motor Protective relay provided by the Pump Manufacturer. This relay shall protect the pump motor as needed. Control wires and conduits for this relay shall be included as part of this scope of work. Said relay shall be integral to the Control Panel and shall provide permissive as required for proper operation of the pump motor.

   2). The Pump Control panel shall have a pump Alternating relay. This feature shall alternate the pumps so as to make the run time as even as possible. The PLC shall also be programmed to alternate which pump will start and then allow the next pump to start the next time. The alternating relay can be used as a back up to the PLC to alternate pumps as needed or in the event that the Alternator relay needs to be removed or replaced. All hardware and wiring shall be built into the cabinet. A graphic on the TOUCHPAD and HMI will indicate which pump is running.

   3). A Manufacturer Pump Protection Relay shall also be provided to provide manufacturer approved protection for each pump. These relays shall, at a minimum, provide a seal failure; motor over temperature. These indications shall operate as pilot lights on the front of the Control Panel. Further these alarms, shall also engage (Y2 X07) after time delay.

   4). (HAD X00) shall be a contact from the Pump Control Panel. to indicate that the motor is in Hand or Automatic Mode. The switch shall be a manual hand switch located on the Pump Starter.

      a). In Auto Mode the PLC/Alternator and the float switches shall have control of the LS Pumps. A contact (HAD X00) shall indicate that the switch is in this mode. In Automatic mode a contact from the VFD shall indicate that the VFD is running the pump (YR X05).

b). In Hand Mode all Automatic Control shall be bypassed and an indication on the TOUCHPAD shall indicate that the pumps is running in this mode. Local control shall be indicated by a contact in (Y1 X00)

5). Pump Run Time shall be Provided on the Panel Door with a runtime meter.

6). In the event that the Pump is called to run but does not send a run status with a 10 second period, the TOUCHPAD will indicate a Pump Fault Failed to Start alarm (Y2 X07)

7). Other indications from contacts in the field and indicated on the TOUCHPAD shall be as follows:

a). Alarm O/L Trip (Y2 X06)

b). Alarm Fail to Start (Y2 X07)

c). Running status that will be a contact provided from the VFD to the PLC to indicate the motor is running (YR X06)

B. Loop 600

1. The Contractor shall furnish and install a Level Transducer as indicated in the plans and specs that will indicate the real-time Level (LIT E600) of water in the Liftstation Wet Well. The Level Transducer shall be a DWYER PBLTX Submersible Level Transducer or approved equal. The sensor shall be a loop powered instrument. The signal wires shall be run in a conduit from the Meter in in the Wet Well to the nearby Pump Control Panel. The Level Transducers shall generate an independent a 4-20mA signal to be manipulated by the Liftstation PLC. This signal shall ultimately display at the Touchpad. Transducer shall convey a level signal in realtime to the Touchpad display and the PLC shall have the capability to manipulate this signal for its intended uses. (LI E600).

C. Loop 700

1. The Diesel Pump shall be equipped with Contacts to provide status of certain conditions pertaining to the Diesel Pump. A Contact (YL7 E700) shall be a contact originating in the Diesel Pump that indicates a Low Fuel Level. This signal shall be wired in to the RTU and shall provide an indication of this condition at the HMI. A Contact (YL8 E701) shall be a contact originating in the Diesel Pump that indicates a fail to run. Once the Pump is given a signal to run and does not for a programmed amount of time an alarm shall show this alarm at the HMI. A Contact (YL9 E702) shall be a contact originating in the Diesel Pump that indicates a Run status of the Diesel Pump. This signal shall be wired in to the RTU and shall provide an indication of this condition at the HMI.

D. Run Sequence for Pumps:

1. **STARTING OF PUMPS:** Upon receiving the start command from the floats and/or the level transducer, the PLC shall give the command for the next scheduled pump to run as allowed by the alternator sequence. In the event that this pump does not start, the PLC will then give a Pump #1 failed to start alarm and then proceed to the next scheduled pump, and so on until a pump starts and satisfies the situation. Upon receiving the first start command the pump being started will ramp up to 100% or 60 Hz. The purpose of starting in this manner is to allow for the pump to flush the forcemain downstream. The required pump will run at 100% or 60Hz for an adjustable amount of time as pre-

determined by the Engineer. This time shall be made adjustable by the programming of an Engineer's screen that will allow such adjustments. Once the allotted time is reached the PLC will lower the speed of the VFD to allow the VFD to control the level of the water in the wet well. Upon reaching the Low Level of the wetwell, the required pump will stop running. With the alternating sequence the second pump will now start first and the sequence shall be repeated rotating all three pumps as first to start in sequential order.

2. **PUMP STOP:** At the end of the pump cycle (i.e.. the level of the wet well is satisfied), the PLC will issue a stop command to the pumps running. The last pump that cycle will be givne a command to ramp up to 100% or 60 Hz. The purpose of this end of cycle ramp up is allow for the pump to flush the forcemain downstream. The required pump will run at 100% or 60Hz for an adjustable amount of time as pre-determined by the Engineer. This time shall be made adjustable by the programming of an Engineer's screen that will allow such adjustments. Once the allotted time is reached the PLC will send a stop command to the VFD. In the event that the level in the wetwell reaches at or below LLL, all pumps shall stop and the LLL level shall dictate operation for pump safety.

3. The intent of these plans and specifications is to allow the pumps to be primarily controlled by the PLC contingent on the level of the water in the wet well according to the Level Transducer. In the event that the Level Transducer fails, the float switches shall be used as the secondary level control. Alternation shall be required when either the float switchers or the Level Transducer are controlling the pumps.

END OF SECTION

40 94 33 LOCAL OPERATOR INTERFACE (LOI)

1.00 GENERAL

1.01 SUMMARY

A. Section includes:

1. Local operator interface (LOI) control systems hardware and software.

B. B. Related sections:

1. Section 01 33 00 – Document Management.
2. Section 40 61 13 - Common Work Results for Process Control and Instrumentation Systems.

1.02 REFERENCES

A. As specified in Section 40 61 13.

1.03 DEFINITIONS

A. As specified in Section 40 61 13.

1.04 SYSTEM DESCRIPTION

A. Provide all LOI hardware identified in the Contract Documents.

1.05 SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 and 40 61 13.

B. Product data:

1. Complete manufacturer’s brochures for each item of equipment.
2. Complete manufacturer’s brochures that identify LOI software and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
3. Manufacturer’s operation and installation instructions.
4. Additional requirements:
    a. Display type and size.
    b. Operator input.
    c. Processor type and speed.
    d. Memory size.
    e. Programming protocols.
    f. Communication protocols.
    g. Power requirements.
    h. Operating temperature and humidity ranges. NEMA ratings.

C. Shop drawings:

1. Furnish the following:

a. System block diagram showing relationship and connections between devices. Include manufacturer and model information, and address settings.

b. Mounting drawings with dimensions and elevations for each equipment location, including identification of all components, preparation and finish data, and nameplates.

c. Electrical connection diagrams.

d. Complete grounding requirements.

2. Graphic Screens:

a. Color printouts of each graphic screen and all control pop-ups.

3. Furnish data sheets for each component together with a technical product brochure or bulletin:

a. Manufacturer's model number.

b. Project equipment tag.

4. Complete and detailed bills of materials identified by each cabinet. Include with each bill of material item the following:

a. Quantity.

b. Description.

c. Manufacturer.

d. Part numbers.

D. Operation and maintenance manuals:

1. Complete installation, operations, calibration, and testing manuals as described in Section 40 61 13.

E. Record documents:

1. Electrical connection diagrams revised to reflect any changes made in the field and submitted as record Drawings.

1.06 QUALITY ASSURANCE

A. As specified in Section 40 61 13.

B. Examine the complete set of Contract Documents and verify that the LOI equipment is compatible with the installed conditions.

C. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

D. Provide LOI hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

E. System compatibility:

1. The software must be the standard operating software system designed specifically for use with the LOI hardware.
2. The software must be furnished and developed by the manufacturer of the LOI hardware.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40 61 13.

1.08 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 40 61 13.

1. Provide LOI equipment suitable for the installed site conditions including, but not limited to, site altitude, site seismic conditions, humidity, and ambient temperatures.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 40 61 13.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

A. As specified in Section 40 61 13.

B. Provide system upgrades and maintenance fixes for a period of 2 years from substantial completion.

2.00 PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Allen-Bradley: PanelView Plus 7 Standard.

B. Provide the LOI graphic software system manufactured by the LOI hardware manufacturer.

C. One of the following or equal:

1. Rockwell Software FactoryTalk View Machine Edition.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Local Operator Interface:

1. General:

a. Provide local operator interfaces located on the face of the VCP as indicated in the contract documents.

b. NEMA 12 rated.

c. Local Operator Interface consists of graphical display screen with operator input capabilities.

d. Capable of stand-alone operation in conjunction with 1 PLC.

e. Equipped with data network communication capabilities.

2. Display:

a. Type:

1). Color TFT LCD screen.

b. Resolution:

1). 640 by 480 pixels.

c. Size: As 10.4".

d. Easy display viewing at any angle in various ambient light conditions.

e. Operator input:

1). Configurable touch screen.

f. Screen update speed: The screen update speed and screen change speed less than 1 second.

g. Provide following features for outdoor use:

1). Anti-glare screen overlay.

2). Luminescence: Minimum 1,000 Nits.

3. Graphic configuration:

a. Easily configured graphics by:

1). Portable laptop computer both locally and via the PLC data network.

b. As specified in Section in this Section.

4. Memory:

a. Application:

1). 32 MB Flash EPROM.

5. CPU: Minimum 100 MHz.
6. Communications:
    a. Ethernet/IP.
7. Environment:
    a. Temperature: 0 to 50 degrees Celsius.
    b. Relative humidity: 10 to 90 percent.
8. Electrical:
    a. Power supply:
        1). 120 VAC.

B. Human machine interface software:
1. Provide a complete software package to be used for programming the necessary screens and operator interaction with the LOIs.
2. Operating system:
    a. Microsoft Windows 7.
3. Furnish software with preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.
4. Software must allow bitmaps to be imported or exported to or from other applications.
5. Capable of generating custom reports, complete with screen prints.
6. Capable of working with multiple screens concurrently.
7. Provide dialog boxes for defining object attributes.
8. Configure objects using fill in dialog boxes.
9. Furnish graphic and text editor that allows custom formatting in order to customize and change the appearance of objects and text:
    a. Allow selection of different fill patterns to define object status.
10. As a minimum, provide the following object capabilities:
    a. Operator inputs:
        1). Momentary pushbutton.
        2). Maintained pushbutton.
        3). Latched pushbutton.
        4). Multistate pushbutton.
        5). Keypad enable button.
        6). Cursor point.
    b. Control list selectors:
        1). Standard control list.

2). Piloted control list.

c. Global objects.

d. Display objects:

1). Bar graph.

2). Scale.

3). Message display.

4). Multistate indicator.

5). List indicator.

6). Numeric data display.

e. Screen selector objects:

1). Go to.

2). Return.

3). Screen list selector.

f. Embedded variables:

1). Time.

2). Date.

3). Numeric variable.

g. Graphics:

1). Lines.

2). Shapes.

3). Freeform drawings.

4). Imported graphics.

5). Background text.

6). Selection table for standard ISA symbols.

7). PID controller faceplate.

h. Alarm screens.

11. Documentation:

a. Provide complete user documentation, including examples of how to operate the various modules within the system.

b. Provide the documentation in electronic format, HTML based with the ability to search for topics by keyword or search or specific text.

12. On-line help:

a. Provide an on-line "help" facility, based upon Windows standard Hypertext:

1). Useful, context-sensitive information on the operation of the package:

a). That can be invoked on-line through a point-and-click operation.

b). The "help" facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 40 61 13.

3.00 PART 3 EXECUTION

3.01 EXAMINATION

A. A. As specified in Section 40 61 13.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 40 61 13.

B. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

C. Provide panel support bracing if more than 25 percent of the area has been removed to allow for the mounting of the LOI.

D. All tags used and/or assigned as part of the application programming work are to use the tag and loop identifications found on the P&IDs.

E. Station graphics:

1. Configure the graphic display for each device both in the treatment plant, and/or process area, including but not limited to:

a. Symbols for:

1). Pumps.

2). Valves.

3). Major instruments.

4). Flowmeters.

5). Pressure transmitter.

6). Major equipment.

b. Alarm symbols including intrusion alarm.

c. Relevant test and operational data.

d. Status for each controller or controlled device:

1). Hand-Off-Auto Status.

2). Local-Off-Remote Status.

3). Run.

4). Call.

5). Fail.

6). Open.

7). Close.

8). Hold.

9). Modulate.

10). Running.

e. Depict a change of state of pumps and valves by a change in color.

2. Production and usage bar graph:

a. Depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.

3. System level summary:

a. Show the level for the plant influent and effluent production, etc, via a display using bar graphs and numbers, as determined during the requisite graphics meeting.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 40 61 13.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 40 61 13.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 40 61 13.

B. Perform the training using pre-approved and qualified representatives of the ICSC and or manufacturer of the LOI software:

1. A representative of the ICSC may perform the training only if the representative has completed the manufacturer's training course for the LOI software.

3.11 PROTECTION

A. As specified in Section 40 61 13.

3.12 SCHEDULES (NOT USED)

END OF SECTION

DIVISION 44

POLLUTION & WASTE CONTROL EQUIPMENT

44 11 29 ODOR CONTROL EQUIPMENT

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install a odor control system at Lift Station No. 4 to remove and treat air from the wet well. The filtration system will utilize deodorizing solution in a 55 gallon drum compatible from the same manufacturer as the odor control equipment.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Odor Solve
2. Approved equal.

B. Design Criteria; System Configuration and Performance:

1. The odor control system shall consist of an intake line, positive siphon fan, intake fan, filter chamber, filter material, cleaned air return vent, intake vent, exhaust vent connection, odor solution pump, disposal pump, clear chemical flow check site, filter back flush valve, and aluminum frame. The unit shall be designed to withstand a 100 mph wind without damage or overturning. Overall height, including baseplate, shall not exceed 7 feet.
2. The system will provide a minimum of 15 air exchanges of the wet well volume per hour.
3. The Manufacturer shall certify that the system meets the requirements for a chemical injection system in accordance with the latest revision of the Uniform Fire Code.

C. Manufacturer's Representative for Startup and Testing: The services of the Manufacturer's technical representative shall be provided for pre-startup installation checks, startup assistance, training of Owner's operating personnel, troubleshooting and other services as required in Section 01 75 00 "Starting and Adjusting."

1.03 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:

1. Shop Drawings.
2. Operation and Maintenance Manuals.
3. Certificate of Adequacy of Design.

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

A. External / Internal Fans: Odor control system will include two 6” high cfm inline ducting fans for both the external and internal applications. The fans will include ceramic coated composite blads and center hub with permanently lubricated bearing.

   1. Airflow: 442 cgm
   2. Speed: 2380 rpm
   3. Motor: 95 W amp draw (0.9)
   4. Insulation Class F motor protection IP44
   5. Dimensions: 11x14x14.5 inches
   6. Power: 120 V / 60Hz / NEMA 5/5

B. Filter Unit: Odor control system will include a filter unit of Schedule 40 PVC with sealed permanent joints. Filter will include an “U” duct with suction inducting internal fan, “Y” for venting clean air, retractable drain tub with clear upper section for visual inspection of chemical flow, and an integrated in-line valve for back flushing the filter element.

C. Filter Material: Filter unit will contain up to fourteen 10” diameter fiberglass disks coated with tackifier.

   1. Nominal Disk Thickness: 2”
   2. Actual Disk Thickness: 1-3/4”
   3. ERV: Less Than 5
   4. Initial Resistance: 0.08” WC
   5. Final Resistance: 0.50” WC
   6. UL Class 900

D. Odor Solution: Provide one 55-gallon drum of deodorizing solution provided by manufacturer.

E. Chemical Pump: Odor control system will include one (1) chemical pump to inject the odor solution into the filter material. Chemical pump will include dual suction and discharge ports with twin lines of ¼” polyethylene tubing.

   1. Materials
      a. Polycarbonate housing
      b. Santoprene Pump Tube
      c. Santoprene Check Valve Duckbill
      d. Pump Head Rollers: HDPE
      e. Roller Bushings: Oil impregnated sintered bronze
      f. Suction / Discharge Tubing: #5 Polyethylene
      g. All Fasteners: Stainless steel
      h. Pump Head Latches: Polypropylene
   2. Pump

a. Motor Type: 1/30 HPO, shaded pole, class B

b. Duty Cucle: Continuous

c. Motor Voltage (Amp Draw)" 120 V 60 Hz 1 PH (1.7)

d. Power Cord Type: SJTOW

e. Power Cord Plug End: 120V 60 Hz NEMA 5/5

f. 44 rpm

g. 170 gpd, 25 psi

F. Disposal Pump: Odor control system will include one (1) utility pump to flush the remaining odor solution and odor residue from the odor drum to the lift station.

1. Type Compact Flexible Impeller
2. Voltage 115V
3. Motor Enclosure Open
4. Motor Type Universal AC/DC
5. Body Stainless Steel
6. Max Head = 37.3 ft
7. Max Liquid Temp = 140 degrees Fahrenheit
8. Thermal Protection Automatic
9. 5000 rpm
10. Power = 1/10 HP
11. Amp Draw (1.6)
12. Duty intermittent
13. Inlet/Outlet (in) = 3/8 ID; ¾ OD
14. Impeller Buna-N
15. Shaft Material Stainless Steel

G. Support Frame: Mount the system on a 3'x3' aluminum support frame within 10 ft of the lift station exhaust vent as indicated on the drawings.

H. Control Panel: The Manufacturer shall supply a control panel, with required motor starters, to operate and control the system. Panel shall meet applicable requirements of Division 26. Wiring between control panel and electrical components of the system shall be provided by the Manufacturer.

3.00 EXECUTION

3.01 INSTALLATION

A. Carefully handle and install the components of the odor control system to prevent damage to any part of the system. Carefully handle and install the equipment in accordance with the Manufacturer's installation instructions.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of the odor control system, an acceptance test will be conducted to verify the satisfactory operation of the system. The test shall be conducted in a manner approved by and in the presence of the Engineer. The equipment will be checked for leakage, general operation, etc. The equipment must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

END OF SECTION

44 42 56.04 SUBMERSIBLE PUMPS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install two (2) new submersible sewage pumps at Lift Station No. 4 and two (2) new submersible sewage pumps at Lift Station No. 35. Coordinate wetwell access doors with the slide rails. Accessories shall be furnished as required for a complete functioning pumping unit in accordance with the specified performance and installation conditions.

B. The pump supplier shall furnish discharge elbows, pump impellers, guiderails, brackets, anchor bolts and anchor bolt layouts and bases, lifting cables and cable grip system, existing access hatch safety grates and power cables as indicated on the plans.

C. Pump and motor shall each have a standard Manufacturer's nameplate securely affixed with adhesive in a conspicuous place, showing the ratings, speed, rotation, serial number, model number, manufacturer, and other pertinent data.

D. For this specification section, the Equipment Manufacturer shall be defined as the Pump Manufacturer or his designated representative. The Equipment Manufacturer shall be responsible for supplying and coordinating the design, testing, and installation of the pumps and motors. In order to ensure compliance with this paragraph the motors must be manufactured by the Equipment Manufacturer. The Equipment Manufacturer shall be responsible for the adequacy and compatibility of the pump and motor.

E. The pump supplier shall also provide all of the maintenance required for the first year of operation including the following as a minimum:

1. After 60 days of operation, run each pump and record voltage and amperage, pull each pump, open the volute and examine the condition of the volute, impeller, and wear rings. Check condition of coating system on motor housing. Perform any necessary repair under terms of the warranty. Prepare a field service report.

2. After 12 months operation, repeat procedure described above. Change oil in the seal chambers.

F. Pumping units shall be operated by soft starters. Pumping unit motors shall be designed to be suitable for use with soft starters. Refer to Section 26 29 13 "Motor Starters" for information on soft starters (provided by the MCC Manufacturer).

G. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

A. ACCEPTABLE MANUFACTURERS (Acceptable manufacturers must meet all requirements including efficiencies required by these specifications to be approved for construction.)

1. Flygt

2. Sulzer

B. MANUFACTURER'S REPRESENTATIVE FOR STARTUP AND TESTING: The services of the Manufacturer's technical representative shall be provided for pre-startup installation checks, startup assistance, training of Owner's operating personnel, troubleshooting and other services as required in Section 01 75 00 “Starting and Adjusting”.

C. SERVICE OF MANUFACTURER'S REPRESENTATIVE

1. Pump Manufacturer Representative

a. The pump manufacturer shall furnish the services of a competent factory technician, who shall have had a minimum of ten (10) years experience in the installation, adjustment, and operation of the equipment which is being furnished under this contract. This service is for the purpose of insuring proper installation and adjustment of the equipment (proposed pump and motor setup); instructing operating personnel in proper operation, maintenance, and care of the equipment; for making operation tests of equipment and making recommendations for obtaining the most efficient use thereof.

b. The service representative shall be at the site at any time the Construction CONTRACTOR is assembling, setting, aligning, connecting or adjusting and testing the pump and motor assembly, and shall direct such work and certify in writing to the OWNER that it has been properly installed and operates satisfactorily during acceptance tests.

c. The minimum time required to be on-site for 8 hours/day, not including travel time, is as follows: A minimum of 3 days (3 trips minimum to perform the services listed in 1.03.E.1).

1) Check pump and motor installation

2) Pump start-up and testing

3) Troubleshooting

4) Personnel training

If additional time is required, the factory representative must be available regardless of the number of trips and time required for each activity.

1.03 SUBMITTALS

Submittals shall be in accordance with Section 01 33 00 “Document Management” and shall include:

A. Shop Drawings.

1. Shop drawings shall include a complete description of the equipment offered including control and mounting system. Shop drawings shall include catalog cuts and pertinent engineering data required to fully evaluate the equipment. Characteristic curves shall be submitted with the shop drawings showing the capacity, head, efficiency, and brake horsepower throughout the full operating range of the pump. Complete specifications on the control equipment including a list of optional features shall be submitted with the shop drawings. Submittal data shall be in such form and so presented that the Engineer may readily review the data**.**

2. Manufacturer must furnish evidence of having an authorized fully staffed and stocked service facility within 200-mile radius of the jobsite as well as having 24 hour parts availability. If manufacturer cannot meet one or both of these requirements, a detailed plan on how customer service and maintenance will be provided must be submitted for approval.

3. Data sheets supplying the following information for the pumping units shall be submitted with the shop drawings.

a. Pump Manufacturer

1) Characteristic Curves (capacity, head, efficiency, recommended operating range indicated on curves, motor curves, required NPSH and brake horsepower throughout the operating range of the pump from shut off to maximum specified operating capacity. Characteristic curves shall have the capacity plotted as abscissa and the operating head, brake horsepower, efficiency and required NPSH plotted as ordinates.)

2) Data Sheet: Fill out and submit with the Shop Drawing submittal the information requested on the Pump Submittal Data Sheet (Attachment A)

b. Motor Manufacturer shall supply documentation for the motors as follows

1) Letter of Compatibility: The soft starter supplier in conjunction with the pump/motor supplier shall issue a letter of compatibility stating that the soft starter and motor are compatible.

2) Data Sheet: Fill out and submit with the Shop Drawing submittal the information requested on the Motor Submittal Data Sheet (Attachment B)

3) Rated full load horsepower

4) Rated volts

5) Number of phases

6) Frequency in hertz

7) Full load amperes (FLA)

8) Motor no load data (i.e. amps, power factor, etc.)

9) Locked rotor amperes (LRA) at rated voltage and Locked rotor KVA/HP.

10) Synchronous speed (srpm)

11) Guaranteed maximum slip at full load in percent

12) NEMA insulation system classification and description of manufacturer's method of application.

13) Temperature rise at rated full load by resistance temperature detector

14) Maximum ambient temperature for which motor is designed

15) Service factor

16) The limiting temperature rise by resistive temperature detector motor as design and corresponding horsepower

17) Bearing size and calculation

18) Safe stall time

19) Maximum acceleration time with NEMA standard Wk2 value, at rated voltage and at 90 percent of rated voltage

20) Number of safe starts in succession when starting from a 40 degree Celsius ambient, intermediate waiting periods, and other conditions for driving equipment with a NEMA standard Wk2 value

21) Efficiency at 1/4, 1/2, 3/4, full load; and service factor

22) Power factor at 1/4, 1/2, 3/4, full load; and service factor

23) Maximum kVAR allowed for power correction without overexciting the motor. Maximum allowed kVAR shall be included on the motor nameplate as well.

24) Surge protection information, including mounting details

25) Thermistors literature with wiring diagram.

4. AIS certifications for any hardware and/or metal components incorporated within the submittal.

B. Operation and Maintenance Manuals

Manuals shall be prepared by the equipment Manufacturer per Section 01 33 04 “Operation and Maintenance Data” and shall incorporate storage and installation instructions and operation and maintenance procedures, appropriate final certified shop drawings, performance curves, and test data. Manuals may be Manufacturer's standard instructions, but shall be supplemented as necessary to cover any special feature not included in standard material. Submit preliminary manuals for review prior to delivery of the equipment.

C. Certified Test Curves for Lift Station No. 4 Pumps

D. EQUIPMENT INSTALLATION REPORT

Submit Equipment Installation Reports from the motor manufacturer and pump manufacturer.

1. Data sheets supplying the following information for the pumping units shall be submitted with the shop drawings.

    a. Pump

        1) Make and type of pump

        2) Speed, RPM

        3) Horsepower at rated head, HP

        4) Total weight (pump and motor), Lbs.

        5) Rated capacity and head on pump curve

    b. Motor

        1) Make and type of motor

        2) Brake horsepower of motor, HP

        3) Locked Rotor Current at full nameplate voltage, Amps

        4) Full load current at full nameplate, Voltage

        5) Motor Voltage Phase, Phase

        6) Motor service factor

        7) Insulation class and temperature rise at service factor load

1.04 STANDARDS

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

1. American Water Works Association (AWWA)

2. American National Standards Institute (ANSI)

3. ASTM International (ASTM)

4. National Electrical Manufacturers Association (NEMA)

5. National Electric Code (NEC)

6. Test Code of the Hydraulic Institute Standards (HIS)

7. Institute of Electrical and Electronic Engineers (IEEE)

8. The applicable provisions of the following electrical standards shall apply as if written here in their entirety:

a. ANSI/NEMA MG-I - Motors and Generators

b. UL 1004 - Standard for Safety for Electric Motors

c. ANSI/NEMA MG-II - Installation and Operation of Electric Motors

d. IEEE STD 112 - Standard Test Procedure for Polyphase Induction Motors and Generators

e. IEEE STD 85 - Standard Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery

f. ANSI 51.2 - Physical Measurement of Sound

g. Other Standards - Motors shall be built to all other applicable NEMA, ANSI, and IEEE standards not included above.

1.05 DESIGN CONDITIONS

A. The pumps shall be designed to handle raw sewage on a continuous duty basis and shall be capable of passing a 3" non-deformable sphere. Flygt N impellers have been approved by the TCEQ for use on this project if selected.

Pumps shall be guaranteed free from cavitation and/or vibration throughout the system performance range. The pumps shall meet the operating conditions as specified and shall be designed to operate on a continuous duty basis. Design conditions for the pumps at each lift station shall be as specified. Also see attached system head curves for design conditions.

B. The presence of abrasives, rags, large solids and stringy materials shall not be considered as abnormal, unanticipated or abusive with regard to the equipment operation or warranty.

C. Pump manufacturer shall review existing wet well configuration/dimensions and coordinate with the CONTRACTOR to field locate base, guide rails and cable grips and note any required design modifications required to accommodate the supplied pumps.

1.06 DELIVERY AND STORAGE

A. The Manufacturer shall be responsible for delivery of the pump, motor, and accessories, f.o.b. to the job site or to such storage site as may be designated by the Owner or Construction Contractor, in good condition and undamaged.

B. Unloading and storage of the equipment shall be the responsibility of the Construction Contractor who shall inspect the equipment for apparent damage. Equipment which is found to be damaged shall not be accepted until properly repaired or replaced by the Manufacturer.

C. The pumps, motors, and accessories shall be stored indoors. When this equipment is stored indoors, it shall never be in direct sunlight and the indoor temperature shall be maintained at a level satisfactory to the Owner. The Contractor is responsible for providing the indoor storage facility or enclosure.

D. Furnish anchor bolts and necessary appurtenances as necessary to meet the Installation Contractor's schedule.

1.07 WARRANTY

A. Manufacturer shall warrant the pumps and motors furnished under this specification for a period of two (2) years against defects in materials and workmanship and operational failure.

B. In the event of failure of any part or parts of the equipment and motors during the first two (2) years of service, provided that the pumps and motors have been operated and maintained in accordance with good practice, the Manufacturer shall furnish, deliver and install the defective part or parts at the Manufacturer's own expense. Manufacturer is also responsible for submersible pump removal, reinstallation and freight.

C. The first two (2) years of service shall be interpreted as the twenty-four (24) month period following the installation, adjusting and acceptance testing, and the start of actual operation of the equipment.

D. At the one (1) year warranty and the two (2) year warranty inspection, the OWNER and Manufacturer shall together perform an equipment evaluation on each unit during the 11th and 23rd month of the warranty. This shall be a complete electrical, mechanical, and hydraulic evaluation of the pumps and motors. The Manufacturer's cost for the equipment evaluations shall be included in the price under this contract, and the coordination and scheduling of the annual equipment evaluation shall be the responsibility of the Manufacturer. A detailed report will be produced by the Manufacturer after the evaluation describing the tests, data collected, and issues identified. Refer to section 1.01.F. for additional requirements.

1.08 SPARE PARTS

Manufacturer/Supplier shall submit a complete listing of spare parts for all equipment and motors furnished under this specification whether said equipment is or is not of his/her manufacture. Also furnish the list and price of manufacturer's recommended normal wear and tear spare parts for the equipment furnished in this Purchase Order.

2.00 PRODUCTS

2.01 SUBMERSIBLE SEWAGE PUMP

A. Each pump, motor, and cable assembly shall be furnished in one integral unit, factory assembled by the Pump Manufacturer. Pump shall be listed as explosion proof (Class I, Division I) by Underwriter Laboratories (U.L.), or Factory Mutual (F.M.).

B. The pump design shall be such that the pumping unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection. The discharge connection shall be permanently installed in the wet well. The pump shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be disconnected. The guide mechanism shall be a non-sparking design and U.L. or C.S.A. listed. Connection and disconnection of the pumping unit from the discharge piping shall not require personnel to enter the wetwell. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pump unit.

C. The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged.

D. Major parts, such as the stator casing, oil casing, sliding bracket, volute, and base coupling shall be constructed of cast iron or bronze. Pump impeller shall be constructed of abrasion-resistant ASTM A-532 cast iron or A48/Class 35B cast iron. Surfaces coming into contact with the pumped liquid shall be protected by a factory-applied epoxy coating or shall be stainless steel. External bolts, nuts, and fastening hardware shall be a minimum AISI 316 series stainless steel.

2.02 PUMP CONSTRUCTION

A. Pump Volute: The volute shall be constructed of ASTM A-536 (65-45-12) ductile iron or A 48 Class 35B cast iron. The discharge flange shall be 125 PSI A.N.S.I. drilling. Nominal casing thickness shall be 7/8" minimum. The casing shall be hydrostatically tested at 1.5 times the maximum operating pressure. A wear ring shall be provided in the volute which is constructed of AISI 329 duplex stainless steel or AISI 440 stainless steel with a minimum Brinnell hardness of 400 or Brass ASTM C83600. Wear ring provided shall be compatible with mating material to prevent galling.

For the Flygt N impeller, wear rings are not required. The volute shall have a replaceable suction cover insert ring and shall be cast of ASTM A-532 (Allow III A) 25% chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

B. Impeller: The impeller shall be constructed pf abrasion-resistant ASTM A-532 cast iron or A48/Class 35B cast iron, and shall be of the enclosed, non-clogging, dynamically balanced, one, two or three vane design capable of passing 3" diameter spherical solids. The impeller shall have a slip fit onto the motor shaft and drive key and shall be fastened using the manufacturer's standard technique. The impeller wear ring shall be AISI 304 stainless steel, with a minimum Brinnell hardness of 200.

For the Flygt N impeller, the impeller shall be of ASTM A-532 (Alloy III A) 25% chrome cast iron, dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The leading edges of the impeller shall be hardened to Rc 60 and the volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

C. Shaft: The pump shaft shall be series 421 stainless steel. Carbon steel shafts or shafts with sleeves of any type are not acceptable. The shaft shall be one-piece construction without joints or stubs attached. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. Shaft overhang shall not exceed 2.5 times the shaft diameter.

D. Mechanical Seals: Each pump shall be equipped with a double mechanical seal of the cartridge type or a balanced tandem-type design, running in an oil reservoir. The upper and lower faces of the rotating portion of the seal shall be made of tungsten carbide or a high-quality silicon carbide. The two faces shall be held in contact by multiple springs or bellows to ensure uniform face following of the rotating faces against the stationary faces. The entire seal shall be mounted within the oil chamber. The lower stationary seal face shall be made of tungsten carbide or a high-quality silicon carbide. The seals shall require neither routine maintenance, nor adjustment, and shall not be damaged when the pump is run dry. When required, seal oil inspection shall be achieved without disassembly of the pump. The seal shall not require the pumped liquid as a lubricant. All metal parts shall be 316 stainless steel.

E. O-Rings and Fasteners: All mating surfaces of the pump and motor shall be machined and fitted with Viton or Buna-N O-rings where watertight sealing is required. Sealing shall be accomplished by the proper fitting of the parts and not be compression or special torque requirements. All external screws and fasteners shall be made of 316 stainless steel.

F. Bearings: The impeller and motor shaft for each pump shall be suspended on two permanently lubricated ball bearings that are designed by the manufacturer. The motor bearings shall be sealed and permanently lubricated with high temperature grease. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

2.03 MOTOR AND CABLE

A. The motor shall be housed in an air-filled chamber, watertight enclosure. The motor shall conform to NEMA design Class B, and incorporate minimum Class H insulation material to withstand a continuous operating temperature of 155° C (311°F), and provide a Class B Temperature Rise. The pump and motor shall be capable of handling liquids with a maximum temperature of 40°C (104°F). The motor shall be capable of sustaining up to 10 evenly spaced starts per hour. The motor shall be capable of operating in dry or partially submerged conditions for extended periods without damage.

B. The pump cooling system, if required, shall be a self-contained closed loop cooling system or open system using pumped media for cooling. The motor shall be cooled via a high purity mineral oil or water/glycol cooling medium circulated through a jacket surrounding the air-filled motor cavity. The cooling medium shall be circulated by an impeller mounted on the pump/motor shaft. The cooling jacket shall surround the entire motor including the top and down the length of the motor. The cooling medium circulation impeller shall cause the cooling fluid to move through the jacket from which it picks up heat from the motor. This heat is then directed into the internal heat exchanger that transfers the heat to the pumped liquid. The heat exchanger shall be located below the sealing chamber. It shall be provided with a labyrinth design channel system such that sufficient contact time is maintained in the heat exchanger to allow for continuous pump operation without overheating. Cooling system shall enable the pump to work continuously at rated output regardless of whether the motor is above or below the surface of the liquid, including operation of VFD where pump may be run continuously at lower levels.

C. Motors shall be designed for use with solid state reduced voltage starter (SSRVS).

D. The SSRVS and motor shall be completely compatible electrically. The SSRVS Manufacturer and the Motor Manufacturer shall together issue a letter of compatibility at the time Shop Drawings are submitted.

E. The nameplate motor service factor shall be at least 1.15. The motor shaft shall be 400 series stainless steel.

F. If a larger motor than that listed in the schedule in section 3.04 of this section is proposed as an alternate, the Contractor shall be responsible for all modifications required to the electrical system, including starters, feeders to the equipment, feeders from the utility company, switch gear, etc. at no additional cost to the Owner.

G. The motors shall be 460 volt, 3 phase, 60 cycle. The motor rated RPM speed will match that of the pump such that no gear or speed reducer is required. Lead wires shall be suitable for operation in oil. Motor shall be designed for use with solid-state reduced voltage soft-starter and across-the-line starter.

H. The motor shall be provided with Klixon motor thermal switches embedded in the windings to protect the motor from burnout due to excessive heating. Inrush on starting shall be no more than allowed by NEC Code Letter F for motors larger than 100HP, and no more than allowed by NEC Code Letter G for motors 100HP and less.

I. Each motor shall be suitable for use in a NEC Class 1, Division 1, Group D location and be U.L. or C.S.A. listed. The motor shall have moisture detector with normally open (N.O.) dry contact. Refer to Division 26 for other electrical requirements.

J. The electrical cable entrance to the motor shall be provided with positive strain relief to prevent leakage or pullout of the cable in the event that a force is accidentally placed on the cable during the raising or lowering of the pump. The design of cable entry shall preclude specific torque requirements to ensure a watertight and submersible seal. Each pump shall be equipped with adequate cable to be routed from the termination junction box to the pump without any splices. The entry cable system shall be warranted as described in Section 1.07 WARRANTY.

K. Wire leads entering the junction box chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Alternately, the junction box chamber shall be sealed from the motor with a poured epoxy seal with bared conductor to prevent wicking. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Sufficient cable shall be supplied to extend from the motors to the pump control without splicing. Each pump shall be equipped with adequate cable to be routed from the pump controller to the pump without any splices at a minimum. The power cable shall be sized according to NEC and ICEA standards and also meet P122-MSHA approval and this classification shall be embossed on the cable. The cable entry junction chamber shall be isolated from the motor by a terminal board. Manufacturer standard sealing process, if superior to this requirement, shall be acceptable if approved by Engineer during the submittal review.

L. The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression seals (O-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board each with an individual O-ring to prevent liquid passage.

M. The motor, cable, and electrical controls shall be sized, furnished, and installed so that the motor shall never exceed the nameplate rating at any point on the pumping curve and for the maximum amperage when the motor is in the 1.15 service factor.

N. Provide stainless steel cable strain relief on each cable at wet well roof slabs.

O. Each unit shall have motor seal failure sensor(s) which shall be field wired to a pump monitor. The pump monitor shall be provided by the pump supplier and shall be shipped to the SSRVS supplier. Refer the Pump Control Schematic drawing for additional information.

2.04 DISCHARGE ELBOW AND GUIDERAIL BASE

A. A discharge elbow and guiderail base shall be provided for each pump and shall be permanently installed in the wetwell. Anchor bolt design is the sole responsibility of the pump manufacturer.

B. AISI 316 Stainless steel anchor bolts embedded in concrete (pump station bottom slab) in accordance with pump manufacturer's layout and recommendations shall secure these connections. Anchor bolts embedded in only the base's grout will not be accepted.

2.05 GUIDERAIL AND LIFTING CHAIN

A. The guiderails and lifting chain positive recovery system shall be sized by the pump supplier. Guiderails and lifting chains shall be constructed of stainless steel. Intermediate and upper guiderail brackets shall be provided by the pump supplier to achieve the arrangement shown on the Plans.

B. The slide rails shall be continuous Schedule 40 ANSI 316 stainless steel designed to resist corrosion in sewage applications. Any joints in the rails shall be reinforced from within if pipe is used; continuously full-depth welded, ground smooth, and treated to resist corrosion. If pipe is used, it shall be minimum Schedule 40. The rail system shall be of adequate length to extend from the lower guide holders on the pump discharge connection to 6" below the top of the wet well. The system shall be mounted with 316 stainless steel hardware. Systems utilizing guide cable are not acceptable. Guide rails must be non-sparking type.

C. The rail support system shall be furnished by the Pump Manufacturer, to adequately support the guide (slide) rails. Intermediate guide rail supports shall be used every 12 to 15 feet or as recommended by the pump manufacturer. The system shall be mounted with 316 stainless steel hardware.

D. Each pump shall be fitted with:

1. 316 S.S. cable and chain for use with Kellum cable grips.

2. All electrical cables shall be bundled together into a single unit so as to ease operator handling of the cables. The bundled cables shall be outfitted with three (3) single loop support grips. One support shall be used to restrain the cable at the surface while the pump is in the normal operating position. One support shall be placed on the pump end of the bundled cables and one support (upside down) at the center of the span for the bundled cables.

3. The chain support grips, chain and associated hardware shall have a minimum working load limit (WLL) of 1-1/2 times the total pump/motor weight.

2.06 SLIDING COUPLING SYSTEM

A. A sliding guide bracket shall be an integral part of the pumping unit or securely attached thereto. The guide bracket shall be designed such that no strain is placed on the pump or guide rails. The volute casing shall have a machined discharge flange to automatically and firmly connect with the discharge connection, which when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. Discharge base elbow and base plate shall be supplied by the Pump Manufacturer.

B. The pump sliding coupling system shall be designed so that the downward force of the machined mating flanges shall shear away rags, hair, or other debris that would prevent a uniform watertight seal. No portion of the pump unit shall bear directly on the floor of the wet well. The pump body and slide coupling mating faces shall be bronze against cast iron or cast iron with gasket against cast iron.

2.07 EXISTING ACCESS DOOR HATCHWAYS

The existing access doors will be used at Lift Station Nos. 10 and 25. Exposed concrete will be repaired and coated per Section 09 96 01 “Concrete Protective Coating”. Pump manufacturer will review existing access dimensions and notify engineer if any additional modifications are needed to accommodate proposed pumps. Safety grate will be provided for existing hatches per Section 08 31 00 “Floor Access Doors”.

The access manhole at Lift Station No. 15 will remain in place.

New access doors will be provided at Lift Station Nos. 4, 17, and 35 per Section 08 31 00 “Floor Access Doors”.

2.08 SPECIAL TOOLS

Furnish with the equipment, one (1) set of any special tools or devices required for the assembly, operation, and maintenance of all equipment furnished. All tools shall be of the non-sparking type.

2.09 PUMP PAINTING

Pumps, motors, base plates, discharge elbows, and guiderails shall be painted in accordance with Section 09 96 00.01 “High-Performance Coatings”.

2.10 PUMP MONITORS

A. Provide a motor stator and cable entry leak sensor for each pump. The sensor shall be as manufactured by Flygt, Crouzet model NR series, or approved equal.

B. Provide a motor stator temperature relay.

C. Provide a lower bearing sensor.

D. The pump monitors shall be shipped to the SSRVS manufacturer.

2.11 LEVEL SWITCHES AND LEVEL TRANSMITTER

Level switches and level transmitter shall be provided under Division 40.

2.12 PUMP CONTROLS

Pump Controls shall be located in the SCADA RTU cabinet (provided by the SCADA Integrator under Division 40) and the pump starters (provided by others under Division 26).

3.00 EXECUTION

3.01 INSTALLATION

Installation shall be in accordance with the Manufacturer's instructions. Any modification to the structure as a result of requiring different size access door hatchways is the responsibility of the Contractor.

3.02 FIELD QUALITY CONTROL

Upon completion of installation of the equipment, an acceptance test to verify the satisfactory operation of each unit shall be conducted. The Contractor shall provide the services of authorized representative to conduct all field tests. The test shall be conducted in a manner approved by and in the presence of the Engineer. The unit shall be checked for excessive noise, vibration, alignment, general operation, ease of removal, etc. All automatic and manual controls shall be tested to verify that they function in accordance with the requirements. Verify that drive equipment operates without being overloaded. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

3.03 PAINTING

Pumps, motors, baseplates, discharge elbows, and guiderails shall be painted in accordance with SECTION 09 96 00.01 “High-Performance Coatings” of these Specifications.

3.04 SCHEDULES

Characteristic	Lift Station No. 4 Condition Requirements	Lift Station No. 35 Condition Requirements
System Curve	Figure 1	Figure 2
Equipment No.	Pump Nos. 1, 2	Pump Nos. 1, 2
Number of Units	2	2
Fixed or Variable Speed	Variable Speed	Fixed Speed
Rated Point *	**Figure 1 – LS #4 System**	**Figure 3 – LS #35 System**
Total Firm Capacity (GPM)	1,455 gpm (max speed)	120 gpm
Total Head, TDH (ft.)	210 ft	21 ft
Hydraulic Efficiency at Rated Pt.	67% (min.)	50% (min.)
No. of Pumps in Parallel	1 (1 firm, 1 spare)	2 (1 firm, 1 spare)
Maximum Shutoff Head (ft.)	300 ft	38 ft
Maximum Horse Power (HP)	175 HP	5 HP
Maximum Speed (RPM)	1780	1760
Preferred Operating Region	70% through 120% of BEP	70% through 120% of BEP
Allowable Operating Region**	50% through 130% of BEP	50% through 130% of BEP
Minimum diameter of test sphere (in.)	3	3
NPSHa (Calculated based on the "All Pumps Off" elevation)	33.5 ft.	33.5 ft
Minimum Rated (Full Load) Motor (Uncorrected) Power Factor (%)	0.83	0.84
Minimum Rated (Full Load) Motor Efficiency (%)	0.947	0.851
Rated Motor Frequency (Hz)	60	60
Rated Motor Voltage (V)	460	460

*Rated operating points based on C-120 System Curve

*Lift Station No. 4 minimum speed must maintain a minimum 3 ft/s velocity in the existing 10-inch force main.

**Proposed pump(s) must be able to operate within its allowable operating region for Rated Points for all system curves indicated with the NPSHa.

PUMP SUBMITTAL DATA SHEET ATTACHMENT A

SUBMERSIBLE SEWAGE PUMPS

Submit the following data with Shop Drawings for each size of Pumping Unit for each lift station:

Submittal Data Sheet No. 1:

Lift Station No. ____		
Item No.	Description	**Pumps 1 and 2**
1	Make and Type Design	
2	Rated Speed	
3	Casing Material	
4	Impeller Diameter and Material	
5	Max. Impeller Diameter for Casing	
6	Diameter of Suction Flange	
7	Diameter of Discharge Flange	
8	Shutoff Head	
9	Diameter of Shaft at Impeller	
10	Maximum Brake Horsepower	
11	NPSH Required at Rated Head	
12	NPSH Required at Minimum Head	
13	Suction Specific Speed	
14	Specific Speed	
15	Minimum Hatch Size for Removal	

1	Complete Pumping Unit	

MOTOR SUBMITTAL DATA SHEET ATTACHMENT B

SUBMERSIBLE SEWAGE PUMPS

Submit the following data with shop drawing submittal for each size and type of Motor:

Equipment Number(s) _____

Manufacturer		Motor HP	
Frame Size		Enclosure Type	
Type		RPM	
Voltage		Phase	
Starting Method		Hertz	
Duty		Insulation Class	
Full Load Amps			
No Load Amps			
No Load Power Factor			
Locked Rotor Amps at Rated Voltage		Maximum Thrust Rating	
Locked Rotor Torque		% Breakdown Torque	
Locked Rotor KVA/HP		Rotor WK2 (lb-ft2)	

NEMA Design _____
Service Factor _____
Inrush Current (% of Full Load) _____
Max Safe Stalled Time (seconds) _____
Number of Safe Starts Per Day _____
Number of Consecutive Starts _____

*Full Load Temp Rise, in Degree Celsius over 50 Celsius Ambient (at 1.0 S.F.) _____
*Service Factor Temp Rise, in Degree Celsius over 50 Celsius Ambient (at 1.15 S.F.) _____
*Limiting Temperature Rise _____

	Efficiency	Power Factor	Current
1.15 S.F. Load			
4/4 Load			
3/4 Load			
1/2 Load			
1/4 Load			

Maximum KVAR allowed for Power Factor Correction without overexciting the motor _____

END OF SECTION

FIGURE 1

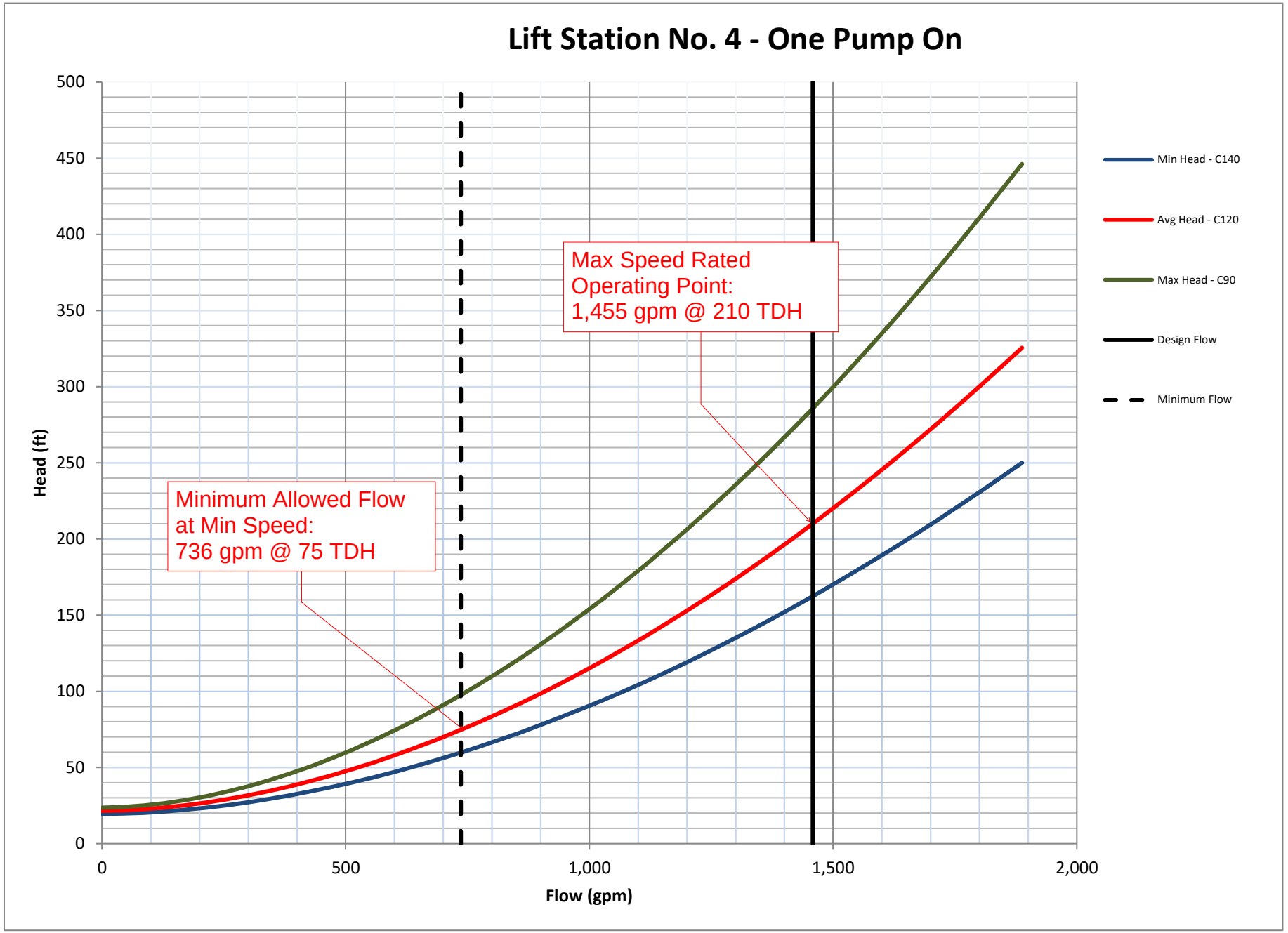
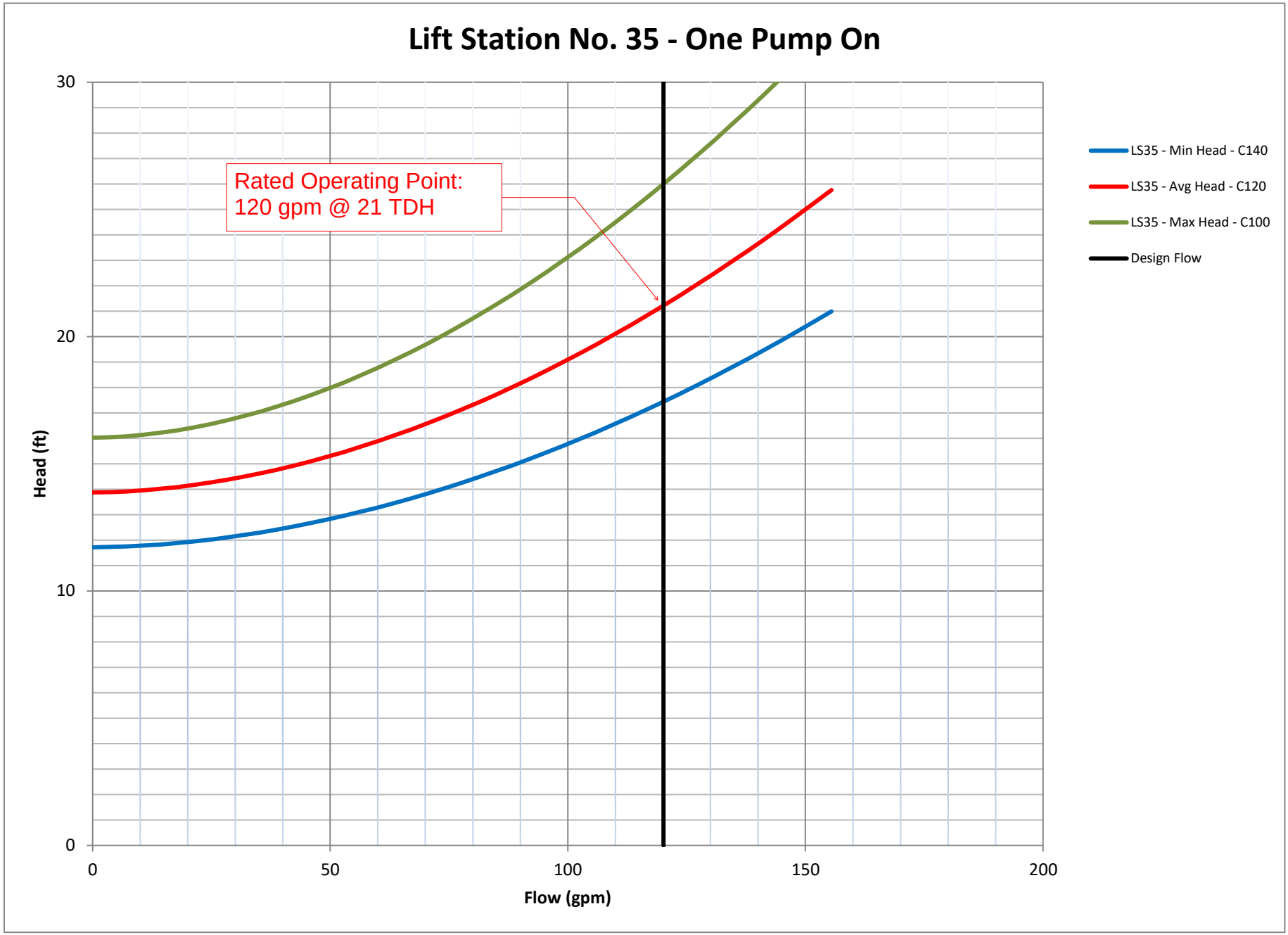

Lift Station No. 4 - One Pump On
Head (ft)
Flow (gpm)
0
50
100
150
200
250
300
350
400
450
500
0
500
1,000
1,500
2,000
Max Speed Rated
Operating Point:
1,455 gpm @ 210 TDH
Minimum Allowed Flow
at Min Speed:
736 gpm @ 75 TDH
Min Head - C140
Avg Head - C120
Max Head - C90
Design Flow
Minimum Flow

FIGURE 2


Lift Station No. 35 - One Pump On
Rated Operating Point:
120 gpm @ 21 TDH
Head (ft)
Flow (gpm)
0
10
20
30
0
50
100
150
200
LS35 - Min Head - C140
LS35 - Avg Head - C120
LS35 - Max Head - C100
Design Flow

44 42 56.09 SELF-PRIMING NON-CLOG CENTRIFUGAL PUMPS

1.00 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, materials, equipment and incidentals necessary to install two (2) horizontal self-priming centrifugal non-clog sewage pumps at Lift Station No. 15 and Lift Station No. 17.

B. The pumping units furnished will be complete with pumps, drives, bases, anchorages, belts, suction vacuum gauge, discharge pressure gauge, air release valve and any other appurtenances required for a complete installation as specified herein. Equipment furnished and installed under this Section will be assembled, erected and placed in proper operating condition in full conformity with the Plans, Specifications, engineering data, and instructions and recommendations of the Equipment Manufacturer as approved by the Engineer. Equipment manufacturer may not provide skid that includes valves and piping, and may not provide valves and piping as part of a package unit.

C. The system configuration for each lift station is as follows:

1. Lift Station No. 15 existing 6-inch asbestos concrete discharge force main carries flow to a manhole upstream of Lift Station No. 16. Flow and pressure measurements taken on the existing discharge pipe indicate that the existing force main is in poor condition. The self-priming centrifugal pumps for Lift Station No. 15 must be sized for the head condition of existing condition of the force main, with the ability to meet the condition of a new / rehabilitated force main with the change of belt and sheaves.

2. Lift Station No. 17 existing 6-inch asbestos concrete discharge force main carries flow to a manhole upstream of Lift Station No. 16. The existing force main is being replaced along the same alignment with this project. Proposed pumps are sized for use with the new force main. Proposed pumps are sized for use with the new force main, which must be installed prior to bringing the new pumps online.

D. For this specification section, the Equipment Manufacturer is defined as the Pump Manufacturer or their designated representative. The Equipment Manufacturer is responsible for supplying and coordinating the design, testing, and installation of the pumps and motors. To ensure compliance with this paragraph the motors must be provided by the Equipment Manufacturer as a package unit with the pumps. The Equipment Manufacturer will be responsible for the adequacy and compatibility of the pump and motor.

E. The pump supplier must also provide all the maintenance required for the first year of operation including the following as a minimum:

1. After 60 days of operation, run each pump and record voltage and amperage, open the volute of each pump and examine the condition of the volute, impeller, and wear rings. Check condition of coating system on motor housing and of the belt and sheaves. Perform any necessary repair under terms of the warranty. Prepare a field service report.

2. After 12 months operation, repeat procedure described above. Change oil in the seal chambers.

F. This project is subject to the American Iron and Steel (AIS) requirements of Section 608 of the Federal Water Pollution Control Act. All iron and steel products for construction, alteration, maintenance, or repairs incorporated in these plans must be produced in the United States.

1.02 QUALITY ASSURANCE

A. Contractor is responsible for providing a complete and working system for Lift Station No. 37 that meets the design conditions as set forth in the contract documents. If the system provided done not meet the design conditions as identified in the plans and specifications, a complete working system replacement system will be provided at no expense to the Owner.

B. Design Criteria:

1. Pump Performance Requirements:

Location	Lift Station No. 15	Lift Station No. 17
Pumped Fluid	Wastewater	Wastewater
Number of units	2	2
Fixed or Variable Speed	Fixed	Fixed
Pump Suction Size / Pipe Suction Size	4” / 6”	4” / 4”
Pump Discharge Size / Pipe Discharge Size	4” / 4”	4” / 4”
System Curve	Figure 1	Figure 2
Rated Point * Total Firm Capacity (GPM) Total Head, TDH (ft.) Hydraulic Efficiency at Rated Pt. No. of Pumps in Parallel	 342 gpm 38 ft 50% (min.) 2 (1 firm, 1 spare)	 271 gpm 28 ft 50% (min.) 2 (1 firm, 1 spare)
Minimum shutoff head	50 ft	35 ft
Maximum NPSHr (for ALL operating conditions)	18.12’	12.85’
NPSHa (Calculated based on the “All Pumps Off” elevation)	20.12’	14.85’
Maximum motor horsepower (max speed)	10 HP	5 HP
Maximum suction lift	11.77’	15.59’
Minimum Rated (Full Load) Motor (Uncorrected) Power Factor (%)	0.89	0.89
Minimum Rated (Full Load) Motor Efficiency (%)	0.88	0.88
Rated Motor Voltage (V)	460	460

*Rated operating points based on the following curves for the given lift station: LS15/C-105; LS17/C-120. Proposed pump (s) must also be able to operate within their allowable

operating region for all system curves indicated in Figure 1 thru Figure 2 for the NPSHa indicated in the above table.

2. Each pump, within its rated speed range, will be designed to retain adequate liquid in the pump casing to ensure unattended automatic repriming in a complete open system. No auxiliary priming apparatus including priming lines from a separate water source are acceptable. Upon completion of repriming cycle, pumps will deliver full rated capacity at rated TDH at the designated total dynamic suction lift.

    a. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, will be submitted for approval prior to shipment.

3. All motors will conform to the design, construction and performance requirements of the National Electric Manufacturers Association (NEMA) as may be applicable for the intended service. The nameplate horsepower rating of the motor will not be exceeded at any point on the pump's operating curve for the maximum speed of the drive unit.

C. Manufacturer's Representative for Startup and Testing: The services of the Manufacturer's technical representative will be provided for pre-startup installation checks, startup assistance, training of Owner's operating personnel, troubleshooting and other services as required in Section 01 75 00 "Starting and Adjusting" and as described below.

1. The minimum time required to be on-site for 8 hours/day, not including travel time, is as follows: A minimum of 3 days (3 trips minimum to perform the services listed in 1.01.F). This includes checking pump and motor installation, pump start-up and testing, troubleshooting, and personnel training.

2. If additional time is required, the factory representative must be available regardless of the number of trips and time required for each activity.

D. Manufacturer must have a minimum of five (5) successful projects completed with the Owner and a minimum twenty (20) years' experience.

E. The pumps and pump station manufacturer must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.

F. The pumps and pump station manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability by the use of best management practices, technological advances, promoting environmental awareness and continual improvement.

G. Manufacturer must show proof of original product design and testing. Products violating intellectual property regulations shall not be allowed, as they may violate international law and expose the user or engineer to unintended liabilities. "Reverse-engineered" products fabricated to substantially duplicate the design of original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design, which may contribute to product failure.

1.03 SUBMITTALS

A. Submittals will be in accordance with Section 01 33 00 “Document Management” and will include:

1. Shop Drawings: In addition to other specified requirements, shop drawings will include the following:

   a. Details on the Plans are dimensioned according to the specified pump. If a pump is proposed having different dimensions and thus changing the layout dimensions of the Plans, but is otherwise acceptable, submit with the shop drawings a revised piping layout for the Engineer’s approval.

   b. Shop drawings will include a complete description of the equipment offered including control and mounting system. Shop drawings will include catalog cuts and pertinent engineering data required to fully evaluate the equipment. Characteristic curves will be submitted with the shop drawings showing the capacity, head, efficiency, and brake horsepower throughout the full operating range of the pump. Complete specifications on the control equipment including a list of optional features will be submitted with the shop drawings. Submittal data will be in such form and so presented that the Engineer may readily review the data**.**

   c. Manufacturer must furnish evidence of having an authorized fully staffed and stocked service facility within 200-mile radius of the jobsite as well as having 24 hour parts availability. If manufacturer cannot meet one or both of these requirements, a detailed plan on how customer service and maintenance will be provided must be submitted for approval.

   d. Data sheets supplying the following information for the pumping units will be submitted with the shop drawings.

      a). Pump Manufacturer

         1) Characteristic Curves (capacity, head, efficiency, recommended operating range indicated on curves, motor curves, required NPSH and brake horsepower throughout the operating range of the pump from shut off to maximum specified operating capacity. Characteristic curves will have the capacity plotted as abscissa and the operating head, brake horsepower, efficiency and required NPSH plotted as ordinates.)

         2) Data Sheet: Fill out and submit with the Shop Drawing submittal the information requested on the Pump Submittal Data Sheet (Attachment A)

      b). Motor Manufacturer will supply documentation for the motors as follows

         1) Letter of Compatibility: The soft starter supplier in conjunction with the pump/motor supplier will issue a letter of compatibility stating that the soft starter and motor are compatible.

         2) Data Sheet: Fill out and submit with the Shop Drawing submittal the information requested on the Motor Submittal Data Sheet (Attachment B)

         3) Rated full load horsepower

         4) Rated volts

5) Number of phases

6) Frequency in hertz

7) Full load amperes (FLA)

8) Motor no load data (i.e. amps, power factor, etc.)

9) Locked rotor amperes (LRA) at rated voltage and Locked rotor KVA/HP.

10) Synchronous speed (srpm)

11) Guaranteed maximum slip at full load in percent

12) NEMA insulation system classification and description of manufacturer's method of application.

13) Temperature rise at rated full load by resistance temperature detector

14) Maximum ambient temperature for which motor is designed

15) Service factor

16) The limiting temperature rise by resistive temperature detector motor as design and corresponding horsepower

17) Bearing size and calculation

18) Safe stall time

19) Maximum acceleration time with NEMA standard Wk2 value, at rated voltage and at 90 percent of rated voltage

20) Number of safe starts in succession when starting from a 40 degree Celsius ambient, intermediate waiting periods, and other conditions for driving equipment with a NEMA standard Wk2 value

21) Efficiency at 1/4, 1/2, 3/4, full load; and service factor

22) Power factor at 1/4, 1/2, 3/4, full load; and service factor

23) Maximum kVAR allowed for power correction without overexciting the motor. Maximum allowed kVAR will be included on the motor nameplate as well.

24) Surge protection information, including mounting details

25) Thermistors literature with wiring diagram.

2. Operation and Maintenance Manuals.

   Manuals will be prepared by the equipment Manufacturer per Section 01 33 04 “Operation and Maintenance Data” and will incorporate storage and installation instructions and operation and maintenance procedures, appropriate final certified shop drawings, performance curves, and test data. Manuals may be Manufacturer's standard instructions, but will be supplemented as necessary to cover any special feature not included in standard material. Submit preliminary manuals for review prior to delivery of the equipment.

3. AIS certifications for any hardware and/or metal components incorporated within the submittal.

1.04 DELIVERY AND STORAGE

A. The Equipment Manufacturer will be responsible for delivery of the pump, motor, and accessories, f.o.b. to the job site or to such storage site as may be designated by the Owner or Construction Contractor, in good condition and undamaged.

B. Unloading and storage of the equipment will be the responsibility of the Construction Contractor who will inspect the equipment for apparent damage. Equipment which is found to be damaged will not be accepted until properly repaired or replaced by the Equipment Manufacturer.

C. The pumps, motors, and accessories will be stored indoors. When this equipment is stored indoors, it will never be in direct sunlight and the indoor temperature will be maintained at a level satisfactory to the Owner. The Contractor is responsible for providing the indoor storage facility or enclosure.

D. Furnish anchor bolts and necessary appurtenances as necessary to meet the Installation Contractor's schedule.

1.05 WARRANTY

A. The pump station manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written 5-year 100% warranty shall include specific details described below.

1. In addition to defects in material and workmanship are warranted 100% for sixty (60) months to be resistant to rust, corrosion, corrosive soils, effects of airborne contamination or physical failures occurring in normal service for the period of the pump station warranty. Pro-Rated or warranties lesser than 100% for 5 years shall not be acceptable.

2. All other equipment, apparatus, and parts furnished shall be warranted 100% for sixty (60) months, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, O rings, etc. The pump station manufacturer shall be solely responsible for warranty of the station and all components.

B. In the event of failure of any part or parts of the equipment and motors during the first two (2) years of service, provided that the pumps and motors have been operated and maintained in accordance with good practice, the Equipment Manufacturer will furnish, deliver and install the defective part or parts at the Equipment Manufacturer's own expense. Equipment Manufacturer is also responsible for pump removal, reinstallation and freight in the event of pump replacement at no expense to the Owner.

C. The first two (2) years of service will be interpreted as the twenty-four (24) month period following the installation, adjusting and acceptance testing, and the start of actual operation of the equipment.

D. At the one (1) year warranty and the two (2) year warranty inspection, the Owner and Equipment Manufacturer will together perform an equipment evaluation on each unit during the 11th and 23rd month of the warranty. This will be a complete electrical, mechanical, and hydraulic evaluation of the pumps and motors. The Equipment Manufacturer's cost for the equipment evaluations will be included in the price under this contract, and the coordination and scheduling of the annual equipment evaluation will be the responsibility of the Equipment Manufacturer. A detailed report will be produced by the Equipment Manufacturer after the evaluation describing the tests, data collected, and issues identified.

2.00 PRODUCTS

2.01 MANUFACTURED PRODUCTS

Approved Manufacturers

A. Gorman Rupp

B. Approved Equal

2.02 HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

A. The openings and passages of the pumps will be large enough to permit the passage of a sphere 3 inches in diameter and any trash or stringy material which can pass through the bar screen. The pumps will be equipped with a removable cover plate, allowing complete access to pump interior to permit the clearance of stoppages and to provide simple access for service and repairs without disturbing suction or discharge piping. Designs that require removal of complete cover plate assembly for access to the impeller will not be accepted.

B. Each pump will be fitted with a replaceable cast iron wear plate. Replacement of the wear plate, impeller and seal will be accomplished through a removable cast iron coverplate. The entire rotating assembly, which includes bearings, shaft, seal, and impeller will be removable as a unit without disturbing pump volute or piping.

C. The impeller will be two-vaned, untapered, semi-open, non-clog, cast in ductile iron with integral pump-out vanes on the back shroud and will thread onto a pump shaft of high carbon steel. Means will be provided for external adjustment of the impeller to the wear plate.

D. A solids management system including inspection cover, back cover plate with obstruction free flow path, and aggressive self-cleaning wear plate to clear eye of impeller during operation will be included for each pump.

1. A replaceable wear plate secured to the back cover plate by studs and nuts. Wear plate shall be self-cleaning design ensuring that debris is cleared away and does not collect on the impeller vanes.

2. The nature of the conveyed medium poses significant challenges to the continuous operation of the pump. Of particular concern is the clogging of the impeller by debris in the pumped medium including but not limited to long rags, fibers, and like debris which are able to wrap around the impeller vanes, stick to the center of the vanes or hub, or lodge within the spaces between the impeller and the housing.

3. The aggressive self-cleaning wear plate shall have integral laser cut notches and grooves in combination with a “tooth” designed to disturb and dislodge any solids which might otherwise remain on the impeller in dynamic operation. Wear plate is designed to constantly and effectively clear the eye of the impeller without the use of blades or cutters.

E. In consideration for safety, a pressure relief valve shall be supplied in the inspection cover plate. Relief valve shall open at 75-200 PSI.

F. One O-ring of Buna-N material shall seal inspection cover plate to back cover plate.

G. Two O-rings of Buna-N material shall seal back cover plate to pump casing.

H. The shaft will be covered and protected with a removable stainless steel sleeve. The shaft will be contained within a cast iron bearing pedestal of ample size to contain heavy duty ball thrust bearing and radial bearing of adequate size to withstand imposed loads. Bearings will be oil lubricated, with the bearing pedestal cooled by pumped liquid. The pump shaft will be sealed against leakage by a balanced mechanical seal. Both the stationary sealing member and mated rotating member will be tungsten-titanium carbide alloy.

I. The mechanical seal will be installed within a separate oil-filled reservoir of the pump pedestal, the oil being both lubricating and cooling media. The seal must be removable and replaceable through the cover plate opening. The pumps will incorporate molded one-piece suction check valves that can be removed or installed through the removable cover plate opening, without disturbing the suction piping. The pump volute casing will contain no openings of a smaller diameter than the sphere size specified.

J. Pumps will be V-belt operated and provided with V-belt bases fabricated of steel. The pump will be connected to the motor through belts and sheaves sized to provide the pump speed specified. Two spare sets of sheaves, belts, mechanical seals and bearings will be provided for each pump furnished. One spare wear plate will be provided for each pump furnished. Belts and sheaves will be covered with an OSHA guard.

K. The pumps will have cast iron bodies. Thrust bearing will be open ball and radial bearing will be open double ball with snap ring. Pump will come equipped with an oil level sight gauge, stainless steel pressure relief valve, a lift eye, an air release valve, suction line vacuum gauge, and discharge line pressure gauge.

L. An externally removable suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished from the top of pump without disturbing the suction piping or completely draining the casing. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

M. Pump shall include flange kit consisting of two ASA spool flanges that shall be one piece cast iron class 30 suitable for attachment to suction and discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

N. Serviceability

1. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs by incorporating the following features.
2. No special tools shall be required for replacement of any components within the pump.

2.03 MOTORS

A. Motors for the pumps will be horizontally mounted adjacent to the pumps. Motors will be induction type, 460-volt, 3-phase, 60-Hz, for across the line starting. Horsepower rating of motors will be as required for the applicable operating conditions and will not be less than elsewhere set forth in the specification.

B. Motors will have full Class F or better insulation. The motor insulation will be non-hygroscopic epoxy type premium grade.

C. When operating at the specified service factor and at rated voltage and frequency, the temperature rise for motors will not exceed those given in NEMA Standard MG1-12-42.

D. Locked-rotor currents for motors will not exceed those given in NEMA Standard MG1-12.34, and name plates will be marked with applicable Code Letters in accordance with NEMA Standard MG1-10.37.

E. Motors will have space heaters.

3.00 EXECUTION

3.01 INSTALLATION

Install the pumps in strict accordance with Manufacturer’s recommendations.

3.02 FIELD QUALITY CONTROL

Upon completion of installation of the equipment, an acceptance test to verify the satisfactory operation of each unit will be conducted. The test will be conducted in a manner approved by and in the presence of the Engineer. The unit will be checked for excessive noise, vibration, alignment, general operation, etc. The unit must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner. Field testing must prove satisfactory operation when Lift Station No. 1 is pumping, and when Lift Station No. 1 is not pumping.

3.03 SPARE PARTS KIT

A. There shall be furnished with the pumps the following minimum spare parts:

1. One spare pump mechanical seal (complete), and with it all gaskets, seals, sleeves, O rings, and packing required to be replaced during replacement of the seal.
2. One set of impeller clearance adjustment shims.
3. One set cover plate O ring.
4. One rotating assembly O ring.

PUMP SUBMITTAL DATA SHEET ATTACHMENT A

SUBMERSIBLE SEWAGE PUMPS

Submit the following data with Shop Drawings for each size of Pumping Unit for each lift station:

Submittal Data Sheet No. 1:

Lift Station No. ____		
Item No.	Description	**Pumps 1, 2**
1	Make and Type Design	
2	Rated Speed	
3	Horsepower required at rated head	
	Capacity	
3	Casing Material	
4	Impeller Diameter and Material	
5	Max. Impeller Diameter for Casing	
6	Diameter of Suction Flange	
7	Diameter of Discharge Flange	
8	Shutoff Head	
9	Diameter of Shaft at Impeller	
10	Maximum Brake Horsepower	
11	NPSH Required at Rated Head	
12	NPSH Required at Minimum Head	
13	Suction Specific Speed	
14	Specific Speed	
15	Minimum Hatch Size for Removal	

1	Complete Pumping Unit	

MOTOR SUBMITTAL DATA SHEET ATTACHMENT B

SUBMERSIBLE SEWAGE PUMPS

Submit the following data with shop drawing submittal for each size and type of Motor:

Equipment Number(s) _____

Manufacturer		Motor HP	
Frame Size		Enclosure Type	
Type		RPM	
Voltage		Phase	
Starting Method		Hertz	
Duty		Insulation Class	
Full Load Amps			
No Load Amps			
No Load Power Factor			
Locked Rotor Amps at Rated Voltage		Maximum Thrust Rating	
Locked Rotor Torque		% Breakdown Torque	
Locked Rotor KVA/HP		Rotor WK2 (lb-ft2)	

NEMA Design _____

Service Factor _____

Inrush Current (% of Full Load) _____

Max Safe Stalled Time (seconds) _____

Number of Safe Starts Per Day _____

Number of Consecutive Starts _____

*Full Load Temp Rise, in Degree Celsius over 50 Celsius Ambient (at 1.0 S.F.) _____

*Service Factor Temp Rise, in Degree Celsius over 50 Celsius Ambient (at 1.15 S.F.) _____

*Limiting Temperature Rise _____

	Efficiency	Power Factor	Current
1.15 S.F. Load			
4/4 Load			
3/4 Load			
1/2 Load			
1/4 Load			

Maximum KVAR allowed for Power Factor Correction without overexciting the motor _____

END OF SECTION

FIGURE 1

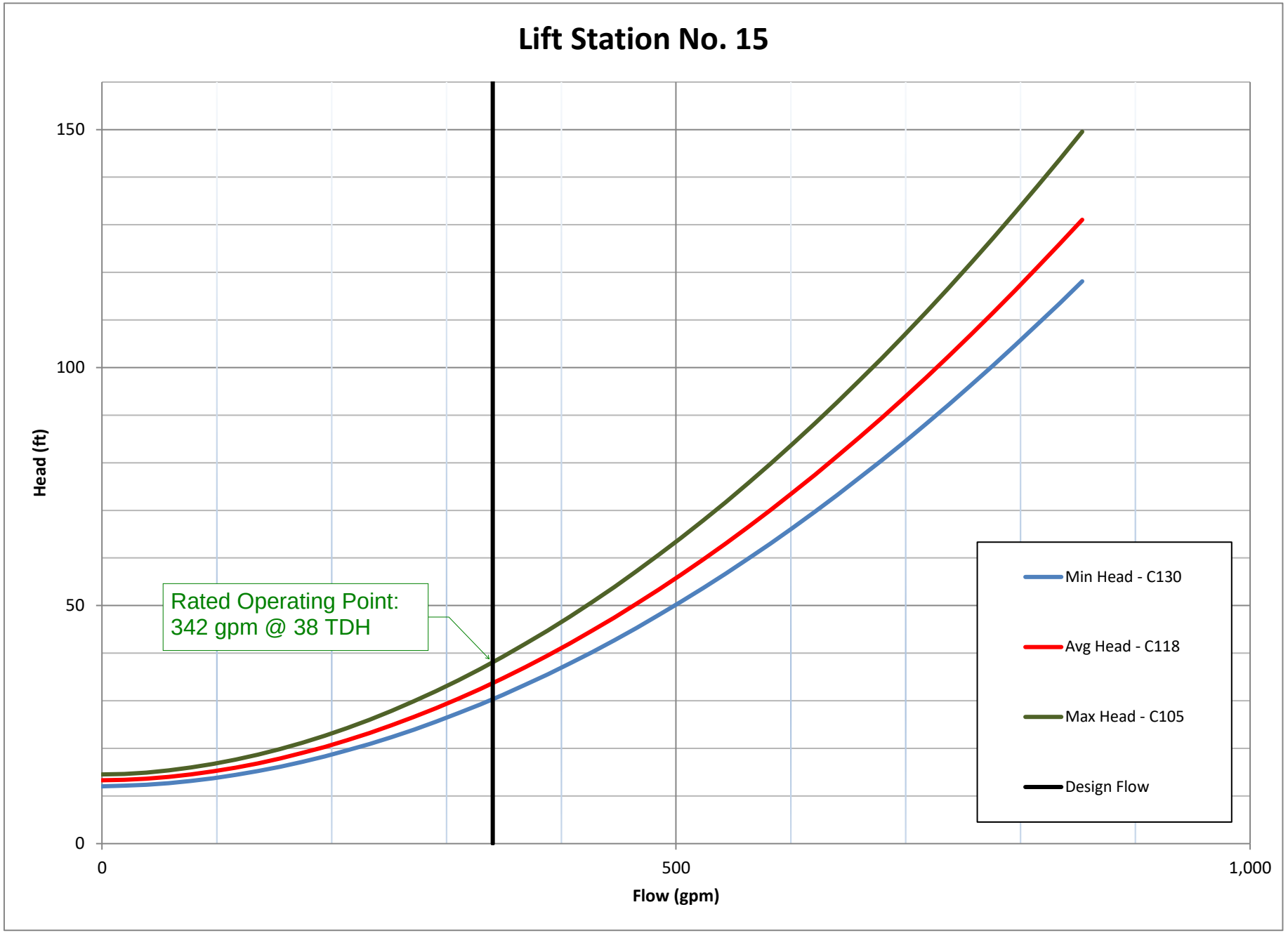
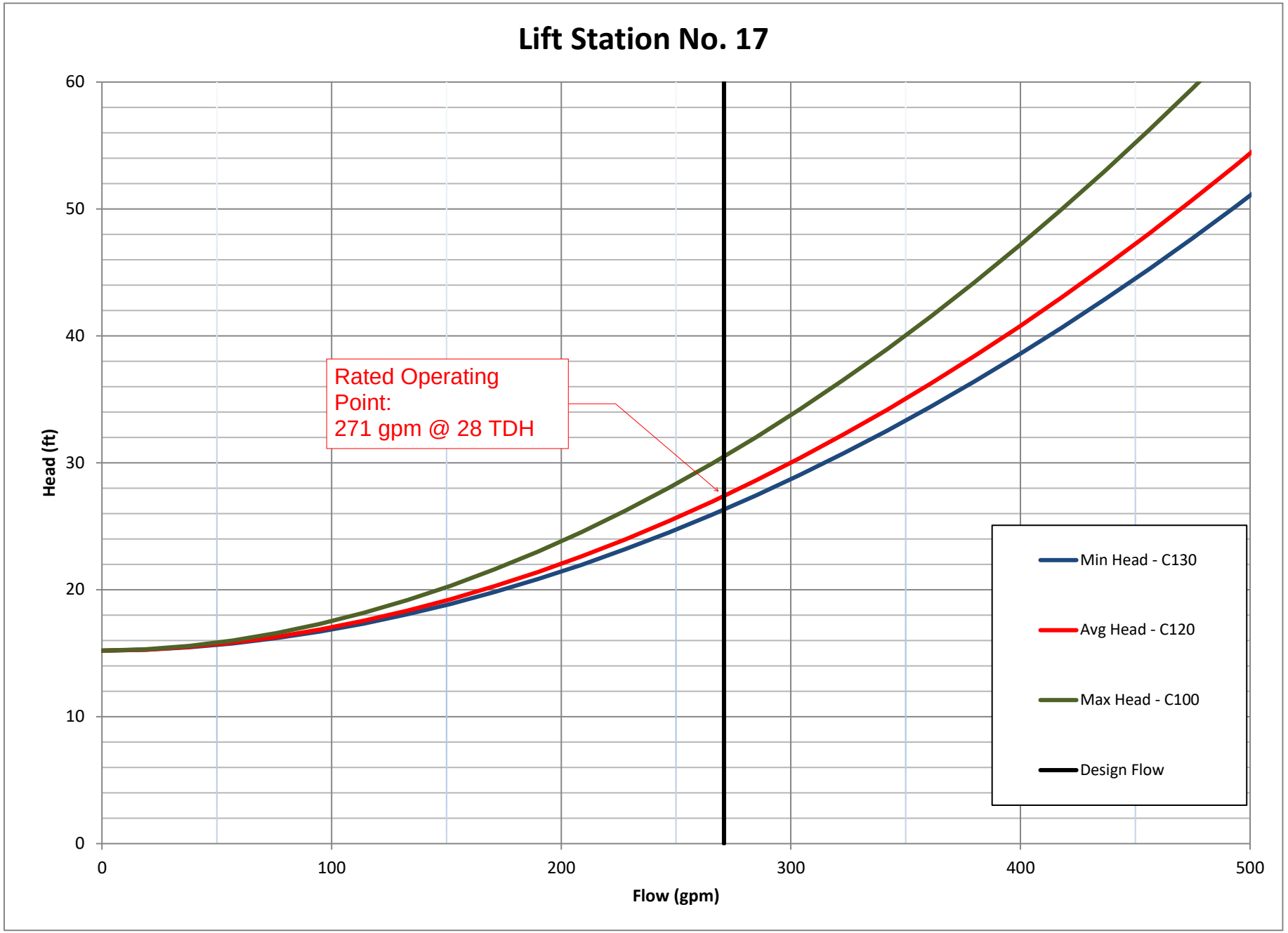

Lift Station No. 15
150
100
50
0
Head (ft)
0
500
1,000
Flow (gpm)
Rated Operating Point:
342 gpm @ 38 TDH
Min Head - C130
Avg Head - C118
Max Head - C105
Design Flow

FIGURE 2


Lift Station No. 17
60
50
40
30
20
10
0
Head (ft)
0
100
200
300
400
500
Flow (gpm)
Rated Operating Point:
271 gpm @ 28 TDH
Min Head - C130
Avg Head - C120
Max Head - C100
Design Flow

APPENDIX A

GEOTECHNICAL ENGINEERING REPORT

Proposed LMWD Utility Improvements
Port Isabel, Texas

PSI Project No. 03121857

PREPARED FOR:

Freese & Nichols
9601 McAllister Freeway, Ste. 1008
San Antonio, Texas 78216

August 2, 2019

BY:

PROFESSIONAL SERVICE INDUSTRIES, INC.
2020 N. Loop 499, Ste 302
Harlingen, Texas 78550
Phone: (956) 423–6826
Fax: (956) 423–5735

Professional Service Industries, Inc.
2020 N. Loop 499, Ste 302
Harlingen, TX 78550
Office - 956.423.6826

August 2, 2019

Freese & Nichols
9601 McAllister Freeway, Ste. 1008
San Antonio, Texas 78216

Attn: Ms. Jacqueline McMahon, E.I.T.

RE: GEOTECHNICAL ENGINEERING REPORT
PROPOSED LMWD UTILITY IMPROVEMENTS
PORT ISABEL, TEXAS
PSI Project No. 03121857

Dear Ms. McMahon:

Professional Service Industries, Inc. (PSI), an Intertek company, is pleased to submit this Geotechnical Engineering Report for the referenced project. This report includes the results of field and laboratory testing along with recommendations for use in preparation of the appropriate design and construction documents for this project.

PSI appreciates the opportunity to provide this Geotechnical Engineering Report and looks forward to continuing participation during the design and construction phases of this project. If there are any questions pertaining to this report, or if PSI may be of further service, please contact the PSI office.

PSI also has great interest in providing materials testing and inspection services during the construction of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.
Texas Board of Professional Engineers Certificate of Registration # F003307

Rockford Miller, E.I.T.
Project Manager
Geotechnical Services

Dexter Bacon, P.E.
Chief Engineer

August 2, 2019

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1.0 PROJECT INFORMATION

1.1 PROJECT AUTHORIZATION

Professional Service Industries, Inc., (PSI), an Intertek company, has completed a field exploration and geotechnical evaluation for the proposed Laguna Madre Water District (LMWD) Utility Improvements project to be constructed in various locations within Port Isabel, Texas. Mr. Charles Kucherka, P.E., representing Freese & Nichols, authorized PSI's services by issuing Subconsultant Authorization dated May 23, 2019, signed June 11, 2019 and with respect to the mutually agreed upon Master Subconsultant Agreement, signed on December 13, 2013.

1.2 PROJECT DESCRIPTION

Project information was provided by Ms. Jacqueline McMahon, E.I.T., with Freese & Nichols and included a revised Scope of Work for Geotechnical Investigation, that included information for a lift station wet well relocation near Lift Station No. 17 and force main installation for Lift Station No. 11.

The geotechnical recommendations presented in this report are based on the available project information, structure locations, and the subsurface materials described in this report. If any of the noted information or assumptions made are incorrect, please inform PSI so that the recommendations presented in this report can be amended as necessary. PSI will not be responsible for the implementation of provided recommendations if not notified of changes in the project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study is to evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations and guidelines for use in preparing the design and other related construction documents for the proposed project. The scope of services included drilling borings, performing laboratory testing, and preparing this geotechnical engineering report.

This report briefly outlines the available project information, describes the site and subsurface conditions, and presents the recommendations regarding the following:

- A review of surface topographical features, geologic features, and site conditions;
- Boring location plan and boring logs with laboratory test results of subsurface materials encountered including groundwater levels;
- Geotechnical discussion pertaining to subsurface conditions, variation of soil stratums and soil strengths, groundwater and other geotechnical related issues;
- Foundation and lateral earth pressure recommendations and anticipated buoyancy pressures for the proposed lift station, to include mat foundation systems and below-grade wall systems;
- General construction, excavation, trenching and backfill bedding material recommendations for the proposed force main construction, and;
- Seismic design site classification per the International Building Code.

The scope of services for this geotechnical exploration did not include an environmental, mold nor detailed seismic/fault assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or

around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 SITE DESCRIPTION

The following table provides a generalized description of the existing sites conditions based on visual observations during the field activities and other available information.

TABLE 2.1: SITE DESCRIPTION FOR LIFT STATION NO. 17 WET WELL

Site Location Description	Alley between W. Madison St. and W. Monroe St. Port Isabel, Texas WGS84 (26.07029°, -97.20763°)
Existing Site Conditions	LMWD Lift Station No. 17 to the north
Existing Grad/Elevation Changes	Gentle slope south
Existing Site Ground Cover	Grass
Ground Surface Soil Support Capability	Firm enough for field equipment

TABLE 2.2: SITE DESCRIPTION FOR LIFT STATION NO. 11 FORCE MAIN

Site Location Description	Woodys Lane Port Isabel, Texas (26.06398°, -97.22233°)
Existing Site Conditions	NE corner of existing WWTP lagoon
Existing Grad/Elevation Changes	Relatively level
Existing Site Ground Cover	Pavement
Ground Surface Soil Support Capability	Firm enough for field equipment

2.2 FIELD EXPLORATION

Field exploration for the project consisted of drilling a total of two (2) borings. The boring design element, boring labels, and approximate depths are provided in the following table.

TABLE 2.3: FIELD EXPLORATION SUMMARY

Design Element	Boring Label	Approx. Depth of Boring
Lift Station No. 17 Wet Well	B-1	40 feet
Lift Station No. 11 Force Main	B-2	20 feet

The boring locations were selected by PSI personnel and were located in the field using available landmarks and GPS coordinates using a recreation-grade device. Elevations of the ground surface at the boring locations were not provided to PSI and should be surveyed by others, if required. Therefore, the references to elevations of various subsurface strata are based on depths below existing grade at the time of drilling. The approximate boring locations are depicted on the Boring Location Plan provided in the Appendix.

TABLE 2.4: FIELD EXPLORATION DESCRIPTION

Drilling Equipment	Truck-Mounted Drilling Equipment
Drilling Method	B-1: Mud Rotary Wash B-2: Straight Flight Augers
Drilling Procedure	Applicable ASTM and PSI Safety Manual
Field Testing Procedures	Hand Penetrometer Standard Penetration Testing (ASTM D1586)
Sampling Procedure	Split Barrel Sampling of Soils (ASTM D1586)
Frequency of Groundwater Level Measurements	Initial Reading, Delayed Reading and After Drilling Reading
Boring Backfill Procedures	Soil Cuttings, Bentonite Pellets and Asphalt Patch on B-2
Sample Preservation and Transportation Procedure	General accordance with ASTM D4220

During the field activities, the encountered subsurface conditions were observed, logged, and visually classified (in general accordance with ASTM D2488). Field notes were maintained to summarize soil types and descriptions, water levels, changes in subsurface conditions, and drilling conditions.

2.3 LABORATORY TESTING PROGRAM

PSI supplemented the field exploration with a laboratory testing program to determine additional engineering characteristics of the subsurface soils encountered. The laboratory testing program included:

- Moisture Content Tests (ASTM D2216);
- Atterberg Limits (ASTM D4318); and,
- Material Finer than No. 200 (ASTM D1140).

The laboratory testing program was conducted in general accordance with applicable ASTM test methods. The results of the laboratory tests are provided in the Appendix on the Logs of Boring. Portions of samples not altered or consumed by laboratory testing will be retained for 60 days from the date shown this report and will then be discarded.

2.4 SITE GEOLOGY

B-1 - Lift Station No. 17 Wet Well Location:

As shown on the Geologic Atlas of Texas, McAllen-Brownsville Sheet, reprinted in 1979, the site is located in an area where the **Alluvium Deposits (Qam)** formation is mapped at or near the ground surface. The Alluvium Deposits are floodplain deposits of the lower course of Rio Grande and are divided into areas dominantly silt and sand. The deposits consist mainly of clay, silt, sand, gravel, and organic matter. The silt and sand are calcareous and dark gray to dark brown in color. The sand is mostly quartz with gravel along the Rio Grande including sedimentary rocks from the Cretaceous and Tertiary periods and a wide variety of igneous and sedimentary rocks from Trans-Pecos Texas, Mexico and New Mexico including agate.

B-2 - Lift Station No. 11 Force Main Location:

As shown on the Geologic Atlas of Texas, McAllen-Brownsville Sheet, reprinted in 1979, the site is located in an area where the **Windblown Deposits (Qcd)** is present at or near the ground surface. The formation is from the mid-Holocene Epoch. This formation consists of clay dune and clay-sand dune deposits. Clay, silt, and sand ranging from mostly clay and silt in coastal areas to a mixture of clay, silt and sand inland. The engineering properties are consistent with low compressibility, low shrink-swell potential, good to fair drainage, high shear strength and low plasticity.

2.5 SUBSURFACE CONDITIONS

The results of the field and laboratory testing have been used to determine an anticipated generalized surface profile of the project site. The following subsurface descriptions are of a generalized nature to highlight the major subsurface stratification features and material characteristics. This soil profile descriptions have been summarized in the following tables.

TABLE 2.5: GENERALIZED SOIL PROFILE: B-1 - LIFT STATION NO. 17 WET WELL LOCATION

Layer	Depth of Layer (ft)		Soil Type	Avg. ω (%)	Avg. LL (%)	Avg. PI	Avg. % Pass. #200	Avg. SPT Value
	Top	Bot.						
1	0	5	Clayey Sand	10	-	-	14	9
2	5	9	Poorly Graded Sand w/ Clay	25	-	-	8	3
3	9	19	Lean Clay w/ Sand	32	35	17	79	1
4	19	29	Fat Clay	39	62	34	100	2
5	29	34	Lean Clay	30	26	7	91	3
6	34	40	Fat Clay	40	68	38	97	1

Note: ω: Moisture Content, LL: Liquid Limit, PI: Plasticity Index, SPT: Standard Penetration Test (blows/ft)

TABLE 2.6: GENERALIZED SOIL PROFILE: B-2 - LIFT STATION NO. 11 FORCE MAIN LOCATION

Layer	Depth of Layer (ft)		Soil Type	Avg. ω (%)	Avg. LL (%)	Avg. PI	Avg. % Pass. #200	Avg. SPT Value
	Top	Bot.						
1	From bottom of Flexible Base	5	Lean Clay	19	32	10	89	8
2	5	14	Lean Clay w/ Sand	25	31	9	82	2
3	14	20	Lean Clay	29	45	26	92	5

Note: ω: Moisture Content, LL: Liquid Limit, PI: Plasticity Index, SPT: Standard Penetration Test (blows/ft)

The boring logs included in the Appendix should be reviewed for information at the boring locations. The boring logs include soil descriptions, stratifications, locations of the samples, and field and laboratory test data. The stratifications shown on the boring logs only represent the conditions the specific boring location and represent the approximate boundaries between subsurface materials. The actual transitions between strata may be more gradual or more distinct. Variations will occur and should be expected across the site.

2.5.1 GROUNDWATER INFORMATION

Water level measurements were performed during drilling and after completion of drilling. Specific information concerning groundwater is noted on each boring log presented in the Appendix of this report. The groundwater measurements are summarized in the following table.

TABLE 2.7: GROUNDWATER LEVELS (DEPTHS)

Boring Designation	Boring Depth (feet)	During Drilling (feet)	After Drilling (feet)	10 min Delayed (feet)
B-1	40	5	-	4
B-2	20	10	11	-

Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. In relatively pervious soils, such as sandy soils, the indicated depths are considered to be a relatively reliable indicator of groundwater levels. In relatively impervious soils, however, water levels observed in the borings even after several days may not provide reliable indications of groundwater table elevations. If more detailed water level information is required, observation wells or piezometers could be installed at the site, and water levels could be monitored.

The groundwater levels presented in this report are the levels that were measured at the time of our field activities. It is recommended that the contractor determine the actual groundwater levels at the site at the time of the construction activities to determine the impact, if any, on the construction procedures. The contractor should be prepared to control groundwater, if encountered, during construction.

3.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

3.1 GEOTECHNICAL DISCUSSION

The geotechnical exploration was performed for a proposed wet well replacement at LMWD Lift Station No. 17 and a proposed new 18-inch diameter force main line to replace an existing 12-inch diameter force main that will be abandoned in place. The soil conditions located at the proposal wet well are composed of granular soils over soft cohesive soils and the groundwater table was approximately 4 feet below existing grade. The soil conditions located at the proposed force main are composed of firm cohesive soils over soft cohesive soils and the groundwater table was approximately 10 feet below existing grade. Dewatering activities will be required at the location of the proposed wet well for the construction of the mat foundation and below grade wall structure. For the proposed force main trench shoring and control of groundwater will likely be required construct the force main line pipe.

Based upon the information gathered from the soil borings and laboratory testing, PSI is providing recommendations for a mat foundation system and below grade wall system for the development of the new lift station and associated appurtenances. In addition, PSI is providing shoring considerations, pipe bedding considerations and backfill compaction requirement for the development of the in force main.

The following design recommendations have been developed based on the previously described project characteristics and subsurface conditions encountered. If there are changes in the project criteria, PSI should be retained to review the changes to determine if modifications of the recommendations presented in this report will be required. The findings of such a review will be presented in a supplemental report. Once final design plans and specifications are available, a general review by PSI is recommended to verify that the earthwork and foundation recommendations presented in this report have been properly interpreted and implemented within the construction documents.

3.2 LIFT STATION FOUNDATION AND BELOW GRADE WALL DESIGN RECOMMENDATIONS

3.2.1 MAT FOUNDATION RECOMMENDATIONS

PSI recommends that the lift station be supported on a conventional mat foundation bearing on the natural soils and/or compacted structural select fill as noted in the following table. Since the founding depth of the mat foundation is to set below the groundwater table, the development of a dewater operations plan will need to be developed for the construction of the mat foundation.

In addition, consideration needs to be taken into account of the upward buoyancy pressures that are going to be applied to the lift station since the base of the lift station is about 20 feet below the groundwater table. These uplift pressures are often resisted by increasing the width of the mat foundation so that a portion of the mat has passive soil resistance from the overlying soils. Increased uplift capacity can also be accomplished by increasing the thickness of the mat and walls to increase the weight of the structure.

The following table contains the allowable bearing pressure for a mat foundation that can be used for design of the proposed structure.

TABLE 3.1: MAT FOUNDATION DESIGN PARAMETERS

Foundation Depth Range	20 to 25 feet below final adjacent grade
Design Buoyancy (Uplift) Pressure	2,000 psf
Allowable Bearing Pressure	1,000 psf
Approximate Settlement	Less than 1 inch
Modulus of Subgrade Reaction (k_1)	70 pci
Sliding Resistance (ultimate)	Utilize a coefficient of friction of 0.2 between the base of the foundation element and underlying material
Passive Resistance (ultimate)	An equivalent fluid weighing 220 pcf may be used to resist lateral forces
Uplift Resistance (ultimate)	Utilize the weight of the foundation concrete and the soil above it. The ultimate uplift resistance can be based on effective unit weights of 110 and 150 pcf for soil and concrete, respectively
Exposed Subgrade Treatment	Remove 12 inches of existing replace below bottom of mat and replace with 12" CLSM (flowable fill) mudmat
Dewatering required	Yes, wells or well pointing will be required since bottom of lift station is approximately 20 feet below the gwt

3.2.2 BELOW GRADE WALL DESIGN RECOMMENDATIONS

Conventional concrete below grade walls may be utilized to support the lift stations wet well walls planned at the subject site. The following tables provide general requirements for the design and installation of below grade walls at the subject site.

The walls should be designed to resist lateral earth pressures. Equivalent lateral earth pressure values for both at rest and active earth pressure conditions are shown in the following tables. At-rest values should be use for lift station wall design. The walls should also be designed for additional lateral loads due to any slopes behind the wall, hydrostatic pressures, surcharges and live loads. Lift Station walls are typically designed utilizing at-rest earth pressures.

- The earth pressure values for the above water table condition correspond to the total unit weight of soil. The earth pressure values below the groundwater table correspond to the buoyant or submerged unit weight of soil.
- Drainage systems should be provided near, or at the base of walls to collect and remove groundwater and minimize the potential for a buildup of hydrostatic pressure on the walls. If provisions to prevent accumulation of water behind the walls are not provided, the walls should be designed to resist the hydrostatic head in addition to the buoyant lateral earth pressures. The hydrostatic pressures should be accounted for the full height of the wall. Additional direction is provided below.
- Any additional lateral loads due to surcharge and live loads should also be included in the design. The lateral pressure on the wall due to a uniform surcharge load can be taken as earth pressure coefficient values multiplied by the surcharge pressure. PSI should be contacted to assess the earth pressures, if any structures are located within the close proximity of the below grade walls.

- **Fat CLAY (CH) soils are not recommended for use as backfill material behind the wall.**
- **Coarse materials are the preferred type of backfill to be used during construction.**

TABLE 3.2: LATERAL EARTH PRESSURE COEFFICIENTS

Type of Backfill Behind the Retaining System (Free of organics, other deleterious materials)	Soil Parameters	At-Rest Condition (Backfill)
Lean Clay (CL) PI less than 20 & Max. particle size of 3-inches	γ = 110 pcf, $\varphi' = 25^0$	0.58
Clayey Sands (SC)/Silty Sands/ Crushed Limestone	γ = 120 pcf, $\varphi' = 30^0$	0.50
Sands (SP) or Sand with silt (SP-SM) Less than 10% fines	γ = 120 pcf, $\varphi' = 35^0$	0.43

It is imperative that the backfill be properly compacted behind the retaining structures in order to reduce possible stresses on adjacent slab-on-grade construction.

TABLE 3.3: EQUIVALENT FLUID PRESSURES

Type of Backfill Behind the Retaining System (Free of organics, other deleterious materials)	Soil Parameters	At-Rest Condition (Backfill)[c]	
		Above W.T.	Below W.T.[a]
Lean Clay (CL) PI less than 20 & Max. particle size of 3-inches.	γ = 110 pcf, $\varphi' = 25^0$	72	36
Clayey Sands (SC)/Silty Sands[b]/ Crushed Limestone	γ = 120 pcf, $\varphi' = 30^0$	63	31
Sands (SP) or Sand with silt (SP-SM)[b] Less than 10% fines	γ = 120 pcf, $\varphi' = 35^0$	53	27

Notes:
(a) Buoyant Equivalent Fluid Weight: No hydrostatic fluid weight effect of 62.4 pcf; (W.T.): Water Table
(b) Granular Soils: At least a one-foot clay cap over granular soils at top of the wall
(c) Values are pounds per square foot per foot of wall height

TABLE 3.4: COMPACTION AND TESTING REQUIREMENTS FOR BELOW GRADE WALLS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Requirement
Wall Areas	Subgrade soil at base of excavation	ASTM D 698	≥ 95%	0 to +4%	1 per 5,000 SF
	Backfill (Onsite Material)	ASTM D 698	≥ 95%	–1% to +3%	1 per 5,000 SF; min. 3 per lift
	General Fill (Onsite Material)	ASTM D 698	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 per lift

PSI recommends that a permanent seepage collection system be installed behind the wall to prevent the development of excessive hydrostatic pressures from acting on the wet well walls. Drainage collection should be accomplished with slotted piping and a geotextile fabric (such as Mirafi 140N or equivalent) to help minimize the intrusion of fine-grained particles into the drain system. A full-height drain behind the wet well walls could consist of gravel meeting the requirements of ASTM D448 or ASTM C33 coarse concrete aggregate Size No. 57, 6 or 67. The column of gravel should extend from the base of the structure to within two feet of the top of the structure. Alternatively, consideration may be given to utilizing a manufactured geosynthetic material for wall drainage, which would be used as an alternate to the full height gravel drain.

PSI should review the final lift station design documents when complete to observe that the intent of these recommendations has been performed.

3.2.3 BUOYANCY RESISTANCE

Should it not be practical to increase the mat thickness and wall thickness to resist buoyancy, driven pile foundations connected to the mat foundation could be used for this purpose. Uplift resistance would then be the weight of the lift station and mat foundation and uplift resistance of the driven piles. Uplift resistance from the piles would be the dead weight of the piles plus the allowable skin friction capacity. For these soils, an allowable skin friction of f_a=125 psf is recommended for the soils 25 feet below the bottom elevation of the mat.

3.2.4 SITE SEISMIC DESIGN RECOMMENDATIONS

For the purposes of seismic design, based on the encountered site conditions and local geology, PSI interpreted the subsurface conditions to satisfy the **Site Class E** criteria for use at this site as defined by the International Building Code (IBC). The site class is based on the subsurface conditions encountered at the soil borings, the results of field and laboratory testing, experience with similar projects in this area, and considering the site prepared as recommended herein. The table below provides recommended seismic parameters for the project based on the 2018 edition of the IBC.

TABLE 3.5: RECOMMENDED DESIGN SEISMIC PARAMETERS FOR BOTH SITES

Seismic Parameter	IBC 2018
0.2 sec (S_S)	0.038g
1.0 sec (S_1)	0.013g
Site Coefficient 0.2sec, F_a	2.4
Site Coefficient 1.0 sec, F_v	4.2
0.2 sec (S_{DS})	0.06g
1.0 sec (S_{D1})	0.036g

3.3 FORCE MAIN LINE IMPROVEMENT RECOMMENDATIONS

Based upon the information provided the force main line piping will be an 18-inch diameter pipe with a depth of the proposed force main piping from approximately 8 to 15 feet from existing grade. Variations in the soil stratigraphy from those identified during the study may be observed at the time of the construction due to the spacing between the borings and actual variations in the geology related to the environment of deposition.

The design and construction of the buried force main line will involve the consideration of several different factors with regard to the soils along the alignment. These factors include the types of soils comprising the alignment, the strength of these soils, and groundwater levels that may be anticipated along the alignment. Groundwater, when present, will apply buoyant forces to buried pipe and can also present significant challenges to the excavation of trenches for the construction of the sewer line. Granular soils such as sands encountered in the test borings can also present a challenge during construction as they will likely slough into the excavation unless the excavation is appropriately sloped, or a retention system is installed to prevent sloughing.

Groundwater was observed during the drilling and sampling operations along the force main line. Dewatering the excavation for the installation may be necessary for construction of the proposed force main line depending on prevailing climatic conditions and soil conditions in specific areas. It is possible that areas of "perched" groundwater may be present, especially after rain events. Therefore, groundwater/stormwater control measures such as sump and pump or well points may be required and should be considered to control groundwater.

3.3.1 SHORING CONSIDERATIONS

Based upon the information provided, the proposed force main line will be about 8 to 15 feet below existing grade. Due the site and soil limitations, open-cut excavations with sloping sides may not be possible, practical or safe.

TABLE 3.6: OSHA SOIL TYPES FOR OPEN CUT EXCAVATIONS

Depths (ft)	Material Type	Unconfined Compressive Strength (tsf)	OSHA Type
0 to 5	Lean Clay (CL)	1.0	B
5 to 14	Lean Clay w/ Sand (CL)	0.3	C
14 to 20	Lean Clay (CL)	0.6	C

Full-depth trench shielding (trench box) is recommended for the force main line construction. The design of the shoring is typically provided by the Trench Shoring Engineer. However, PSI recommends that the shoring system be in contact with the sidewalls of the trench and be designed to resist lateral earth pressures. Additionally, hydrostatic pressures, equipment loads, and other surcharges should be considered for trench shoring design.

TABLE 3.7: LATERAL EARTH PRESSURE COEFFICIENTS

Material Type	Soil Parameters	Depth Range (ft)	At-Rest Condition, K_o	Active Condition, K_a	Passive Conditions, K_p
Lean Clay (CL)	γ = 110 pcf, $\varphi' = 25^0$	0 to 15	0.60	0.41	2.5

These values are unfactored (no factor of safety) and do not consider hydrostatic pressures. We anticipate that dewatering will be necessary to construct the force main line. Depending upon the extent of the dewatering operation, we recommend a hydrostatic pressure be added to the lateral earth pressures presented in the previous table in a triangular distribution. An appropriate factor of safety should be included in the design.

Utility design and construction details including trench shoring and groundwater control are outside of the scope of this project. We would be pleased to assist in this evaluation if desired. The follow tables are provided for the design of the trench shoring system.

3.3.2 EXCAVATION BOTTOM AND BEDDING RECOMMENDATIONS

After a stable excavation bottom is obtained, granular bedding material should be placed in the excavation. The bedding materials and granular backfill should be placed in accordance with the pipe manufacturer's requirements to approximately 12 inches above the pipe to allow placement of backfill material.

Dewatering should be carefully monitored to make certain that the groundwater level is 2 feet or more below the base of the excavations. If allowed to rise into or near the base of the excavation, "quick" conditions may develop. Quick conditions are considered to be unsafe and could compromise the integrity of the pipe support.

3.3.3 BACKFILL AND COMPACTION RECOMMENDATIONS

After placement of the bedding and granular fill, the excavation can be backfilled using excavated soils. The backfill soils should be placed in loose lifts not exceeding 8 inches, moisture conditioned and compacted as in indicated in the following table until pavement subgrade level is achieved.

TABLE 3.8: COMPACTION AND TESTING REQUIREMENTS FOR DRAINAGE LINE BACKFILL

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Force Main Line	On-site Excavated Soil (Pipe Excavation Backfill)	ASTM D 698	≥ 95%	-1 to +3%	1 per 300 lft

If water is to be added, it should be uniformly applied and thoroughly mixed into the soil. Each lift of compacted backfill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

In lieu of backfill with materials as described above, the excavation from 2 feet above the top of pipe to within 1 foot of final grade maybe backfilled with a controlled low strength material (CLSM), also referred to as flowable fill. The use of CLSM can often reduce the time required for completion of the

excavation backfill, allowing faster construction. It is recommended that a design mix be submitted for approval prior to using CLSM as excavation backfill. The final 1 foot of backfill should be completed using flexible base placed and compacted in lifts as recommended in Section 5.2.

4.0 CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundations, earthwork and related activities of this project. PSI cannot accept any responsibility for any conditions which deviate from those described in this report, nor for the performance of the foundations if not engaged to also provide construction observation and materials testing for this project. The PSI geotechnical engineer of record should be retained to provide continuing geotechnical consulting services and construction document review, even if periodic on-call testing is contracted with PSI Construction Services.

4.1 INITIAL SITE PREPARATION CONSIDERATIONS

4.1.1 SUBGRADE PREPARATION FOR SITE WORK OUTSIDE PROJECT WORK AREAS

Grade adjustments outside of the work areas can be made using select or general fill materials. The clean excavated onsite soils may also be reused in areas not sensitive to movement.

TABLE 4.1: SUBGRADE PREPARATION FOR NON-STRUCTURAL - GENERAL FILL

Minimum Undercut Depth	6 inches or as needed to remove roots, organic and/or deleterious materials
Exposed Subgrade Treatment	Proof-roll with rubber tired vehicle weighing at least 2 tons. A representative of the Geotechnical Engineer should be present during proof-roll.
Proof-Rolled Pumping and Rutting Areas	Excavate to firmer materials and replace with compacted general or select fill under direction of a representative of the Geotechnical Engineer
General Fill Type	Clean material free of roots, debris and other deleterious material with a maximum particle size of 4 inches
Maximum General Fill Loose Lift Thickness	8 inches

TABLE 4.2: FILL COMPACTION RECOMMENDATIONS OUTSIDE OF WORK AREAS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Outside of Structure or Trenching Areas	General Fill	ASTM D 698	≥ 95%	0 to +4%	1 per 10,000 SF; min. 3 per lift

4.1.2 EXISTING SITE CONDITIONS

The following table outlines construction considerations in consideration of demolition of existing structures, demolition of existing paving, procedures for abandoning old utility lines and removing trees.

TABLE 4.3: CONSIDERATIONS FOR DEMOLITION

Abandoned Utilities	
Utilities of former structures located with in footprint of new construction	Remove pipe, bedding and backfill and then replace with select fill placed using controlled compaction
Utilities of former structures located outside of footprint of new construction	Abandon in place using a grout plug

4.2 MOISTURE SENSITIVE SOILS/WEATHER RELATED CONCERNS

Soils are sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork, foundation, and construction activities during dry weather.

4.3 FOUNDATION EXCAVATION OBSERVATIONS

The foundation excavations should be observed by a representative of PSI prior to reinforcing steel or concrete placement to assess that the foundation materials are consistent with the materials discussed in this report. This is especially important to identify the condition and acceptability of the exposed subgrades under the foundation. Soft or loose soil zones encountered at the bottom of the beam excavations should be removed to the level of competent soils as directed by the Geotechnical Engineer. Cavities formed as a result of excavation of soft or loose soil zones should be backfilled with compacted select fill or lean concrete.

After opening, excavations should be observed and concrete placed as quickly as possible to avoid exposure to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If excavations must be left open an extended period, they should be protected to reduce evaporation or entry of moisture.

4.4 DRAINAGE CONSIDERATIONS

Water should not be allowed to collect in or adjacent to foundation excavations, on foundation surfaces, or on prepared subgrades within the construction area either during or after construction. Proper drainage around grade supported flatwork is also important to reduce potential movements. Excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Providing rapid, positive drainage away from the building will reduce moisture variations within the underlying soils and will therefore provide a valuable benefit in reducing the magnitude of potential movements.

4.5 EXCAVATIONS AND TRENCHES

Excavation equipment capabilities and field conditions may vary. Geologic processes are erratic and large variations can occur in small vertical and/or lateral distances. Details regarding “means and methods” to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor. The comments contained in this report are based on small diameter borehole observations. The performance of large excavations may differ.

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. PSI understands that these regulations are being strictly enforced, and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and Federal safety regulations.

PSI is providing this information solely as a service to the client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and Federal safety or other regulations. A trench safety plan was outside the scope of this project.

5.0 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the client for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional Geotechnical Engineering practices in the local area. No other warranties are implied or expressed. This report may not be copied without the expressed written permission of PSI.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that the engineering recommendations have been properly incorporated in the design documents. At this time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

This report has been prepared for the exclusive use of Freese & Nichols and the LMWD for specific application to the proposed LMWD Utility Improvements to be constructed in Port Isabel, Texas.

APPENDIX

intertek psi
2020 N. Loop 499, Suite 302
Harlingen, Texas 78550
Office - 956.423.6826

Boring Location Map

Proposed LMWD Utility Improvements
Laguna Madre Water District
Port Isabel, Texas
PSI Project No.: 03121857

NOT TO SCALE
Google Earth 2019
PLATE 1a

N

intertek psi
2020 N. Loop 499, Suite 302
Harlingen, Texas 78550
Office - 956.423.6826

Boring Location Map

Proposed LMWD Utility Improvements
Laguna Madre Water District
Port Isabel, Texas
PSI Project No.: 03121857

NOT TO SCALE
Google Earth 2019
PLATE 1b

N

LOG OF BORING NO. B-1

LMWD Utility Improvements
Port Isabel, Texas
PSI Project No.:03121857

TYPE BORING: Mud Rotary Wash — LOCATION: 26.070294°, -97.207630°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 / PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: Ukn							
			Clayey Sand (SC), medium brown, loose, moist	14	7			10		
					6			9		
5			Poorly Graded Sand with Clay (SP-SC), light brown, very loose, moist to wet, with shell	8	3			25		
					3			25		
10			Lean Clay with Sand (CL), grayish brown, very soft, wet	74	0	39	20	34		
15				84	2	30	14	29		
20			Fat Clay (CH), medium brown, very soft, wet	100	1	62	34	37		
25					3			41		
30			Lean Clay (CL), medium brown, very soft, moist	91	3	26	7	30		
35			Fat Clay (CH), medium brown, very soft, moist to wet		2			31		
40				97	1	68	38	49		
45										

COMPLETION DEPTH: 40.0 FEET — DEPTH TO WATER: 5 ft
DATE: 6/20/19 — DELAYED WATER READING: 10 Minute Delay: 4 ft

BL_TEXAS_LMWD UTILITY IMP BL.GPJ PSI_CORP.GDT 7/29/19

PLATE 2

intertek psi
Geotechnical Consulting Services
Harlingen, Texas

LOG OF BORING NO. B-2

LMWD Utility Improvements
Port Isabel, Texas
PSI Project No.:03121857

TYPE BORING: Solid Stem Flight Auger

LOCATION: 26.063978°, -97.222331°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 / PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: Ukn							
			Asphaltic Concrete, 1.5 inches thick	18				4		
			Flexible Base, Clayey Sand with Gravel (SC), 5.5 inches thick	89	12	32	10	16		
			Lean Clay (CL), medium brown, stiff to firm, moist		5			22		
5			Lean Clay with Sand (CL), medium brown, very soft, moist	81	3	31	9	18		
				84	2			29		
10					1			31		
			Lean Clay (CL), medium brown, very soft to firm, moist	97	3	45	26	32		
15										
				85	6			27		
20										
25										
30										
35										
40										
45										

COMPLETION DEPTH: 20.0 FEET
DATE: 6/20/19

DEPTH TO WATER: 10 ft
DELAYED WATER READING: After Drilling: 11 ft

BL_TEXAS LMWD UTILITY IMP BL.GPJ PSI_CORP.GDT 7/29/19

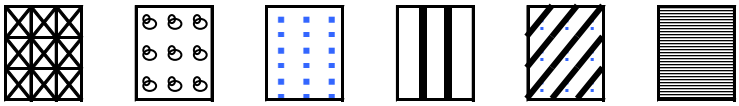
PLATE 3

intertek psi

Geotechnical Consulting Services
Harlingen, Texas

KEY TO TERMS AND SYMBOLS USED ON LOGS

SOIL TYPE

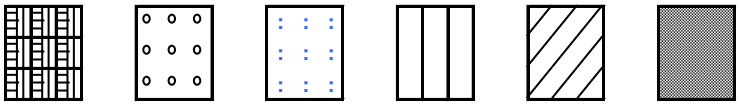


ROCK | GRAVEL | SAND | SILT | CLAY | SHALE

SAMPLER TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON

MODIFIERS



STONE | GRAVELY | SANDY | SILTY | CLAYEY | FILL

NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

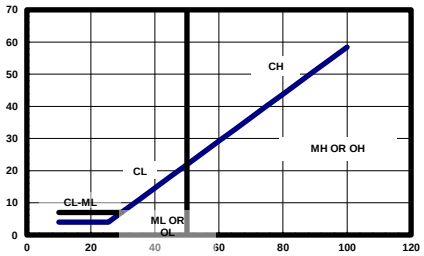
MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING NO. 4 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING NO. 4 SIEVE	CLEAN GRAVEL (LITTLE OR NO FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIABLE FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING NO. 4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND, GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS, GRAVELY SAND (L.FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/ LOW PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
			OH	ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS AND MAN-MADE SOIL MIXTURES	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	SHEAR STRENGTH IN TONS/FT^2
VERY SOFT	0. TO 0.125
SOFT	0.125 TO 0.25
FIRM	0.25 TO 0.5
STIFF	0.5 TO 1.0
VERY STIFF	1.0 TO 2.0
HARD	> 2.0 OR 2.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0-4
LOOSE	4-9
MEDIUM DENSE	10-29
DENSE	30-49
VERY DENSE	> 50 OR 50+



ABBREVIATIONS

HP - HAND PENETROMETER
TV - TORVANE
MV - MINIATURE VANE
UC - UNCONFINED COMPRESSION TEST
UU - UNCONSOLIDATED UNDRAINED TRAIXIAL
CU - CONSOLIDATED UNDRAINED

NOTE: PLOT INDICATES SHEAR STRENGTH AS OBTAINED BY ABOVE TESTS

HYDRO-STATIC WATER LEVEL

WATER LEVEL UNDER HYDRO - STATIC PRESSURE HEAD

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

6"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	2.0	0.42	0.074		0.002

GRAIN SIZE IN MM

GEOTECHNICAL ENGINEERING REPORT

Proposed LMWD Force and Gravity Main Improvements
Port Isabel, Texas

PSI Project No. 0312026

PREPARED FOR:

Freese & Nichols, Inc.
9601 McAllister Freeway, Suite 1008
San Antonio, Texas 78216

April 15, 2020

BY:

PROFESSIONAL SERVICE INDUSTRIES, INC.
2020 N. Loop 499, Ste 302
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Professional Service Industries, Inc.
2020 N. Loop 499, Ste 302
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Office - 956.423.6826

April 15, 2020

Freese & Nichols, Inc.
9601 McAllister Freeway, Suite 1008
San Antonio, Texas 78216

Attn: Ms. Jacqueline McMahon, E.I.T.

RE: GEOTECHNICAL ENGINEERING REPORT
PROPOSED LMWD FORCE AND GRAVITY MAIN IMPROVEMENTS
PORT ISABEL, TEXAS
PSI Project No. 0312026

Dear Ms. McMahon:

Professional Service Industries, Inc. (PSI), an Intertek company, is pleased to submit this Geotechnical Engineering Report for the referenced project. This report includes the results of field and laboratory testing along with recommendations for use in preparation of the appropriate design and construction documents for this project.

PSI appreciates the opportunity to provide this Geotechnical Engineering Report and looks forward to continuing participation during the design and construction phases of this project. If there are any questions pertaining to this report, or if PSI may be of further service, please contact our office.

PSI also has great interest in providing materials testing and inspection services during the construction of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.
Texas Board of Professional Engineers Certificate of Registration # F003307

Rockford Miller, E.I.T.
Project Manager

Richard E. Webb, P.E.
Principal Consultant

April 15, 2020

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1.0 PROJECT INFORMATION

1.1 PROJECT AUTHORIZATION

Professional Service Industries, Inc., (PSI), an Intertek company, has completed a field exploration and geotechnical evaluation for the proposed Laguna Madre Water District (LMWD) Force and Gravity Main Improvements project to be constructed at within the city of Port Isabel, Texas. Ms. Jacqueline McMahon, E.I.T., representing Freese & Nichols, Inc. (FNI) authorized PSI's services on March 9, 2020 by issuing a Notice-to-Proceed email and with respect to FNI Subconsultant Authorization AMD #1 and PSI Proposal No. 297311-R1 dated February 12, 2020.

1.2 PROJECT DESCRIPTION

Project information was provided by Ms. Jacqueline McMahon, E.I.T., with FNI and included a Scope of Work for Geotechnical Investigation, that included information on lift station improvements of force and gravity main lines. In addition, Project Overview maps were provided identifying the existing lift stations, the force and gravity main lines locations and proposed boring locations as indicated below:

- LS 17 Force Main Project Overview, Figure 1.0-1, drafted by FNI.
- LS 25 Force Main Project Overview, Figure 1.0-1, drafted by FNI.
- Lift Station No. 30 Proposed Improvements, Figure 3.8-4, drafted by FNI.
- Route 3B Alignment, Figure 3.5-1, drafted by FNI.
- Google Earth kmz file showing soil borings locations titled LMWD Amend01 Bores.

The geotechnical recommendations presented in this report are based on the available project information, structure locations, and the subsurface materials described in this report. If any of the noted information or assumptions made are incorrect, please inform PSI so that the recommendations presented in this report can be amended as necessary. PSI will not be responsible for the implementation of provided recommendations if not notified of changes in the project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study is to evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations and guidelines for use in preparing the design and other related construction documents for the proposed project. The scope of services included drilling borings, performing laboratory testing, and preparing this geotechnical engineering report.

This report briefly outlines the available project information, describes the site and subsurface conditions, and presents the recommendations regarding the following:

- A review of surface topographical features, geologic features, and site conditions.
- Boring location plan and boring logs with laboratory test results of subsurface materials encountered including groundwater levels.
- Geotechnical discussion pertaining to subsurface conditions, expansive soils, variation of soil stratums and soil strengths, groundwater and other geotechnical related issues.
- General construction, excavation, trenching and backfill bedding material recommendations for the proposed force and gravity main construction.

The scope of services for this geotechnical exploration did not include an environmental, mold nor detailed seismic/fault assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 SITE DESCRIPTION

The geotechnical drilling for the soil borings was completed in various locations with the City of Port Isabel, Texas. Boring B-1 was within a residential area at the northwest corner of W. Jefferson St. and S. Yturria St., and Boring B-2 was in an open area north of Woody Lane and northwest of the existing baseball park. Borings B-3 thru B-6 were adjacent to SH-100, either on a pavement surface or off the road is a grass area. LMWD provided traffic control for the drilling activities conducted on pavement surfaces. The boring locations were relatively level, and the surfaces were firm enough for field equipment.

2.2 FIELD EXPLORATION

Field exploration for the project consisted of drilling a total of six (6) borings. The boring design element, boring labels, and approximate depths are provided in the following table.

TABLE 2.1: FIELD EXPLORATION SUMMARY

Design Element	Boring Label	Approx. Depth of Borings
Lift Station No. 17 Force Main	B-1	15 ft
Lift Station No. 30 Gravity Main	B-2	20 ft
Lift Station No. 25 Force Main	B-3 & B-4	20 ft
SH-100 Gravity Main	B-5 & B-6	20 ft

The boring locations were selected by PSI personnel and were located in the field using available landmarks and GPS coordinates using a recreation-grade device. Elevations of the ground surface at the boring locations were not provided to PSI and should be surveyed by others, if required. Therefore, the references to elevations of various subsurface strata are based on depths below existing grade at the time of drilling. The approximate boring locations are depicted on the Boring Location Plans provided in the Appendix.

TABLE 2.2: FIELD EXPLORATION DESCRIPTION

Drilling Equipment	Truck-Mounted Drilling Equipment
Drilling Method	Continuous-Flight Auger
Drilling Procedure	Applicable ASTM and PSI Safety Manual
Field Testing Procedures	Hand Penetrometer Standard Penetration Testing (ASTM D1586)
Sampling Procedure	Split-Barrel Sampling of Soils (ASTM D1586) Thin-Walled Tube Sampling of Soils (ASTM D1587)
Frequency of Groundwater Level Measurements	Initial Reading and After Drilling
Boring Backfill Procedures	Soil Cuttings and Asphalt Patch
Sample Preservation and Transportation Procedure	General accordance with ASTM D4220

During the field activities, the encountered subsurface conditions were observed, logged, and visually classified (in general accordance with ASTM D2488). Field notes were maintained to summarize soil types and descriptions, water levels, changes in subsurface conditions, and drilling conditions.

2.3 LABORATORY TESTING PROGRAM

PSI supplemented the field exploration with a laboratory testing program to determine additional engineering characteristics of the subsurface soils encountered. The laboratory testing program included:

- Moisture Content Tests (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Material Finer than No. 200 (ASTM D1140)

The laboratory testing program was conducted in general accordance with applicable ASTM test methods. The results of the laboratory tests are provided in the Appendix on the Logs of Boring. Portions of samples not altered or consumed by laboratory testing will be retained for 60 days from the date shown this report and will then be discarded.

2.4 SITE GEOLOGY

As shown on the Geologic Atlas of Texas, McAllen-Brownsville Sheet, reprinted in 1979, the site is located in an area where the **Alluvium Deposits (Qam)** formation is mapped at or near the ground surface. The Alluvium Deposits are floodplain deposits of the lower course of Rio Grande and are divided into areas dominantly silt and sand with elements of clay, gravel, and organic matter.

2.5 SUBSURFACE CONDITIONS

The results of the field and laboratory testing have been used to determine an anticipated generalized surface profile of the project site. The following subsurface descriptions are of a generalized nature to highlight the major subsurface stratification features and material characteristics. This soil profile descriptions have been summarized in the following table.

TABLE 2.3: GENERALIZED SOIL PROFILES

Location	Layer	Depth of Layer (ft)		Soil Type	ω (%)	LL (%)	PI	% Pass. #200
		Top	Bot.					
B-1	1	0	13	Clayey Sand	3 to 31	-	-	13 to 21
	2	13	15	Sandy Lean Clay	40	46	29	69
B-2	1	0	18	Lean Clay w/ Sand	23 to 31	36	20	86
	2	18	20	Fat Clay	42	59	36	98
B-3 & B-4	1	0	12	Sandy Lean Clay & Lean Clay	17 to 33	44	28	55 to 89
	2	12	16	Fat Clay (only in B-3)	32	63	42	99
	3	12	20	Sandy Lean Clay & Lean Clay w/ Sand (only in B-3)	31	32	16	71

Location	Layer	Depth of Layer (ft) Top	Bot.	Soil Type	ω (%)	LL (%)	PI	% Pass. #200
B-5 & B-6	1	0	11	Sandy Lean Clay, Lean Clay w/ Sand & Lean Clay	10 to 33	35	18	72
	2	11	20	Clayey Sand	27	-	-	35

Note: ω: Moisture Content, LL: Liquid Limit, PI: Plasticity Index, #: Average, # to #: Range in Descending Order

The boring logs included in the Appendix should be reviewed for information at the boring locations. The boring logs include soil descriptions, stratifications, locations of the samples, and field and laboratory test data. The stratifications shown on the boring logs only represent the conditions the specific boring location and represent the approximate boundaries between subsurface materials. The actual transitions between strata may be more gradual or more distinct. Variations will occur and should be expected across the site.

2.5.1 GROUNDWATER INFORMATION

Water level measurements were performed during drilling and after completion of drilling. Specific information concerning groundwater is noted on each boring log presented in the Appendix of this report. The groundwater measurements are summarized in the following table.

TABLE 2.4: GROUNDWATER LEVELS (DEPTHS)

Boring Designation	Boring Depth (feet)	During Drilling (feet)	After Drilling (feet)	Cave-In (feet)
B-1	15	7	6	-
B-2	20	dry	dry	9
B-3	20	8	15.5	-
B-4	20	7	6.5	-
B-5	20	8	7	-
B-6	20	dry	dry	7

Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. If more detailed water level information is required, observation wells or piezometers could be installed at the site, and water levels could be monitored.

The groundwater levels presented in this report are the levels that were measured at the time of our field activities. The contractor should be prepared to control groundwater, if encountered, during construction.

3.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

3.1 FORCE AND GRAVITY MAIN LINE IMPROVEMENT RECOMMENDATIONS

Based upon the information provided, the existing force and gravity main line will be upgraded to larger diameter pipe between the existing lift stations. The depth of the proposed force and gravity main line ranges from approximately 3 to 15 feet from existing grade. We understood that trenchless construction or horizontal directional drilling (HDD) will be employed at the SH-100 crossing and at boring locations of B-3 & B-4 and B-5 & B-6. Variations in the soil stratigraphy from those identified during the study may be observed during construction due to the spacing between the borings and actual variations in the geology related to the environment of deposition.

The design and construction of the buried force and gravity main lines will involve the consideration of several different factors along the alignment. These factors include the types of soils along the alignment, the strength of these soils, and groundwater levels that may be anticipated along the alignment. Groundwater, when present, will apply buoyant forces to buried pipe and can also present significant challenges to the excavation of trenches for the construction of the sewer line. Sandy soils such as those encountered in the test borings can also present a challenge during construction as they will likely slough into the excavation unless the excavation is appropriately sloped, or a retention system is installed to prevent sloughing.

Groundwater was observed during the drilling and sampling operations along the force and gravity main lines. Dewatering the excavation should be anticipated for construction of the proposed force and gravity main lines depending on prevailing climatic conditions and soil conditions in specific areas. It is possible that areas of “perched” groundwater may also be present, especially after rain events. Therefore, groundwater/stormwater control measures such as sump and pump or well points will likely be required and should be considered to control groundwater.

3.1.1 SHORING CONSIDERATIONS

Based upon the information provided, the proposed force and gravity main line will be about 3 to 15 feet below existing grade. Due the site and soil limitations, open-cut excavations with sloping sides may not be possible, practical or safe.

TABLE 3.1: OSHA SOIL TYPES FOR OPEN CUT EXCAVATIONS

Location	Depth (ft)	Material Type (USCS Symbol)	Unconfined Compressive Strength (tsf)	OSHA Type
B-1	0 to 15	SC	non-cohesive	C
B-2	0 to 15	CL	0.5	C
B-3 & B-4	0 to 15	CL	0.5	C
B-5 & B-6	0 to 11	CL	0.3	C
	11 to 15	SC	non-cohesive	C

Full-depth trench shielding (trench box) is recommended for the force and gravity main line construction and for the trenchless or HDD construction development. The design of the shoring is typically provided by the Trench Shoring Engineer. However, PSI recommends that the shoring system be in contact with the sidewalls of the trench and be designed to resist lateral earth pressures.

Additionally, hydrostatic pressures, equipment loads, and other surcharges should be considered for trench shoring design.

TABLE 3.2: LATERAL EARTH PRESSURE COEFFICIENTS

Material Type	Soil Parameters	Depth Range (ft)	At-Rest Condition, K_o	Active Condition, K_a	Passive Conditions, K_p
Lean Clays (CL)	γ = 110 pcf, $\varphi' = 25^0$	0 to 15	0.60	0.41	2.5
Clayey Sands (SC)	γ = 115 pcf, $\varphi' = 30^0$	0 to 15	0.50	0.33	3.0

These values are unfactored (no factor of safety) and do not consider hydrostatic pressures or surcharge loads. We anticipate that dewatering will be necessary to construct the force and gravity main lines. Depending upon the extent of the dewatering operation, we recommend a hydrostatic pressure be added to the lateral earth pressures presented in the previous table in a triangular distribution. An appropriate factor of safety should be included in the design.

Utility design and construction details including trench shoring and groundwater control are outside of the scope of this project. We would be pleased to assist in this evaluation if desired. The follow tables are provided for the design of the trench shoring system.

3.1.2 EXCAVATION BOTTOM AND BEDDING RECOMMENDATIONS

After a stable excavation bottom is obtained, granular bedding material should be placed in the excavation. The bedding materials and granular backfill should be placed in accordance with the pipe manufacturer's requirements to approximately 12 inches above the pipe to allow placement of backfill material.

TABLE 3.3: COMPACTION AND TESTING RECOMMENDATIONS FOR FORCE/GRAVITY MAIN LINE GRANULAR BEDDING

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Force & Gravity Main Line	Imported Granular Bedding	ASTM D 698	$\geq$ 95%	-1 to +3%	1 per 300 lft

Dewatering should be carefully monitored to make certain that the groundwater level is 2 feet or more below the base of the excavations. If allowed to rise into or near the base of the excavation, "quick" conditions may develop. Quick conditions are unsafe and could compromise the integrity of the pipe support.

3.1.3 BACKFILL AND COMPACTION RECOMMENDATIONS

After placement of the bedding and granular fill, the excavation can be backfilled using excavated soils. The backfill soils should be placed in loose lifts not exceeding 8 inches, moisture conditioned and compacted as in indicated in the following table until pavement subgrade level is achieved.

TABLE 3.4: COMPACTION AND TESTING RECOMMENDATIONS FOR FORCE/GRAVITY MAIN LINE BACKFILL

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Force & Gravity Main Line	On-site Excavated Soil (Pipe Excavation Backfill)	ASTM D 698	≥ 95%	-1 to +3%	1 per 300 lft

If water is to be added, it should be uniformly applied and thoroughly mixed into the soil. Each lift of compacted backfill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

In lieu of backfill with materials as described above, the excavation from 2 feet above the top of pipe to within 1 foot of final grade maybe backfilled with a controlled low strength material (CLSM), also referred to as flowable fill. The use of CLSM can often reduce the time required for completion of the excavation backfill, allowing faster construction. It is recommended that a design mix be submitted for approval prior to using CLSM as excavation backfill. Beneath pavement systems the final 1 foot of backfill should be completed using flexible base placed and compacted in lifts.

4.0 CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the earthwork and related activities of this project. PSI cannot accept any responsibility for any conditions which deviate from those described in this report. The PSI geotechnical engineer-of-record should be retained to provide continuing geotechnical consulting services and construction document review, even if periodic on-call testing is contracted with PSI Construction Services.

4.1 INITIAL SITE PREPARATION CONSIDERATIONS

4.1.1 SUBGRADE PREPARATION FOR AREAS OUTSIDE SITE WORK

Grade adjustments outside of the site work areas can be made using select or general fill materials. The clean excavated onsite soils may also be reused in areas not sensitive to movement.

TABLE 4.1: SUBGRADE PREPARATION FOR NON-STRUCTURAL - GENERAL FILL

Minimum Undercut Depth	6 inches or as needed to remove roots, organic and/or deleterious materials
Exposed Subgrade Treatment	Proof-roll with rubber-tired vehicle weighing at least 20 tons. A representative of the Geotechnical Engineer should be present during proof-roll.
Proof-Rolled Pumping and Rutting Areas	Excavate to firmer materials and replace with compacted general or select fill under direction of a representative of the Geotechnical Engineer
General Fill Type	Clean material free of roots, debris and other deleterious material with a maximum particle size of 4 inches
Maximum General Fill Loose Lift Thickness	8 inches

TABLE 4.2: FILL COMPACTION RECOMMENDATIONS OUTSIDE OF WORK AREAS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Outside Work & Pavement Areas	General Fill	ASTM D698	≥ 95%	0 to +4%	1 per 10,000 SF; min. 3 per lift or 1 per 300 lft; min. 3 per lift

4.2 MOISTURE SENSITIVE SOILS/WEATHER RELATED CONCERNS

The soils along the alignment are sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork, and construction activities during dry weather.

4.3 DRAINAGE CONSIDERATIONS

Water should not be allowed to collect in or adjacent to excavations or on prepared subgrades within the construction area either during or after construction. Excavated areas should be sloped toward one corner or end to facilitate removal of collected rainwater, groundwater, or surface runoff.

4.4 EXCAVATIONS AND TRENCHES

Excavation equipment capabilities and field conditions may vary. Geologic processes are erratic and large variations can occur in small vertical and/or lateral distances. Details regarding “means and methods” to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor. The comments contained in this report are based on small diameter borehole observations. The performance of large excavations may differ.

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. PSI understands that these regulations are being strictly enforced, and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and Federal safety regulations.

PSI is providing this information solely as a service to the client. PSI does not assume responsibility for construction site safety or the contractor's or other parties’ compliance with local, state, and Federal safety or other regulations. A trench safety plan was outside the scope of this project.

5.0 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the client for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional Geotechnical Engineering practices in the local area. No other warranties are implied or expressed. This report may not be copied without the expressed written permission of PSI.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that the engineering recommendations have been properly incorporated in the design documents. At this time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

This report has been prepared for the exclusive use of Freese & Nichols, Inc., for specific application to the proposed LMWD Force and Gravity Main Improvements project to be constructed in Port Isabel, Texas.

APPENDIX

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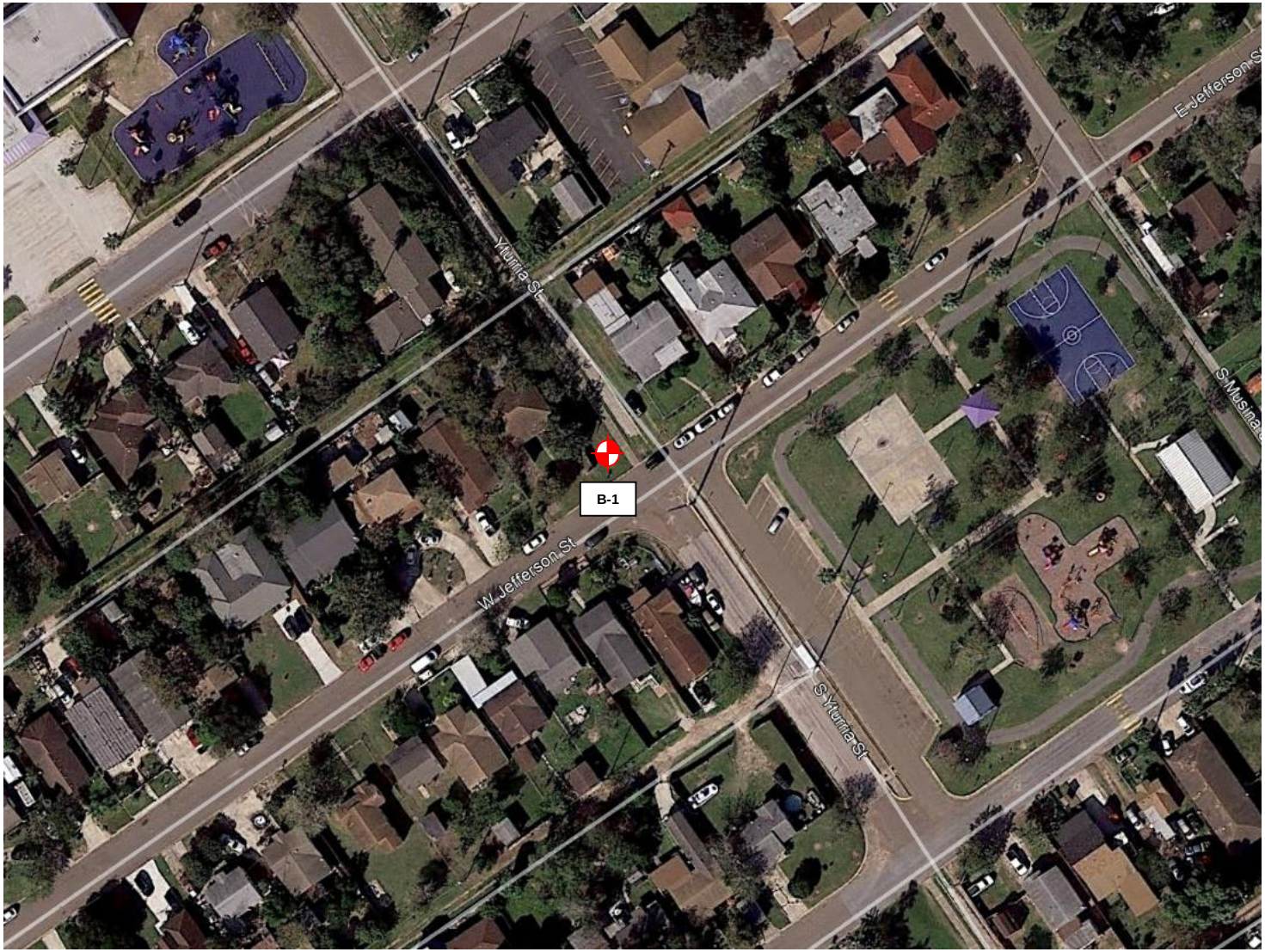
Office - 956.423.6826

Site Vicinity Map

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.: 03122026

NOT TO SCALE
Google Earth 2020
PLATE 1

N



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Boring Location Map

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.: 03122026

NOT TO SCALE
Google Earth 2020
PLATE 2

N

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Boring Location Map

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.: 03122026

NOT TO SCALE
Google Earth 2020
PLATE 3

N

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Boring Location Map

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.: 03122026

NOT TO SCALE
Google Earth 2020
PLATE 4

N

LOG OF BORING NO. B-1

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.071523°, -97.208617°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 / PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Clayey Sand (SC), medium brown, medium dense to very loose	13	8			3		
					5			3		
5				11	3			10		
				21	2			29		
			- grades to light brown		3			31		
10										
			Sandy Lean Clay (CL), grayish brown, soft	69	3	46	29	40		
15										
20										
25										

COMPLETION DEPTH: 15.0 FEET DEPTH TO WATER: 7 ft
DATE: 3/22/16 DELAYED WATER READING: After Drilling: 6 ft

BL_TEXAS_LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

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PLATE 5

LOG OF BORING NO. B-2

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.068624°, -97.221071°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 / PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Lean Clay with Sand (CL), medium brown, soft to firm	83	3	38	22	23		
					5			22		
5				91		35	18	24		
					5			24		
				82	3	34	18	28		
10										
					3			31		
15										
			Fat Clay (CH), medium brown, firm	98	7	59	36	42		
20										
25										

COMPLETION DEPTH: 20.0 FEET DEPTH TO WATER: Not encounterd
DATE: 3/22/16 DELAYED WATER READING: After Drilling: Not encountered, Cave-In at 9 ft

BL_TEXAS_LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

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PLATE 6

LOG OF BORING NO. B-3

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.071643°, -97.221012°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Asphaltic Concrete, 4 inches thick							
			Flexible Base, 10 inches thick	22				17		
			Sandy Lean Clay (CL), dark brown, firm	55	5	40	24	26		
					4			23		
5			Lean Clay (CL), medium brown, firm	89	6	48	33	23		
					6			25		
10			Fat Clay (CL), medium brown, soft	99	3	63	42	32		
15					3			32		
			Lean Clay with Sand (CL), medium brown, soft	81	3	32	16	32		
20										
25										

COMPLETION DEPTH: 20.0 FEET DEPTH TO WATER: 8 ft
DATE: 3/22/16 DELAYED WATER READING: After Drilling: 15.5 ft

BL_TEXAS_LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

intertek psi

PLATE 7

LOG OF BORING NO. B-4

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.071244°, -97.221065°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Lean Clay (CL), dark brown, firm to very soft		6			19		
				89	6	44	28	26		
5								26		
				88	0	43	24	33		
					0			29		
10										
			Sandy Lean Clay (CL), medium brown, soft	62	3	32	17	31		
15										
					3			31		
20										
25										

COMPLETION DEPTH: 20.0 FEET DEPTH TO WATER: 7 ft
DATE: 3/22/16 DELAYED WATER READING: After Drilling: 6.5 ft

BL_TEXAS_LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

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PLATE 8

LOG OF BORING NO. B-5

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.073220°, -97.225193°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Asphaltic Concrete, 4 inches thick							
			Flexible Base, 6 inches thick	29				8		
			Sandy Lean Clay (CL), dark brown, firm	70	5	32	17	20		
					7			22		
5			Lean Clay (CL), medium brown, firm	92	6	40	22	26		
			Sandy Lean Clay (CL), medium brown, firm	65	5	38	21	26		
			Clayey Sand (CL), medium brown, loose to very loose	37	4			28		
10										
					1			28		
15										
				33	2			26		
20										
25										

COMPLETION DEPTH: 20.0 FEET DEPTH TO WATER: 8 ft
DATE: 3/22/16 DELAYED WATER READING: After Drilling: 7 ft

BL_TEXAS_LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

intertek psi

PLATE 9

LOG OF BORING NO. B-6

Proposed LMWD Force/Gravity Main Improvements
Port Isabel, Texas
PSI Project No.:03122026

TYPE BORING: Continuous-Flight Augers LOCATION: 26.072542°, -97.225607°

DEPTH, FT.	SYMBOL	SAMPLES	SOIL DESCRIPTION	% PASSING #200 SIEVE	BLOWS PER FOOT	LIQUID LIMIT	PLASTIC INDEX	MOISTURE CONTENT	SHEAR STRENGTH KSF ○HAND PEN ●UNC 1.0 2.0 3.0 PL WC LL 20 40 60	UNIT DRY WT. LB./CU FT.
			SURF. ELEV.: ukn							
			Lean Clay with Sand (CL), medium brown, stiff to firm		10			10		
				74	5	40	25	24		
5					4			22		
			Sandy Lean Clay (CL), grayish brown, very soft	59	0	27	7	33		
					0			29		
10										
			Clayey Sand (SC), dark brown, loose	32	4			28		
15										
					9			26		
20										
25										

COMPLETION DEPTH: 20.0 FEET DEPTH TO WATER: Not encounterd
DATE: 3/22/16 DELAYED WATER READING: After Drilling: Not encountered, Cave-In at 7 ft

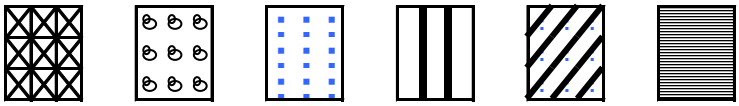
BL_TEXAS LMWD FORCE GRAVITY MAIN IMP BL.GPJ PSI_CORP.GDT 4/14/20

intertek psi

PLATE 10

KEY TO TERMS AND SYMBOLS USED ON LOGS

SOIL TYPE

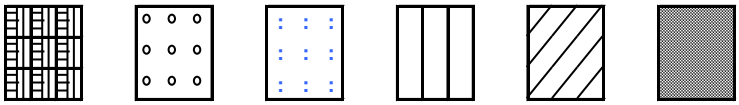


ROCK | GRAVEL | SAND | SILT | CLAY | SHALE

SAMPLER TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON

MODIFIERS



STONE | GRAVELY | SANDY | SILTY | CLAYEY | FILL

NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

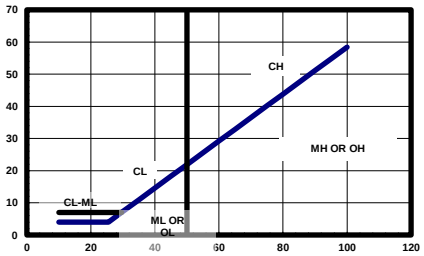
MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING NO. 4 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING NO. 4 SIEVE	CLEAN GRAVEL (LITTLE OR NO FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIABLE FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING NO. 4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND, GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS, GRAVELY SAND (L.FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/ LOW PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
			OH	ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS AND MAN-MADE SOIL MIXTURES	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	SHEAR STRENGTH IN TONS/FT^2
VERY SOFT	0. TO 0.125
SOFT	0.125 TO 0.25
FIRM	0.25 TO 0.5
STIFF	0.5 TO 1.0
VERY STIFF	1.0 TO 2.0
HARD	> 2.0 OR 2.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0-4
LOOSE	4-9
MEDIUM DENSE	10-29
DENSE	30-49
VERY DENSE	> 50 OR 50+



ABBREVIATIONS

HP - HAND PENETROMETER
TV - TORVANE
MV - MINIATURE VANE
UC - UNCONFINED COMPRESSION TEST
UU - UNCONSOLIDATED UNDRAINED TRAIXIAL
CU - CONSOLIDATED UNDRAINED

NOTE: PLOT INDICATES SHEAR STRENGTH AS OBTAINED BY ABOVE TESTS

HYDRO-STATIC WATER LEVEL

WATER LEVEL UNDER HYDRO - STATIC PRESSURE HEAD

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

6" 3" 3/4" 4 10 40 200

BOUL--DERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.0 0.42 0.074 0.002

GRAIN SIZE IN MM

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PLATE 11

GEOTECHNICAL ENGINEERING REPORT

Proposed LMWD Lift Station
No. 4 Improvements
Washington Avenue
Laguna Heights, Texas

PSI Project No. 03122240-R1

PREPARED FOR:

Freese & Nichols, Inc.
9601 McAllister Freeway, Suite 1008
San Antonio, Texas 78216

April 15, 2021

BY:

PROFESSIONAL SERVICE INDUSTRIES, INC.
2020 N. Loop 499, Ste 302
Harlingen, Texas 78550
Phone: (956) 423–6826
Fax: (956) 423–5735

Professional Service Industries, Inc.
2020 N. Loop 499, Ste 302
Harlingen, TX 78550
Office - 956.423.6826

April 15, 2021

Freese & Nichols, Inc.
9601 McAllister Freeway, Suite 1008
San Antonio, Texas 78216

Attn: Ms. Jacqueline McMahon, E.I.T.

RE: GEOTECHNICAL ENGINEERING REPORT
PROPOSED LMWD LIFT STATION NO. 4 IMPROVEMENTS
WASHINGTON AVENUE
LAGUNA HEIGHTS, TEXAS
PSI Project No. 03122240-R1

Dear Ms. McMahon:

Professional Service Industries, Inc. (PSI), an Intertek company, is pleased to submit this Geotechnical Engineering Report for the referenced project. This report includes the results of field and laboratory testing along with recommendations for use in preparation of the appropriate design and construction documents for this project.

PSI appreciates the opportunity to provide this Geotechnical Engineering Report and looks forward to continuing participation during the design and construction phases of this project. If there are any questions pertaining to this report, or if PSI may be of further service, please contact our office.

PSI also has great interest in providing materials testing and inspection services during the construction of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.
Texas Board of Professional Engineers Certificate of Registration # F003307

Rockford Miller, E.I.T.
Project Manager

Richard E. Webb, P.E.
Principal Consultant

April 15, 2021

Dexter Bacon, P.E.
Chief Engineer

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1.0 PROJECT INFORMATION

1.1 PROJECT AUTHORIZATION

Professional Service Industries, Inc., (PSI), an Intertek company, has completed a field exploration and geotechnical evaluation for the proposed Laguna Madre Water District (LMWD) Lift Station No. 4 Improvements project to be constructed on Washington Avenue in Laguna Heights, Texas. Ms. Stephanie Stephenson representing Freese & Nichols, Inc., authorized PSI's services on February 1, 2021 by issuing a Subconsultant Authorization AMD #2 that is based on PSI Proposal No. 323657-R3 dated January 5, 2021 and the mutually agreed upon Master Subconsultant Agreement between Freese & Nichols, Inc., and PSI and dated December 13, 2013.

1.2 PROJECT DESCRIPTION

Project information was provided by Ms. Jacqueline McMahon, E.I.T., with Freese & Nichols, Inc., and included a Scope of Work for Geotechnical Investigation that included information for lift station improvements at LMWD Lift Station No. 4. Based upon the information provided, PSI understands the proposed lift station will be a maximum depth of 30 feet below existing grade. A Google Earth kmz was also provided identifying the location of the existing lift station in Laguna Heights, Texas.

The geotechnical recommendations presented in this report are based on the available project information, structure locations, and the subsurface materials described in this report. If any of the noted information presented above is incorrect, please inform PSI so that the recommendations presented in this report can be amended as necessary. PSI will not be responsible for the implementation of provided recommendations if not notified of changes in the project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study is to evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations and guidelines for use in preparing the design and other related construction documents for the proposed project. The scope of services included drilling borings, performing laboratory testing, and preparing this geotechnical engineering report.

This report briefly outlines the available project information, describes the site and subsurface conditions, and presents the recommendations regarding the following:

- A review of surface topographical features, geologic features, and site conditions.
- Boring location plan and boring log with laboratory test results of subsurface materials encountered including groundwater levels.
- Geotechnical discussion pertaining to subsurface conditions, expansive soils, variation of soil stratums and soil strengths, groundwater, soil hydraulic conductivity and other geotechnical related issues.
- Groundwater dewatering recommendations for the installation of the proposed lift station that will include test results of soil hydraulic conductivity testing and soils transmissivity.
- Foundation and lateral earth pressure recommendations for the proposed lift station, to include mat foundation systems and below grade wall systems.

- Recommendations for the design of flexible asphaltic and rigid concrete pavement systems for the proposed parking and drive areas.
- Other applicable geotechnical items included in the Freese & Nichols "Scope of Services – Geotechnical Investigation" document.

The scope of services for this geotechnical exploration did not include an environmental, mold nor detailed seismic/fault assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 SITE DESCRIPTION

The following table provides a generalized description of the existing site conditions based on visual observations during the field activities and other available information.

TABLE 2.1: SITE DESCRIPTION

Site Location Description	Washington Avenue, Laguna Heights, Texas GPS Coordinates (26.07872°, -97.25455°)
Existing Site Conditions	Fenced area for the existing lift station
Existing Grad/Elevation Changes	Relatively level
Existing Site Ground Cover	Grass
Site Boundaries	Residential area

2.2 FIELD EXPLORATION

Field exploration for the project consisted of drilling one (1) boring. The boring design element, boring labels, and approximate depths are provided in the following table.

TABLE 2.2: FIELD EXPLORATION SUMMARY

Design Element	Boring Label	Approx. Depth of Boring
Lift Station	B-1	50 feet

The boring location was selected by PSI personnel and was located in the field using available landmarks and GPS coordinates with a recreation-grade device. Elevations of the ground surface at the boring location was not provided to PSI and should be surveyed by others, if required. Therefore, the references to elevations of various subsurface strata are based on depths below existing grade at the time of drilling. The approximate boring locations are depicted on the Boring Location Plan provided in the Appendix.

TABLE 2.3: FIELD EXPLORATION DESCRIPTION

Drilling Equipment	Truck-Mounted Drilling Equipment
Drilling Method	Continuous-Flight Auger, Hollow-Stem Augers and Mud Rotary Wash
Drilling Procedure	Applicable ASTM and PSI Safety Manual
Field Testing Procedures	Hand Penetrometer Standard Penetration Testing (ASTM D1586)
Sampling Procedure	Split-Barrel Sampling of Soils (ASTM D1586) Thin-Walled Tube Sampling of Soils (ASTM D1587)
Frequency of Groundwater Level Measurements	Initial Reading and Delayed Reading
Boring Backfill Procedures	Soil Cuttings
Sample Preservation and Transportation Procedure	General accordance with ASTM D4220

During the field activities, the encountered subsurface conditions were observed, logged, and visually classified (in general accordance with ASTM D2488). Field notes were maintained to summarize soil types and descriptions, water levels, changes in subsurface conditions, and drilling conditions.

2.3 LABORATORY TESTING PROGRAM

PSI supplemented the field exploration with a laboratory testing program to determine additional engineering characteristics of the subsurface soils encountered. The laboratory testing program included:

- Moisture Content (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Percent Passing the No. 200 Sieve by Wash (ASTM D1140)
- Sieve Analysis of Soils (ASTM D6913)
- Unconfined Compression Strength Test (ASTM D2166)
- Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (ASTM D5084)
- Chloride and Sulfate Content Determination (TxDOT Tex-145-E)

The laboratory testing program was conducted in general accordance with applicable ASTM test methods. The results of the laboratory tests are provided in the Appendix on the Logs of Boring. Portions of samples not altered or consumed by laboratory testing will be retained for 60 days from the date shown this report and will then be discarded.

2.4 SITE GEOLOGY

As shown on the Geologic Atlas of Texas, McAllen-Brownsville Sheet, reprinted in 1979, the site is located in an area where the **Alluvium Deposits (Qas)** formation is mapped at or near the ground surface. The Alluvium Deposits are floodplain deposits of the lower course of Rio Grande and are divided into areas dominantly silt and sand with elements of clay, gravel, and organic matter.

2.5 SUBSURFACE CONDITIONS

The results of the field and laboratory testing have been used to develop a generalized surface profile of the project site. The following subsurface descriptions highlight the major subsurface stratification features and material characteristics. This soil profile descriptions have been summarized in the following table.

TABLE 2.4: GENERALIZED SOIL PROFILE

Layer	Depth of Layer (ft)		Soil Type	Range ω (%)	Range LL (%)	Range PI	Range % Pass. #200	Avg. SPT N-Value
	Top	Bot.						
1	0	6	Fat Clay w Sand	6-20	64	47	73	24
2	6	18	Sandy Lean Clay & Lean Clay w/ Sand	25-27	28-30	12	65-78	4
3	18	43	Silty Sand	21-31	22	NP	23-39	6
4	43	50	Sandy Fat Clay	26-37	67	48	70	11

Note: ω: Moisture Content
LL: Liquid Limit
PI: Plasticity Index
% Pass. #200: Percent Passing the No. 200 Sieve by Wash
SPT N-Value: Standard Penetration Value
NP: Non-Plastic

The boring log included in the Appendix should be reviewed for information at the boring location. The boring log includes soil descriptions, stratifications, locations of the samples, and field and laboratory test data. The stratifications shown on the boring log only represent the conditions at the boring location and represent the approximate boundaries between subsurface materials. The actual transitions between strata may be more gradual or more distinct. Variations will occur and should be expected across the site.

2.5.1 HYDRAULIC CONDUCTIVITY TEST RESULTS

To help evaluate the suitability of the soils for dewatering operations PSI conducted a hydraulic conductivity test on a bulk sample of the Layer 3 Silty Sand recovered during drilling activities. PSI anticipates that the Layer 3 sands will likely have the most influence on groundwater entering into the excavation during construction.

To help evaluate groundwater flow, a falling head hydraulic conductivity test was selected based on the Atterberg Limits and Percent Passing the No. 200 Sieve by Wash test results. Due to the limitations of the test equipment and the characteristics of the silty sand soils, a definitive measurement of hydraulic conductivity could not be obtained. However, based on the data from the testing conducted, the hydraulic conductivity of the Layer 3 Silty Sand is estimated to range from approximately $1.0x10^{-02}$ to $1.0x10^{-03}$ centimeters per second (cm/sec). Estimated soil transmissivities for the 25-foot thick Layer 3 Silty Sand stratum is estimated to range from approximately 6 to 66 square meters per day (m^2/day) or 150 to 710 square feet per day (ft^2/day).

The dewatering subcontractor would typically perform their own field testing to evaluate the hydraulic conductivity and transmissivity values used for their design.

2.5.2 GROUNDWATER INFORMATION

Water level measurements were performed during drilling and after completion of drilling. Specific information concerning groundwater is noted on each boring log presented in the Appendix of this report. The groundwater measurements are summarized in the following table.

TABLE 2.5: GROUNDWATER LEVELS (DEPTHS)

Boring Location	Boring Depth (feet)	During Drilling (feet)	15 Minute Delay (feet)	Cave-In (feet)
B-1	50	23	15	16

Groundwater levels fluctuate seasonally as a function of rainfall, proximity to creeks, rivers and lakes, the infiltration rate of the soil, seasonal and climatic variations and land usage. If more detailed water level information is required, observation wells or piezometers could be installed at the site, and water levels could be monitored.

The groundwater levels presented in this report are the levels that were measured at the time of our field activities. The contractor should be prepared to control groundwater, if encountered, during construction.

3.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

3.1 GEOTECHNICAL DISCUSSION

The geotechnical exploration was performed for a proposed wet well replacement at LMWD Lift Station No. 4. PSI understands the proposed wet well will extend to a maximum depth of 30 feet below the existing ground surface. The soil conditions at the proposal wet well generally consist of stiff to soft clays overlying silty sands. Groundwater was initially encountered at a depth of approximately 23 feet below the ground surface and rose to a depth 15 feet after a 15-minute delay. Based upon soil moisture contents, the groundwater level at the site is believed to be approximately 6 feet below the existing ground surface.

Based upon the information gathered from the soil borings and laboratory testing, PSI is providing recommendations for a mat foundation system and below-grade wall system for the development of the new lift station and associated appurtenances.

PSI understands that caisson construction methods will be used for the development of the lift stations wet well and that shoring will not be required. Dewatering is anticipated to construct the caisson and the mat foundation of the structure. PSI recommends that the groundwater level during construction be maintained at least 3 feet below the bottom excavation.

The following design recommendations have been developed based on the previously described project characteristics and subsurface conditions encountered. If there are changes in the project criteria, PSI should be retained to review the changes to determine if modifications of the recommendations presented in this report will be required. The findings of such a review will be presented in a supplemental report. Once final design plans and specifications are available, a general review by PSI is recommended to verify that the earthwork and foundation recommendations presented in this report have been properly interpreted and implemented within the construction documents.

3.2 LIFT STATION FOUNDATION AND BELOW GRADE WALL DESIGN RECOMMENDATION

3.2.1 MAT FOUNDATION RECOMMENDATIONS

PSI recommends that the lift station be supported on a mat foundation supported on either the natural soils or compacted select fill. Since the depth of the mat foundation is below the groundwater level, a dewatering plan will be required for the construction of the mat foundation.

In addition, the upward buoyancy pressures acting on the bottom of the mat foundation should be considered. Uplift pressures can be resisted by increasing the width of the mat foundation to provide additional soil overburden pressures on the mat. Increased uplift capacity can also be accomplished by increasing the thickness of the mat and walls to increase the weight of the structure.

The following table contains the allowable bearing pressure for a mat foundation that can be used for design of the proposed structure.

TABLE 3.1: MAT FOUNDATION DESIGN PARAMETERS

Foundation Depth Range	25 to 30 feet below final adjacent grade
Design Buoyancy (Uplift) Pressure	1,500 psf (no Factor of Safety)
Allowable Bearing Pressure	1,000 psf with Factor of Safety of 3
Approximate Settlement	Approximately 1 inch
Modulus of Subgrade Reaction (k_1)	70 pci
Sliding Resistance (ultimate)	Utilize a coefficient of friction of 0.2 between the base of the foundation element and underlying material
Passive Resistance (ultimate)	An equivalent fluid weighing 220 pcf may be used to resist lateral forces
Uplift Resistance (ultimate)	Utilize the weight of the foundation concrete and the soil above it. The ultimate uplift resistance can be based on effective unit weights of 110 and 150 pcf for soil and concrete, respectively
Exposed Subgrade Treatment	Remove 12 inches of existing soils below bottom of mat elevation and replace with 12" CLSM (flowable fill) mudmat (100psi)
Dewatering required	Yes, wells or well pointing will be required

3.2.2 BELOW-GRADE WALL DESIGN RECOMMENDATIONS

Conventional concrete below-grade walls may be utilized to support the lift stations wet well walls planned at the subject site. The following tables provide general requirements for the design and installation of below-grade walls at the subject site.

The walls should be designed to resist lateral earth pressures. Equivalent lateral earth pressure values for both at-rest and active earth pressure conditions are shown in the following tables. At-rest values should be use for lift station wall design. The walls should also be designed for additional lateral loads due to any slopes behind the wall, hydrostatic pressures, surcharges and live loads.

- The earth pressure values for the above water table condition correspond to the total unit weight of soil. The earth pressure values below the groundwater table correspond to the buoyant or submerged unit weight of soil.
- The walls should be designed to resist the hydrostatic head in addition to the buoyant lateral earth pressures. The hydrostatic pressures should be accounted for the portion of the walls extending below a depth of 5 feet.
- Additional lateral loads due to surcharge and live loads should also be included in the design. The lateral pressure on the wall due to a uniform surcharge load can be taken as earth pressure coefficient values multiplied by the surcharge pressure. PSI should be contacted to assess the earth pressures, if any structures are located within the close proximity of the below grade walls.

- **Fat CLAY (CH) soils are not recommended for use as backfill material behind the wall.**
- **Coarse materials are the preferred type of backfill to be used during construction.**

TABLE 3.2: LATERAL EARTH PRESSURE COEFFICIENTS

Type of Backfill Behind the Retaining System (Free of organics, other deleterious materials)	Soil Parameters	At-Rest Condition (Backfill)
Lean Clay (CL) PI less than 20 & Max. particle size of 3-inches	γ = 110 pcf, $\phi' = 25^0$	0.58
Clayey Sands (SC)/Silty Sands/ Crushed Limestone	γ = 120 pcf, $\phi' = 30^0$	0.50
Sands (SP) or Sand with silt (SP-SM) Less than 10% fines	γ = 120 pcf, $\phi' = 35^0$	0.43

TABLE 3.3: EQUIVALENT FLUID PRESSURES

Type of Backfill Behind the Retaining System (Free of organics, other deleterious materials)	Soil Parameters	At-Rest Condition (Backfill)[(c)]	
		Above W.T.	Below W.T.[(a)]
Lean Clay (CL) PI less than 20 & Max. particle size of 3-inches.	γ = 110 pcf, $\phi' = 25^0$	72	36
Clayey Sands (SC)/Silty Sands[(b)]/ Crushed Limestone	γ = 120 pcf, $\phi' = 30^0$	63	31
Sands (SP) or Sand with silt (SP-SM)[(b)] Less than 10% fines	γ = 120 pcf, $\phi' = 35^0$	53	27

Notes:
(a) Buoyant Equivalent Fluid Weight: No hydrostatic fluid weight effect of 62.4 pcf; (W.T.): Water Table
(b) Granular Soils: At least a 1 foot clay cap over granular soils at top of the wall
(c) Values are pounds per square foot per foot of wall height

TABLE 3.4: COMPACTION AND TESTING REQUIREMENTS FOR BELOW GRADE WALLS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Requirement
Wall Areas	Subgrade soil	ASTM D698	≥ 95%	0 to +4%	1 per 5,000 SF
	Backfill	ASTM D698	≥ 95%	–1% to +3%	1 per 5,000 SF; min. 3 per lift
	General Fill	ASTM D698	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 per lift

PSI should review the final lift station design documents when complete to observe that the intent of these recommendations has been performed.

3.2.3 BUOYANCY RESISTANCE

Should it not be possible to increase the mat thickness and wall thickness alone to resist buoyancy, drilled pier foundations connected to the mat foundation could be used for this purpose. Uplift resistance would then be the weight of the lift station and mat foundation and uplift resistance of the drilled piers. Uplift resistance from the drilled piers would be the dead weight of the piers plus the allowable skin friction capacity. For these soils, an allowable skin friction of **f_a= 250 pounds per square foot (psf)** is recommended for the soils at depths ranging from 25 feet to 40 feet below existing grade elevation.

Alternatively, helical piles could be installed and connected to the mat to resist buoyancy forces. Typically, the helical pile subcontractor will determine design helical pile capacities based on soil unit weight and undrained strength properties. The following table outlines the soil properties recommended for helical pile design.

TABLE 3.5: SOIL PROPERTIES FOR HELICAL PILE DESIGN

Soil Description	Depth Range (ft)	Total Unit Weight, γ (pcf)	Total Effective Unit Weight, γ_e (pcf)	ϕ (degrees)	C (psf)
Silty sand	25-35	110	48	29	0
Silty sand	35-43.5	115	53	31	0
Sandy Clay	43.5-50	120	58	0	1400

3.3 CORROSION POTENTIAL

Both metal and concrete elements in contact with soil are subject to corrosion or degradation due to the chemical activity of the soil. Therefore, buried metal and concrete elements should be designed to resist this chemical activity.

The corrosion potential of the soils is also dependent on the pH of the soil and chloride content present in the soil. The result of a laboratory chloride content and pH tests performed on selected soil samples obtained from drilling are indicated in the following tables.

TABLE 3.6: CHLORIDE CONTENT AND PH

Depth (ft)	Chloride Content (mg/kg)	pH
8-10	1208	8.7
28-30	1779	8.9

3.3.1 CHEMICAL ATTACK POTENTIAL FOR DEGRADATION OF CONCRETE

The concentration of water-soluble sulfates is considered to be a good indicator of the potential for chemical attack on concrete. Based on ACI Manual of Concrete Practice (ACI 201.2R-10) or (ACI 318/318R-33), the amount of water-soluble sulfate in soil can be used to evaluate the need for protection of concrete based on the following table.

TABLE 3.7: REQUIREMENTS FOR CONCRETE EXPOSED TO SULFATE

Water Soluble Sulfate in soil (percent by weight)	Sulfate Exposure
0.00 to 0.10	Negligible or Class 0 Exposure
0.10 to 0.20	Moderate or Class 1 Exposure
0.20 to 2.00	Severe or Class 2 Exposure
Over 2.0	Very Severe or Class 3 Exposure

The results of the laboratory sulfate ion concentration tests performed on soil samples obtained at the site are as follows.

TABLE 3.8: SULFATE TEST RESULTS

Depth (ft)	Sulfate Content		Cement Type
	mg/kg	Percent by Wt.	
8-10	3427	0.343	Type V (Modified Type II)
28-30	1653	0.165	Any Type

Based on the test results of selected soil samples, the sulfate ion concentration in the upper clays have severe potential for reactions when exposed to concrete. The silty sand underlining the upper clays have a negligible potential for reactions when exposed to concrete. **The actual cement type to be used shall be determined by the project Structural Engineer.**

3.4 SITE SEISMIC DESIGN RECOMMENDATIONS

For the purposes of seismic design, based on the encountered site conditions and local geology, PSI interpreted the subsurface conditions to satisfy the **Site Class E** criteria for use at this site as defined by the International Building Code (IBC). The site class is based on the subsurface conditions encountered at the soil borings, the results of field and laboratory testing, experience with similar projects in this area, and considering the site prepared as recommended herein. The table below provides recommended seismic parameters for the project based on the 2018 edition of the IBC.

TABLE 3.9: RECOMMENDED DESIGN SEISMIC PARAMETERS

Seismic Parameter	IBC 2018
0.2 sec (S_S)	0.038g
1.0 sec (S_1)	0.013g
Site Coefficient 0.2sec, F_a	2.4
Site Coefficient 1.0 sec, F_v	4.2
0.2 sec (S_{DS})	0.061g
1.0 sec (S_{D1})	0.036g

4.0 PAVEMENT DESIGN RECOMMENDATIONS

4.1 PAVEMENT DESIGN PARAMETERS

PSI understands that flexible and rigid pavements will be considered for this project. Therefore, pavement design recommendations for several levels of traffic loading were developed based on assumptions of potential traffic, drive paths or patterns and anticipated soil support characteristics of pavement subgrades. PSI utilized the "AASHTO Guide for Design of Pavement Structures" published by the American Association of State Highway and Transportation Officials to evaluate the pavement thickness recommendations in this report. This method of design considers pavement performance, traffic, roadbed soil, pavement materials, environment, drainage and reliability. Each of these items is incorporated into the design methodology. PSI is available to provide laboratory testing and engineering evaluation to refine the site-specific design parameters and sections, upon request.

Specific design traffic types and volumes for this project were not available to PSI at the issuance of this report. This traffic information is typically used to determine the number of 18-kip Equivalent Single Axle Loads (ESAL) that is applied to the pavement over its design life. Furthermore, the scope of services for this project did not include California Bearing Ratio (CBR) testing. In lieu of project specific design parameters, general traffic and subgrade parameter assumptions were used for this design. Based on this information, PSI has provided recommended pavement sections for "light-duty" and "heavy-duty" pavements constructed on stable and properly prepared/compacted subgrades. Flexible pavement options with and without geogrid options are also provided for consideration. Details regarding the basis for this design are presented in the table below.

TABLE 4.1: PAVEMENT DESIGN PARAMETERS AND ASSUMPTIONS (RIGID AND FLEXIBLE)

Reliability, percent	75
Initial Serviceability Index, Flexible Pavement	4.2
Initial Serviceability Index, Rigid Pavement	4.5
Terminal Serviceability Index	2.0
Traffic Load for Light-Duty Pavement	15,000 equivalent single axle loads (ESALs)
Traffic Load for Heavy-Duty Pavement	150,000 equivalent single axle loads (ESALs)
Standard Deviation, Flexible Pavement	0.45
Standard Deviation, Rigid Pavement	0.35
Concrete Compressive Strength	4,000 psi
Subgrade California Bearing Ratio (CBR)	2.0 for high plasticity clay subgrade
Subgrade Modulus of Subgrade Reaction, k in pci	75 for high plasticity clay subgrade

Pavements supported on expansive soils will be subject to soil movements. The movements typically occur to some degree over the life of the pavement. Consequently, pavements can be expected to crack and require periodic maintenance.

Light-duty areas include parking and drive lanes that are subjected to passenger vehicle traffic only and exclude entrance aprons and general and single access roadway drives to the parking lot area.

Heavy-duty areas include entrance aprons, general and single access roadway drives to the parking lot area, areas subjected to 18-wheel tractor trailers, including loading and unloading areas, and areas where truck turning and maneuvering may occur.

During the paving life, maintenance to seal surface cracks within concrete or asphalt paving and to reseal joints within concrete pavement should be undertaken to achieve the desired paving life. Perimeter drainage should be controlled to prevent or retard influx of surface water from areas surrounding the paving. Water penetration leads to paving degradation. Water penetration into base or subgrade materials, sometimes due to irrigation or surface water infiltration leads to pre-mature paving degradation. Curbs should be used in conjunction with asphalt paving to reduce potential for infiltration of moisture into the base course. Curbs should extend the full depth of the base course and should extend at least 3 inches into the underlying clayey subgrade.

Material specifications, construction considerations, and section recommendations are presented in following sections.

The presented recommended pavement sections are based on the field and laboratory test results for the project, local pavement design practice, design assumptions presented herein and previous experience with similar projects. The project Civil Engineer should verify that the ESAL and other design values are appropriate for the expected traffic and design life of the project. PSI should be notified in writing if the assumptions or design parameters are incorrect or require modification.

4.2 PAVEMENT SECTION RECOMMENDATIONS

PSI anticipated that the drive accesses and parking areas will be used primarily by passenger vehicles, work trucks and delivery vehicles. PSI is providing parking and drive area sections based on experience with similar facilities constructed on similar soil conditions for the design traffic loading anticipated.

4.2.1 FLEXIBLE PAVEMENT

Recommendations for flexible asphaltic concrete pavement are provided below.

TABLE 4.2: FLEXIBLE PAVEMENT ROADWAY AND PARKING AREA SECTION OPTIONS

Material	**Option 1**		**Option 2**	
Traffic Type	Light	Heavy	Light	Heavy
Hot Mix Asphaltic Concrete	2”	3”	2”	3”
Flexible Base	7”	10”	7”	10”
Lime Stabilized Subgrade	8”		n/a	
Geogrid	n/a		Yes	
Compacted Subgrade	n/a		8”	

4.2.2 RIGID PAVEMENT

Recommendations for rigid concrete pavement are provided below.

TABLE 4.3: RIGID PAVEMENT ROADWAY AND PARKING AREA SECTION OPTIONS

Material	Options	
Traffic Type	Light	Heavy
Portland Cement Concrete	5”	7”
Lime Stabilized Subgrade	8”	

4.2.3 GENERAL PAVEMENT DESIGN AND CONSTRUCTION RECOMMENDATIONS

TABLE 4.4: PAVEMENT DESIGN AND CONSTRUCTION RECOMMENDATIONS

Minimum Undercut Depth	6 inches or as needed to remove roots
Reuse Excavated Soils	Free of roots and debris and meet material requirements of intended use
Undercut Extent	2 feet beyond the paving limits
Exposed Subgrade Treatment	Proof-roll with rubber-tired vehicle weighing at least 20 tons. A representative of the Geotechnical Engineer should be present during proof-roll.
Proof-Rolled Pumping and Rutting Areas	Excavate to firmer materials and replace with compacted general or select fill under direction of a representative of the Geotechnical Engineer
General Fill	Materials free of roots, debris, and other deleterious materials with a maximum rock size of 4 inches with a CBR greater than 3
Minimum General Fill Thickness	As required to achieve grade
Maximum General Fill Loose Lift Thickness	9 Inches
Lime Stabilization	Performed in general accordance with TxDOT Item 260. Subgrade stabilized with lime should achieve a pH of 12.4 or greater. Estimated to be 6% hydrated lime by dry weight.
Geogrid	Geogrid should meet TxDOT Item DMS - 6240. Subgrade should be leveled and smoothed prior to geogrid placement on compacted subgrade.
Flexible Base	TxDOT Item 247, Type A, Grade 1-2
Maximum Flexible Base Loose Lift Thickness	9 Inches
Hot Mix Asphaltic Concrete	TxDOT Item 340, Type D
Concrete Minimum Recommended Strength	4,000 psi (avg. 28-day comp. strength)
Concrete Minimum Reinforcement	No. 3 bars, 18 inches on-center each way Located in top half of concrete section Minimum 2 inches cover
Concrete Construction Joint Minimum Reinforcement	¾-inch diameter dowels 14 inches long Spaced 12 inches on-center along the joint

Contraction Joint Spacing **(In General Accordance with ACI 330)**	Maximum joint spacing should be less than 30 times the thickness of the concrete pavement or 15 feet, whichever is smaller.

TABLE 4.5: COMPACTION AND TESTING RECOMMENDATIONS FOR PAVEMENT AREAS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Pavement Areas	Scarified On-site Soil (Subgrade)	ASTM D698	≥ 95%	0 to +4%	1 per 7,500 SF; min. 3 tests
	General Fill	ASTM D698	≥ 95%	0 to +4%	1 per 10,000 SF; min. 3 per lift
	Flexible Base Material	ASTM D1557	≥ 95%	±3%	1 per 5,000 SF; min. 3 per lift

5.0 CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundations, earthwork, pavements and related activities of this project. PSI cannot accept any responsibility for any conditions which deviate from those described in this report, nor for the performance of the foundations or pavements if not engaged to also provide construction observation and materials testing for this project. The PSI geotechnical engineer-of-record should be retained to provide continuing geotechnical consulting services and construction document review, even if periodic on-call testing is contracted with PSI Construction Services.

5.1 INITIAL SITE PREPARATION CONSIDERATIONS

5.1.1 SUBGRADE PREPARATION FOR SITE WORK OUTSIDE FOUNDATION AND PAVEMENT AREAS

Grade adjustments outside of the foundation and pavement areas can be made using select or general fill materials. The clean excavated onsite soils may also be reused in areas not sensitive to movement.

TABLE 5.1: SUBGRADE PREPARATION FOR NON-STRUCTURAL - GENERAL FILL

Minimum Undercut Depth	6 inches or as needed to remove roots, organic and/or deleterious materials
Exposed Subgrade Treatment	Proof-roll with rubber-tired vehicle weighing at least 20 tons. A representative of the Geotechnical Engineer should be present during proof-roll.
Proof-Rolled Pumping and Rutting Areas	Excavate to firmer materials and replace with compacted general or select fill under direction of a representative of the Geotechnical Engineer
General Fill Type	Clean material free of roots, debris and other deleterious material with a maximum particle size of 4 inches
Maximum General Fill Loose Lift Thickness	8 inches

TABLE 5.2: FILL COMPACTION RECOMMENDATIONS OUTSIDE OF FOUNDATION AND PAVEMENT AREAS

Location	Material	Test Method for Density Determination	Percent Compaction	Optimum Moisture Content	Testing Frequency
Outside of Structure or Pavement Areas	General Fill	ASTM D698	≥ 95%	0 to +4%	1 per 10,000 SF; min. 3 per lift

5.1.2 EXISTING SITE CONDITIONS

The following table outlines construction considerations and procedures for abandoning old utility lines and removing trees.

TABLE 5.3: CONSIDERATIONS FOR DEMOLITION

Abandoned Utilities	
Utilities of former structures located within new foundation footprint of proposed structure	Remove pipe, bedding and backfill and then replace with select fill placed using controlled compaction
Utilities of former structures located outside of foundation pad footprint	Abandon in place using a grout plug
Tree Removal	
Trees located within proposed structure footprint; roadways, parking, and sidewalk areas	Remove root system for full vertical and lateral extent and extend removal for at least 3 feet beyond presence of any root fragment and replace void with compacted general fill or flowable fill

5.2 MOISTURE SENSITIVE SOILS/WEATHER RELATED CONCERNS

The soils encountered are sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork, foundation, and construction activities during dry weather.

5.3 FOUNDATION EXCAVATION OBSERVATIONS

The foundation excavations should be observed by a representative of PSI prior to reinforcing steel or concrete placement to assess that the foundation materials are consistent with the materials discussed in this report. This is especially important to identify the condition and acceptability of the exposed subgrades under the foundation. Soft or loose soil zones encountered at the bottom of the beam excavations should be removed to the level of competent soils as directed by the Geotechnical Engineer. Cavities formed as a result of excavation of soft or loose soil zones should be backfilled with compacted select fill or lean concrete.

After opening, excavations should be observed, and concrete placed as quickly as possible to avoid exposure to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If excavations must be left open more than 48 hours, they should be protected to reduce evaporation or entry of moisture.

5.4 DRAINAGE CONSIDERATIONS

Water should not be allowed to collect in or adjacent to foundation excavations, on foundation surfaces, or on prepared subgrades within the construction area either during or after construction. Proper drainage around grade supported sidewalks and flatwork is also important to reduce potential movements. Excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Providing rapid, positive drainage away from the structures and work areas will reduce moisture variations within the underlying soils and will therefore provide a valuable benefit in reducing the magnitude of potential movements.

5.5 EXCAVATIONS AND TRENCHES

Excavation equipment capabilities and field conditions may vary. Geologic processes are erratic and large variations can occur in small vertical and/or lateral distances. Details regarding “means and methods” to

accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor. The comments contained in this report are based on small diameter borehole observations. The performance of large excavations may differ.

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. PSI understands that these regulations are being strictly enforced, and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and Federal safety regulations.

PSI is providing this information solely as a service to the client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and Federal safety or other regulations. A trench safety plan was outside the scope of this project.

6.0 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the client for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional Geotechnical Engineering practices in the local area. No other warranties are implied or expressed. This report may not be copied without the expressed written permission of PSI.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that the engineering recommendations have been properly incorporated in the design documents. At this time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

This report has been prepared for the exclusive use of Freese & Nichols, Inc., for specific application to the proposed LMWD Lift Station No. 4 Improvements to be constructed on Washington Avenue in Laguna Heights, Texas.

APPENDIX

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Site Vicinity Map

Proposed LMWD Lift Station No. 4 IMP
Washington Ave.
Laguna Heights, Texas
PSI Project No.: 03122240

NOT TO SCALE
Google Earth 2021
PLATE 1

N

intertek psi
2020 N. Loop 499, Suite 302
Harlingen, Texas 78550
Office - 956.423.6826

Boring Location Map

Proposed LMWD Lift Station No. 4 IMP
Washington Ave.
Laguna Heights, Texas
PSI Project No.: 03122240

NOT TO SCALE
Google Earth 2021
PLATE 2

N

Proposed LMWD Lift Station No. 4 Improvements
Washington Ave., Laguna Heights, Texas
Project No. 03122240

BORING B-1

LOCATION: 26.07864, -97.25452

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	HAND PEN (TSF) / UNC CMP (TSF)	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
				Elevation: Ukn										2.0 4.0 6.0		
														PL WC LL		
														20 40 60		
				Fat Clay with Sand (CH), medium brown, stiff to firm	6			19								
					10		73	9			64	17	47			
5				- debris encountered	20			50/1"								
				Sandy Lean Clay (CL), medium brown, soft	25		65	3			28	16	12			
					25			3								
10																
				Lean Clay with Sand (CL), medium brown, firm	27		78	5			30	18	12			
15																
				Silty Sand (SM), medium brown, loose	26		23	6								
20																
					31		34	2								
25																
					23			5								
30																

COMPLETION DEPTH: 50.0 Feet
DATE: 2/2/21-2/2/21

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DEPTH TO GROUND WATER
SEEPAGE (ft.): 23 ft
END OF DRILLING (ft.): Cave-In - 16 ft
DELAYED WATER LEVEL (FT): 15-Min - 15 ft

GEO TESTS 03122240 LMWD LS 4.GPJ RBENNETT GW.GDT 3/23/21

Proposed LMWD Lift Station No. 4 Improvements
Washington Ave., Laguna Heights, Texas
Project No. 03122240

BORING B-1

LOCATION: 26.07864, -97.25452

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	HAND PEN (TSF) / UNC CMP (TSF) 2.0 4.0 6.0	PL 20	WC 40	LL 60	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
35					23			8											
40					21		24	7											
45				Sandy Fat Clay (CH), medium brown, stiff	37		70	11			67	20	48						
50					26													1.86	100
55																			
60																			

COMPLETION DEPTH: 50.0 Feet
DATE: 2/2/21-2/2/21

DEPTH TO GROUND WATER
SEEPAGE (ft.): 23 ft
END OF DRILLING (ft.): Cave-In - 16 ft

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GEO TESTS 03122240 LMWD LS 4.GPJ RBENNETT GW.GDT 3/23/21

Symbol Key Sheet

Material Symbols

"FILL"

Clay (CH)

Sandy Clay (CL)

Silty Clay (CL)

Lean Clay (CL)

Asphalt

Clayey Sand (SC)

Sand (SP)

Silty Sand (SM)

Gravelly Sand (SP)

Base

Clayey Silt (ML)

Sandy Silt (ML)

Silt (ML)

Gravelly Silt (ML)

Concrete

Clayey Gravel (GC)

Sandy Gravel (GP)

Silty Gravel (GM)

Gravel (GP or GW)

Conglomerate

Limestone

Marl

Sandstone

Shale

Strength of Cohesive Soils

Consistency	Undrained Shear Strength, KSF
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

Soil Plasticity

Degree of Plasticity	Plasticity Index (PI)
None	0 to 5
Low	5 to 10
Moderate	10 to 20
Plastic	20 to 40
Highly Plastic	more than 40

Density of Granular Soils

Descriptive Term	SPT Blow Count (blows/ft)
Very Loose	less than 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Standard Penetration Test (ASTM D 1586) Driving Record

Note: Driving is limited to 50 blows per interval, or 25 blows for 0.25 inch advancement, whichever controls. This is done to avoid damaging sampling tools.

Blows Per Foot	Description
25	Sampler was seated 6 inches, then 25 blows were required to advance the sampler 12 inches.
75/8"	Sampler was seated 6 inches, 25 blows were required for the second 6 inch increment and the 50 blow limit was reached at 2 inches of the last increment.
Ref/2"	Sampler could only be driven 2 inches of the 6 inch seating penetration before the 50 blow limit was reached.

Terms Characterizing Structure

Soil Terms	Description
Blocky	Contains cracks or failure planes resulting in rough cubes of material.
Calcareous	Contains appreciable quantities of calcium carbonate.
Fissured	Contains shrinkage cracks, which are frequently filled with fine sand or silt. The fissures are usually near vertical in orientation.
Interbedded	Composed of alternating layers of different soil types.
Laminated	Composed of thin layers of varying color and texture.
Nodules	Secondary inclusions that appear as small lumps about 0.1 to 0.3 inch in diameter.
Partings	Inclusion of different material less than 1/8 inch thick extending through the sample.
Pockets	Inclusion of different material that is smaller than the diameter of the sample.
Seams	Inclusion of different material between 1/8 and 3 inches thick, and extends through the sample.
Slickensided	Has inclined planes of weakness that are slick and glossy in appearance. Slickensides are commonly thought to be randomly oriented.
Streaks or Stains	Stains of limited extent that appear as short stripes, spots or blotches.

Rock Terms	
Bedding Plane	A surface parallel to the surface of deposition, generally marked by changes in color or grain size.
Fracture	A natural break in rock along which no displacement has occurred.
Joint	A natural break along which no displacement has occurred, and which generally intersects primary surfaces.
% Recovery	The ratio of total length of recovery to the total length of core run, expressed as a percentage.
RQD - Rock Quality Designation	The ratio of total recovered length of fragments longer than 4 inches to the total run length, expressed as a percentage.
Weathering	The process by which rock is broken down and decomposed.

Sampler Symbols

Flight Auger

Core Barrel

Disturbed Shelby Tube (3")

No Recovery

Grab Sample

Undisturbed Shelby Tube (3")

SPT Sample

intertek psi

APPENDIX B

Professional Service Industries, Inc. (PSI)
2020 North Loop 499, Suite 302,
Harlingen, TX 78550
Phone: (956) 423-6826

May 24, 2021

Freese & Nichols, Inc.
9601 McAllister Freeway, Suite 1008
San Antonio, Texas 78216

Attn: Ms. Jacqueline McMahon, E.I.T.

Re: **Construction Materials Testing and Observation Proposal**
Proposed Laguna Madre Water District (LMWD) Lift Station Rehabilitation No. 1
Port Isabel, Texas
PSI Proposal No.: 0328-325159-R1

Dear Ms. McMahon:

Professional Service Industries, Inc. (PSI), an Intertek company, is pleased to submit the following proposal to perform Construction Materials Testing and Observation Services on the proposed above referenced project.

PSI proposes to provide experienced, technical personnel to perform testing services as requested in general accordance with sections of the project specifications. In accordance with our assumptions, we have prepared a budget estimate. However, we propose to accomplish the work on a unit fee basis in accordance with the unit rates provided herein. PSI's fees will be determined by the actual amount of technical time expended on the project and the amount of laboratory testing performed. Services are for the typical Quality Control Services.

Please note that the fees for our services are directly related to the contractor's schedule, the quantity of service requests, the quantity and frequency of failed tests / retests, construction delays and other issues outside the control of PSI. We will work with your firm in order to control the budget for our services; however, invoices will be based on the actual services rendered.

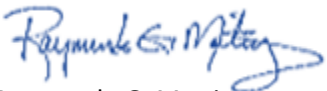
Construction Hive™ is the primary report distribution platform used by PSI to provide a better experience to our clients. You will have 24-hour access to your reports on this website from any internet enabled device with a web browser. Construction Hive™ has powerful report viewing, retrieval and searching capabilities that allow you to find the information you are looking for faster and with greater ease.

This proposal includes our services to observe, test and report on the construction activities listed below. Please note that our services will be performed on an intermittent, call-out, as requested basis. This proposal does not include full time (continuous) on-site observation services. Scheduling will be the responsibility of our client's designated representative. Requests for services must be coordinated prior to the close of the business day preceding the requested activity.

PSI will proceed with the work based on written authorization. The work will be performed pursuant to the Master Subconsultant Agreement between Freese & Nichols and PSI and signed on December 13, 2013.

We look forward to providing our services during construction of the above referenced project. Please do not hesitate to contact our office with any questions or concerns.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.



Raymundo G. Martinez
Branch Manager

Rockford Miller, E.I.T.
Staff Engineer

Attachments: Assumptions Based on Plans and Specifications
Anticipated Construction Materials Testing Services Fee Schedule
Construction Services Schedule of Fees and Services May 2021
PSI General Notes
Project Data Sheet

Assumptions Based on Plans and Specifications	
Plans and Specifications	*Plans*: LMWD Lift Station Rehabilitation No. 1, dated May 2021 and prepared by Freese & Nichols, Inc. *Specifications*: LMWD Lift Station Rehabilitation No. 1, Vol. I & II dated May 2021 and prepared by Freese & Nichols, Inc.
Location	Laguna Vista, Laguna Heights & Port Isabel, Texas
Overview	4 Lift Stations that are to be Rehabilitated and/or Replaced. Apx. 5,800 linear feet of Utility Trenching for piping that ranges in depth of 3 to 15 feet. Asphaltic Concrete paving for replacement at open trench locations and within the Port Isabel WWTP and Jack and Bore construction underneath SH-100.
Utility Trenching	A combination of On Site Soils Backfill, Sand Backfill, Cement Stabilized Backfill and Flowable Fill. Assumed One in place nuclear density test for every 300 linear feet at 4 inch lifts
Concrete Testing	Testing of Lift Station foundations, surface flatwork and pavement curbing. Concrete field testing and creation of 1 set of 4 concrete cylinders for compression testing. Assuming 2 tested at 7 days and 2 at 28 days.
Pavements	Asphaltic Concrete paving for replacement at open trench locations. Lab testing the asphalt and flexible base materials and field testing during installation to include in place density testing on flexible base for every 300 linear feet, in place nuclear density testing using thin lift gauge for asphalt rolling pattern.

Anticipated Construction Materials Testing Services
Project: LMWD Lift Station Rehabilitation Project No. 1
Location: Port Isabel, Texas

	Unit	Quantity
Utility Trenching Backfill		
Laboratory Moisture Density Relationship for On Site Soil Backfill (Standard Proctor)	Each	2
Atterberg Limits on On Site Soil Backfill	Each	2
Percent Passing No. 200 sieve for On Site Soil Backfill Backfill	Each	2
Laboratory Moisture Density Relationship for Sand Backfill (Standard Proctor)	Each	2
Percent Passing No. 200 sieve for Sand Backfill	Each	2
Laboratory Moisture Density Relationship for Cement Stabilized Backfill (Standard Proctor)	Each	2
Percent Passing No. 200 sieve for Cement Stabilized Sand Backfill	Each	2
Cement Stabilized Backfill Compression Testing	Each	4
Senior Engineering Technician (In-place Density Testing on Trenching Backfill)	Each	320
Senoir Engineering Technician (Flowable Fill Sampling, Testing and Field Observations)	Per Hour	18
Flowable Fill Cylinders (Cured and/or Tested in Compression - Set of 4)	Each	24
Transportation Charge	Each	32
Management Services for Supervision and Report Review	Per Hour	37
Pavements		
Laboratory Moisture Density Relationship for Flexible Base (Standard Proctor)	Each	2
Atterberg Limits for Flexible Base	Each	2
Mechanical Grain Size Analysis for Flexible Base	Each	2
Senior Engineer Technician (In-place Density Testing on Flexible Base)	Each	20
Aspahaltic Concrete Extraction/Gradation	Each	2
Asphalt Placement Monitoring (Engineering Technician w/ Thin Lift Gauge)	Per Hour	12
Asphalt Concrete Cores and Thickness Detemination	Each	8
Asphaltic Concrete Core Specific Density	Each	8
Transportation Charge	Each	12
Management Services for Supervision and Report Review	Per Hour	6
Concrete Testing		
Engineering Technician (Concrete Sampling and Testing)	Per Hour	24
Engineering Technician OT (Concrete Sampling and Testing) If Required	Per Hour	6
Concrete Cylinders for Lift Stations (Cured and/or Tested in Compression - Set of 4	Each	32
Senoir Engineering Technician (Reinforced Concrete Inspections)	Each	7
Transportation Charge	Each	16
Management Services for Supervision and Report Review	Per Hour	8

PSI General Notes
1. Unit prices/rates are in effect for 12 months from the submittal date of this proposal and are subject to a 4% annual increase thereafter.
2. Services not included may be quoted upon request.
3. Testing is conducted in general accordance with ASTM procedure and project specifications.
4. All rates are billed on a portal to portal basis.
5. The minimum billing increment for time is the full hour. All hours will be rounded to the next whole hour.
6. A minimum charge of 4 hours applies to field testing and observation services.
7. A per diem charge, if applicable, will be charged at a rate of $150.00 per day.
8. Scheduling or cancellation of field testing and observation services is required no less than the working day prior to the date the services are to be performed. Services scheduled same day will be assessed an additional $100 fee. Services cancelled without advance and/or inadequate notice will be assessed a minimum $150 fee.
9. Charges for retests or field cancellations without notice are not included in this estimate and will be invoiced at the unit rates included herein.
10. Overtime rates will be applicable for services performed before 7:00am and after 5:00pm, over 8 hours per day Monday through Friday and for all hours worked on Saturdays. The overtime rate will be 1.5 times the applicable unit rate. Services performed on Sundays and Holidays will be invoiced at 2 times the applicable hourly rate. Surcharges for laboratory services during overtime hours or for expedited results may apply (these surcharges will be 1.5 times the applicable unit rate). The minimum billing increment for overtime is the hour.
11. Holidays observed in 2018 by PSI are New Year's Day, Good Friday, Memorial Day, Independence Day, Labor Day, Thanksgiving Day & Friday following, Christmas Eve, Christmas Day and following day.
12. Rates involving mileage (including vehicle charge and cylinder/sample pick-up) are subject to change based upon fluctuations in the national average gasoline price. A fuel surcharge may be applied to invoices to offset the increase in fuel prices for a gallon of regular gasoline. Changes may be made at intervals not less than monthly.
13. Review charge to schedule, supervise personnel, evaluate and review reports will be billed at $26.00 per report for all field and laboratory reports.
14. Invoices will be billed on a monthly basis. Invoices will be mailed on or about the third business day after the month to which services were rendered.
15. Concrete test cylinder sizes will be in accordance with ASTM C31 and ACI 318.
16. ACI 301-10 section 1.6.2.2.d, states that the contractor is responsible for "[providing] space and source of electrical power on the project site for facilities to be used for initial curing of concrete test specimens as required by ASTM C31/C31M, for the sole use of the Owner's quality assurance testing agency." PSI understands the term "space" to mean "an environmentally controlled and secure space" for initial curing in the field, and the contractor is required to provide electricity and security of the space. Accordingly, this proposal does not include provisions or the associated fee for PSI to provide this service. The initial curing box can be provided by PSI at the project site for additional fees which shall include the daily rental cost and associated mobilization cost of the curing box. In the event the curing box is stolen or damaged as the site security is the responsibility of the contractor, PSI shall invoice our client the cost of the same at cost plus 15%.
17. The services proposed herein are conventional in nature and do not include any special services that may lessen the risk of conditions that can contribute to moisture, mold or other microbial contaminate amplification in buildings. You may be aware that mold is abundant throughout nature and is comprised of a wide variety of microscopic fungi. Due to its nature, the potential for mold infestations cannot be completely eliminated. However, PSI offers a wide array of professional Moisture, Waterproofing, Roofing and Indoor Air Quality/Mold Consulting services that can help minimize the likelihood of future occurrences. PSI is interested in discussing these service options with you to suit your specific needs and project objectives. If requested, PSI will submit a proposal for these additional services under a separate cover for your review and authorization.

Project Data Sheet
Construction Materials Testing and Observation Services

Project Name:			
Project Physical Address:			
Project Manager:			
Mobile No.:		**Email Address:**	
Site Contact:			
Mobile No.:		**Email Address:**	

Distribution of Test Reports	
Contact Name	**Email Address**

Invoice Requirements			
Your Purchase Order No.:			
Billing Address		**Mailing Address (if different)**	
Attn:		**Attn:**	

Report Distribution:

PSI will deliver reports electronically to the client and others listed on the above distribution list. Reports will be posted on a password protected, secure website (Construction Hive) only available to those on the distribution list. An hourly administrative fee may be assessed for hardcopy mailing and other forms and methods of report delivery.