TECHNICAL SPECIFICATIONS

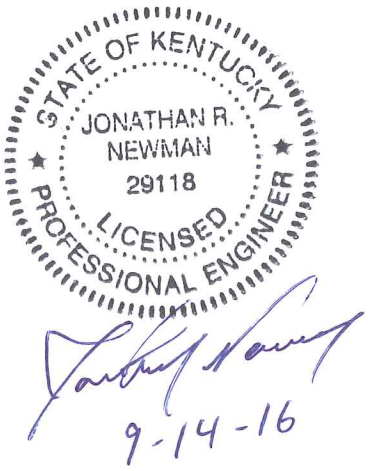
Douglas Wastewater Treatment Plant Expansion

May, 2016

Prepared for:

MWD
Mountain Water District

Mountain Water District
Pikeville, Kentucky



Prepared by:

SUMMIT ENGINEERING INC.

131 Summit Drive, Pikeville, Kentucky 41501 Phone 606-432-1447

Mining Engineering
Architecture

Civil Engineering
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Environmental
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TECHNICAL SPECIFICATIONS

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SECTION 01000

SCOPE OF WORK

PART 1: GENERAL

1.01 LOCATION OF WORK

A. The work of this Contract is located at Douglas in Pike County, Kentucky.

1.02 WORK TO BE DONE

The Contractor shall furnish all materials, labor, equipment and incidentals required to complete and make ready for operation, the Douglas Wastewater Treatment Plant Expansion Project, shown on the Drawings and/or specified herein. The work shall include but is not necessarily limited to the following:

A. CONTRACT 1:

1. Influent Lift Station
2. Plant Headworks & Screening
3. MBR Tank Construction
4. MBR Equipment Installation
5. Equipment Building
6. Ultraviolet Disinfection Upgrade
7. SCADA Upgrade
8. Sludge Processing
9. Influent Flow Metering
10. Yard and Process Piping
11. Paving
12. Regrade and Seeding
13. Instrumentation and Controls
14. Electrical Work

1.03 ABBREVIATIONS AND REFERENCES

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACT	American Concrete Institute
AFBM	Anti-Friction Bearing Manufacturers' Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers' Association
AWPB	American Wood Preservers' Bureau
AWS	American Welding Society
AWWA	American Waterworks Association
BHMA	Builders' Hardware Manufacturers' Association
CBMA	Certified Ballast Manufacturers Association
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers' Association of America
CRSI	Concrete Reinforcing Steel Institute
Fed.Spec.	Federal Specifications
FM	Factory Mutual
HI	Hydraulic Institute
HMI	Hoist Manufacturers' Institute
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers, Inc.

IPCEA	Insulated Power Cable Engineers' Association
JIC	Joint Industry Conferences of Hydraulic Manufacturers
MMA	Monorail Manufacturers' Association
NBHA	National Builders' Hardware Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
NEPA	National Fire Protection Association
NLMA	National Lumber Manufacturers' Association
NWWA	National Woodwork Manufacturers' Association
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety and Health Act (both Federal and State)
PS	Product Standards Sections - U.S. Department of Commerce
IRMA	Rubber Manufacturers' Association
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
TCA	Tile Council of America
TEMA	Tubular Exchanger Manufacturers' Association
UBC	Uniform Building Code
UL	Underwriters' Laboratories, Inc.
WWPA	Western Wood Products Association

Where reference is made to a specification by one of the above mentioned or other associations, it is understood that the latest revisions thereof shall apply.

END OF SECTION

SECTION 01010

SPECIAL PROVISIONS

PART 1: GENERAL

1.01 JURISDICTION & DISPUTES

A. It shall be the responsibility of the Contractor to pay all costs that may be required to perform any of the Work shown on the Contract Drawings or specified herein in order to avoid any work stoppages due to jurisdictional disputes. The basis for subletting work in question, if any, shall conform with precedent Agreements and decisions on record with the Building and Construction Trades Department, AELCIC, dated June, 1973, including any amendments thereto.

B. **Special attention is called to Article 7 of the General Conditions. More specifically the Contractor's attention is called to Article 7.03B. The Contractor is liable for claims by other contractors on the project arising from failure to complete work on time. See also section 1.02 of these Special Provisions.**

1.02 START UP, SUBSTANTIAL COMPLETION, COMPLETE AND READY FOR FINAL PAYMENT

A. Start Up Requirements – for the Contract to be deemed ready to commence the start up period (see item 1.02B), the Contractor shall have completed the following:

1. All plant mechanical (and chemical systems) have been successfully tested,

2. The Owner's Operators have been successfully trained on operation of the plant and its components,

3. The Owner has filed written notice with the Division of Water that the plant has initiated operation.

B. Start Up Period - The start up period commences after the startup requirements have been met.

The Owner's certified operator shall be responsible for operations during start up.

During the start up period the Contractor will be required to:

1. Be responsible for compliance testing as needed to comply with these specifications.

2. Maintain operation of existing plant until new plant is ready for service. Contractor must coordinate any interruption of plant processes with the Owner.

3. Facilitate any training required by manufacturers of equipment outside of Ovivo scope of supply. Ovivo will provide training for its equipment.

4. Continue construction of the outstanding Work of the contract.

C. Substantial Completion – See General Conditions, Article 14.

D. Complete and Ready for Final Payment – See General Conditions, Article 14.

1.02 PROTECTION AGAINST ELECTROLYSIS

A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

1.03 OPERATING INSTRUCTIONS AND PARTS LISTS

A. Where reference is made in the Specifications to Operating Instructions and spare parts lists, the Contractor shall furnish, for each piece of equipment, complete sets giving the information listed below:

1. Clear and concise instructions for the operation, adjustment, and lubrication and other maintenance of the equipment. These instructions shall include a complete lubrication chart.

2. List of all parts for the equipment, with catalog numbers and other data necessary for ordering replacement parts. Include a detailed exploded view of all major equipment or components.

B. Such instructions and parts lists shall be annotated to indicate only the specific equipment furnished. Reference to other sizes and types or models of similar equipment shall be deleted.

C. Such operating instructions and parts lists shall be delivered to the Engineer at the same time that the equipment to which they pertain is delivered to the Site.

1.06 BOLTS, ANCHOR BOLTS AND NUTS

A. All necessary bolts, anchor bolts, nuts, washers, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith unless otherwise specified. Anchor bolts shall be amply sized for the conditions imposed and have suitable washers and, where so required, their nuts shall be hexagonal.

B. All anchor bolts, nuts, washers, plates, and bolt sleeves unless otherwise indicated or specified shall be 316SS. Materials of construction shall be consistent unless otherwise indicated or specified.

C. Unless otherwise specified, stud, tap, and machine bolts, and nuts shall conform to the requirements to the latest ASTM Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to the latest AN Standard Bl.l for Unified Inch Screw Threads (UN and UNR Thread Form).

D. Bolts, anchor bolts, nuts and washers, specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with the latest ASTM Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates; Bars, and Strip, Designation A123, or the latest ASTM Standard Specifications for Zinc Coating (Hot Dip) on Iron and Steel Hardware, Designation A153, as is appropriate.

E. The Contractor shall submit with the shop drawings anchor bolt location plans showing location and depth of embedment for all anchor bolts supplied.

1.07 SLEEVES AND OPENINGS

A. The Contractor shall provide all openings, channels, chases, etc., and furnish and install anchor bolts and other items to be embedded in concrete, as required to complete the Work under this Contract, and shall do all cutting and patching required.

1.9 MATERIAL SAFETY DATA SHEETS

A. Five copies of Material Safety Data Sheets (MSDS) shall be furnished to the Engineer by the Contractor for delivery to the Owner for all chemical supplies such as polymers, paints, solvents, chemicals and lubricants specified for delivery as part of the Contract.

1.10 CONSTRUCTION PHOTOGRAPHS

A. The term "photograph" as used herein refers to a photographic view, including similar exposures taken to assure the usefulness of the photographic record. All photographs shall be taken in color, not black and white.

B. The Contractor shall have twelve (12) photographs of the undisturbed site taken prior to the start of construction. The same views shall be rephotographed upon completion of all construction activities.

C. The Contractor shall have an average of fifty (50) photographs per month made of the work during its progress and fifty (50) photographs of the completed facilities, in addition to those required above in paragraph B. The photographs shall be of such views and taken at such times as the Engineer directs.

D. Prior to construction of additions or modifications to existing structures, there shall be taken for each existing structure a minimum of twelve (12) photographs to be used for indicating the condition of existing structure. These photographs shall be in addition to those specified above.

E. All photographic work shall be done by a qualified, established commercial photographer acceptable to the Engineer. All photographs shall be of the digital nature and be .JPG files of 5 MP or better quality.

The Contractor shall submit one (1) CD or DVD prior to each progress meeting containing all photographs of the construction efforts taken during the current pay period.

The Contractor shall submit three (3) CD's or DVD's upon completion of the project containing ALL construction photographs taken during the life of the project.

F. The all photo files shall be retained in the files of the photographer until the completion of the project and shall then be turned over to the Engineer. The photographer shall release all copyrights, or other restrictions, on the use of the photographic prints and film negatives.

G. **Each photograph shall be time and date stamped on the face of the photo in the .JPG file. Each photograph shall also be accompanied by a description of the work depicted in the photo.**

1.12 VALVE INDICES

A. The Contractor shall be responsible for field locating all new installed valves and

tagging with 316 stainless steel tags. Each valve's tag shall be stamped with a number and words to identify the valve's function and normal operating position. The coding System shall be provided to the Owner for review at least fourteen (14 days) prior to start-up of the equipment. The size of the non-corrosive tag shall be 2 inches in diameter and 19 gage thick or approved equal. Each tag shall be securely attached to each valve by non-corrosive metal wire. All letters and/or numbers shall be enamel filled unless otherwise specified.

1.13 NAMEPLATES

A. With the exceptions mentioned below, each piece of equipment shall be provided with a substantial stainless steel nameplate, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, year of manufacture, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate. The NAMEPLATES shall not be painted.

B. This requirement shall not apply to gate, globe, check, and plug valves.

1.14 EQUIPMENT DRIVE GUARDS

A. All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members unless specified to be stainless steel. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

1.15 FISH AND WILDLIFE

A. The Contractor shall not remove trees larger than 5-inches in diameter at breast height between the dates, March 31 and October 15.

The Contractor is required to comply with all Indiana Bat Conservation Requirements as set forth by the United States Department of the Interior, Fish and Wildlife Service. It is the Contractor's responsibility to obtain any and all permits or surveys pertaining to the Indiana Bat and bear all costs associate therewith.

1.16 PROGRESS MEETINGS

A. The Contractor shall schedule and administer the progress meetings. It shall be

the Contractor's responsibility to prepare agenda, distribute written notice of the meetings, make physical arrangements for meetings and preside at the meetings. The Engineer will record the meeting minutes and distribute copies of minutes within ten (10) days after each meeting. Regular meetings shall be scheduled at a time mutually agreed upon by the Contractor and the Engineer. The Engineer shall call special meetings as progress of work dictates. The meetings will be held in the Contractor's construction trailer, or as directed by the Engineer.

B. The meetings will be attended by the Owner's representatives, the Contractor, and/or subcontractors as pertinent to agenda.

At a minimum the agenda will include the following:

1. Review of the previous meetings;
2. Review of the work progress since last meeting;
3. Discussion of field observations, problems, and decisions;
4. Identification of problems which impede planned progress;
5. Review of any off-site fabrication problems;
6. Discussion of Corrective measures and procedures to regain planned schedule;
7. Review of the Construction Schedule as Indicated;
8. Plan progress during next work period;
9. Review submittal schedules, and expedite as required to maintain schedule;
10. Review the maintenance of quality and work standards;
11. Review any changes proposed by Owner for:
    a. Effect on Construction Schedule;
    b. Effect on Completion date
12. Complete other current business;
13. Coordinate projected progress with other contractors on the project site.

1.17 PROGRESS SCHEDULE

A. The Contractor shall provide the Engineer with a progress schedule as required by the General Conditions. The Contractor is responsible for the proper coordination of his work so as to maintain the schedule as approved.

B. The Contractor's progress schedule shall, at a minimum, indicate in detail the following:

1. The proposed sequence of the Work, with a minimum of operational interruption of the existing facilities.
2. The plan of construction to be employed.
3. Construction activities, correlating with those required for the Schedule of Values.

4. Estimated start and completion dates for each stage of the work and each specific construction activity in order to:

   a. Complete the Work within the contract time.
   b. Schedule progress payments.
   c. Conform with the Schedule of Values.
   d. Provide outlay management information.

END OF SECTION

SECTION 01055

CONSTRUCTION STAKING

1.01 SCOPE

The CONTRACTOR shall furnish all necessary personnel and equipment to provide all customary construction surveys including, but not limited to, the following:

a) Establish right-of-way and construction easement limits.

b) Establish the project construction centerlines

c) Provide adequate reference points to permit prompt re-establishment of the construction centerline throughout the construction.

d) Grade staking

e) Structure staking

f) Establish final “as-built” plan and profile location of all completed facilities and depict same on record drawings.

The CONTRACTOR's staking (survey) party shall be under the general supervision of an ENGINEER registered in the State of Kentucky. IT SHALL BE UNDERSTOOD THAT SUPERVISION OF THE CONSTRUCTION STAKING PARTY IS SOLELY THE RESPONSIBILITY OF THE CONTRACTOR AND ANY ERRORS AND INACCURACIES RESULTING FROM THE OPERATIONS OF THE CONSTRUCTION STAKING PARTY SHALL BE CORRECTED AT NO COST TO THE OWNER.

1.02 SUBMITTALS

Upon completion of the project, the CONTRACTOR shall submit the following to the ENGINEER:

a) the field notes,

b) 'as built' plans on mylar media, of no less scale than the design drawings depicting the “as built” plan and profile location of all constructed facilities.

END OF SECTION

SECTION 01056

QUALITY CONTROL

1.01 CODES, STANDARDS AND INDUSTRY SPECIFICATIONS

A) Material or operations specified by reference to published specifications of a manufacturer, testing agency, society, association or other published standards shall comply with requirements in latest revisions thereof and amendments or supplements thereto in effect on date of Advertisement for Bidders.

B) Discrepancies between referenced codes, standards, specifications and Contract Documents shall be governed by the latter unless written interpretation is obtained from ENGINEER.

C) Material or work specified by reference to conform to a standard, code, law, or regulation shall be governed by Contract Document when they exceed requirements of such references; referenced standards shall govern when they exceed Contract Documents.

D) Proof of Compliance:

Whenever Contract Documents require that a product be in accordance with Federal Specification, ASTM designation, ANSI specification, or other association standard, at ENGINEER'S request, CONTRACTOR shall present an affidavit from manufacturer certifying that product complies therewith. Where requested or specified, submit supporting test data to substantiate.

1.02 MANUFACTURER'S DIRECTIONS

Utilize manufactured articles, materials and equipment as directed by manufacturers unless herein specified to contrary. Discrepancy between an installation required by Contract Documents and manufacturer's instructions and recommendations shall be resolved by ENGINEER before work may proceed. In all cases, the more stringent requirements shall govern.

1.03 TESTING

A) All testing (when required) will be in accordance with the pertinent codes and regulations and with selected standards of the American Society for Testing and Materials.

B) The OWNER will select the testing laboratories.

C) The CONTRACTOR will bear the cost of all testing unless directed otherwise.

END OF SECTION

SECTION 01100

SPECIAL CONDITIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This specification sets forth OWNER'S special project requirements that are UNIQUE to this project. All requirements of this section shall be considered as integral parts of the successful completion of the Project. All items discussed herein are considered incidental to the overall accomplishment of the Project and no separate payment shall be made for these items.

1.2 PROJECT LIMITS AND ACCESS

A. Access to Site is from a public road. Parking shall be confined to an area designated by Owner.

B. Public access to the lake and adjacent recreation areas may not be restricted during construction.

1.3 CONFLICTING ELEMENTS

A. In the event of a conflict between the elements of the Contract Documents, the MORE STRINGENT REQUIREMENT ON THE CONTRACTOR SHALL GOVERN.

1.4 COMMUNICATIONS

A. The CONTRACTOR shall coordinate all work through the ENGINEER.

B. The CONTRACTOR shall notify the OWNER and ENGINEER at least 10 calendar days prior to any construction activity at the site.

1.5 WORKING HOURS

A. Regular working hours shall begin no earlier than 7:00 a.m. and end no later than 7:00 p.m., Monday through Friday.

1.6 EXISTING UTILITIES

A. CONTRACTOR is responsible for locating any existing utilities. He/She is advised that they may elect to contact Before-U-Dig at 1-800-752-6007 no less than two days and no later than 10 days prior to excavation, so that any utility companies that subscribe to this service may be contacted and their lines flagged.

B. Utility outages and shutdown must be coordinated with utility companies.

1.5 HAZARDOUS MATERIALS

C. CONTRACTOR is advised that if any suspected toxic materials or containers with significant volume of free liquid (other than water) are found, the CONTRACTOR shall notify the OWNER immediately. It is not the responsibility of the CONTRACTOR to remove any hazardous materials.

END OF SECTION

SECTION 01110

CONTROL OF MATERIALS

PART 1: GENERAL

1.01 APPROVAL OF MATERIALS

A. Only new materials and equipment shall be incorporated in the Work except where indicated otherwise on the Contract Drawings or directed otherwise by the Engineer. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the Site without prior approval of the Engineer.

B. As soon as possible after the Contract has been executed, the Contractor shall submit to the Engineer, data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the Specifications.

C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the Work, the Contractor shall submit samples of materials for such special tests as may be necessary to demonstrate that they conform to the Specifications. Such samples shall be furnished, stored, packed, and shipped as specified in the General Conditions at the Contractor's expense. Except as otherwise noted, the Contractor will pay for the tests.

D. The Contractor shall submit data and samples sufficiently early to permit consideration and approval before materials are necessary for incorporation in the Work. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.

E. When required, the Contractor shall furnish to the Engineer triplicate sworn copies of manufacturer's shop or mill tests (or reports from independent testing laboratories) relative to materials and equipment performance ratings.

F. After review of the samples, data and test reports, the materials and equipment used on the Work shall in all respects conform therewith.

G. If the Work is to be inspected on behalf of the Owner during its fabrication, manufacture, or testing, or before shipment, the Contractor shall give notice to the Engineer of the place and time where such fabrication, manufacture, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Engineer in ample time so that the necessary arrangements for the inspection can be made.

H. In order to demonstrate the proficiency of workmanship or to facilitate the choice among several textures, types, finishes, and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.

1.02 HANDLING AND STORAGE OF MATERIALS

A. All materials and equipment to be incorporated in the Work shall be handled and stored by the manufacturer, fabricator, supplier and Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft or damage of any kind whatsoever to the material or equipment.

B. Cement, lime, and grout materials shall be stored under a roof and off the ground and shall he kept completely dry at all times. All miscellaneous reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting.

C. All mechanical equipment shall be stored in a building to prevent injury. The building may be a temporary structure on the Site or elsewhere, but it must be satisfactory to the Engineer.

D. All materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the Site, and the Contractor shall receive no compensation for the damaged material or its removal.

E. All pipe and other materials delivered to the job shall be unloaded and placed in a manner which will not hamper the normal operation of the existing facility or interface with the flow of necessary traffic.

F. All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation.

G. Oil lubricated gearing and bearings, are to be shipped with an oil soluble protective coating as recommended by the Equipment Manufacturer. The coating selected is to provide protection against moisture for a period of eighteen (18) months minimum and be easily removed.

H. All equipment requiring Special storage or handling such as protection from freezing, moisture and heat shall be clearly marked on the outside of the shipping container.

I. Storage and demurrage charges by transportation Companies and vendors shall be borne by the Contractor.

J. All deliveries shall be labeled with the Contractor's name and work site.

END OF SECTION

SECTION 01120

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

B. Construction Facilities:
1. Parking.
2. Progress cleaning and waste removal.

C. Temporary Controls:
1. Barriers.
2. Dust control.

D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

A. Owner will pay cost of energy used. Exercise measures to conserve energy. Utilize Owner's existing power service.

B. Complement existing power service capacity and characteristics as required for construction operations.

C. Provide power outlets, with branch wiring and distribution boxes located as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment.

D. Permanent convenience receptacles may not be utilized during construction.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain lighting as required for construction operations.

B. Maintain lighting and provide routine repairs.

C. Permanent building lighting may be utilized during construction.

1.4 TEMPORARY WATER SERVICE

A. Owner will pay cost of temporary water. Exercise measures to conserve energy. Utilize Owner's existing water system, extend and supplement with temporary devices as needed to maintain specified conditions for construction operations.

1.5 TEMPORARY SANITARY FACILITIES

A. Provide temporary toilet facilities for use by construction workers.

1.6 FIELD OFFICES AND SHEDS

A. Designated existing spaces may be used for field offices and for storage, coordinate location with owner.

B. Storage Areas And Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01600.

C. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.7 VEHICULAR ACCESS

A. Location as approved by Owner

B. Provide unimpeded access for emergency vehicles. Maintain 20 feet wide driveways with turning space between and around combustible materials.

C. Provide and maintain access to fire hydrants and control valves free of obstructions.

D. Use designated existing on-site roads for construction traffic.

1.8 PARKING

A. Locate as approved by Owner.

B. When site space is not adequate, provide additional off-site parking.

C. Use of designated existing on-site streets and driveways used for construction traffic is permitted. Tracked vehicles not allowed on paved areas.

D. Use of designated areas of existing parking facilities used by construction personnel is permitted.

E. Do not allow heavy vehicles or construction equipment in parking areas.

F. Permanent Pavements And Parking Facilities:

1. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.

G. Maintenance:
   1. Maintain traffic and parking areas in sound condition free of construction equipment, products, mud, snow, and ice].
   2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

H. Removal, Repair:
   1. Remove temporary materials and construction at Substantial Completion.
   2. Repair existing facilities damaged by use, to original condition.

1.9 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing spaces.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.

E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 TRAFFIC REGULATION

A. Signs, Signals, And Devices:
   1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.
   2. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
   3. Flagperson Equipment: As required by authority having jurisdiction.

B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

C. Flares And Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

D. Haul Routes:
   1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.

1.11 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.12 DUST CONTROL

A. Execute Work by methods to minimize creation of dust from construction operations. Take required precautions to prevent dust from entering sterile areas!

1.13 NOISE CONTROL

A. Provide methods, means, and facilities to minimize noise from demolition and construction operations.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01200

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control and control of installation.

B. Tolerances

C. References.

D. Testing and inspection services.

E. Examination.

F. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, or date of Owner-Contractor Agreement when there are no Bids, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Architect/Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 TESTING AND INSPECTION SERVICES

A. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing.
   1. Prior to start of Work, submit testing laboratory name, address, and telephone number, and names of full time [registered Engineer] [specialist] and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.

B. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by Architect/Engineer.
   1. Laboratory: Authorized to operate at Project location In State of Kentucky.
   2. Laboratory Staff: Maintain full time registered Engineer or specialist on staff to review services.
   3. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

C. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Architect/Engineer or Owner.

D. Reports will be submitted by independent firm to Architect/Engineer and Contractor, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Architect/Engineer and independent firm 24 hours prior to expected time for operations requiring services.
   2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

F. Testing and employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

G. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by Architect/Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

H. Agency Responsibilities:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Architect/Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Architect/Engineer and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Architect/Engineer.
   7. Attend preconstruction meetings and progress meetings.

I. Agency Reports: After each test, promptly submit two copies of report to Architect/Engineer and to Contractor. When requested by Architect/Engineer, provide interpretation of test results. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and specifications section.
   6. Location in Project.
   7. Type of inspection or test.
   8. Date of test.
   9. Results of tests.
   10. Conformance with Contract Documents.

J. Limits On Testing Authority:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.01 SHOP DRAWINGS

A. The Contractor shall submit for the review of the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished in the Contract in accordance with the General provisions and as specified herein. Shop Drawings shall be submitted in sufficient time to allow at least twenty-one (21) calendar days after receipt of the Shop Drawings from the Contractor for checking and processing by the Engineer.

B. Engineer's review of the Contractor's drawings shall be considered as a gratuitous service, given as assistance to the Contractor in interpreting the requirements of the Contract, and in no way shall it relieve the Contractor of any of his responsibilities under the Contract. Any fabrication, erection, setting or other Work done in advance of the receipt of Shop Drawings returned by the Engineer and noted as "Approved' or "Approved as Noted" shall be entirely at the Contractor's risk. The Engineer's review will be confined to general arrangement and compliance with the design concept and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fitting, tolerances, interferences, coordination of trades, etc.

C. Unless otherwise stated elsewhere in the Contract Drawings, a total of six (6) copies of all reviewed Shop Drawings shall be furnished to the Engineer for his use in accordance with the following sequence of operation:

1. Initially six (6) copies and one (1) reproducible copy shall be submitted to the Engineer for review. After review one(1) copy and the reproducible copy will be returned to the Contractor.

2. When Shop Drawings are returned for correction, they shall be immediately corrected and resubmitted for review as described above, and such procedure will not be considered as grounds for delay in completing the Work.

3. Shop Drawings submitted by subcontractors shall be sent directly to the Contractor for preliminary checking. The Contractor shall be responsible for their submission to the Engineer at the proper time so as to prevent delays in delivery of materials.

4. The Contractor shall thoroughly check all subcontractors Shop Drawings as regards to measurements, sizes of members, materials, and details to satisfy himself that they conform to the intent of the Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors by the Contractor for correction before submitting them to the Engineer. Before submission, the Contractor shall mark (stamp) the drawings as being checked and approved by him, dated and signed. The Contractor's approval (stamp) shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract documents and the scope cf work involved. Shop drawings that are not stamped will not be reviewed.

5. All details on Shop Drawings submitted for review shall clearly show the relation of the various parts and where the Work depends upon field measurements, such measurements shall be obtained by the Contractor and noted on the Shop Drawings before being submitted to the Engineer for review.

6. All submissions shall be properly referenced to indicate clearly the specification section, location, service and function of each particular item. All submissions for one item or group of related items shall be complete. The Engineer reserves the right to reject manufacturer's publications in the form of catalogues, pamphlets, or other data sheets when they are submitted in lieu of prepared Shop Drawings. Such submissions shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and submissions showing only general information are not acceptable.

7. If the Shop Drawings contain any departures from the Contract requirements, specific mention thereof shall be made in the Contractor's letter of transmittal. Where such departures require revisions to layouts or structural changes to the Work, the Contractor shall, at his own expense, prepare and submit for approval revised layout and structural drawings for approval. Such drawings shall be of the size approved by the Engineer.

8. All shop drawings shall be in English.

D. The Engineer will review the first and second shop drawing SUBMITTALS at no cost to the Contractor. Review of the third submittal and any subsequent submittal will be at the Contractor's expense. Payment will be deducted from the Contract amount at a rate of 3 times direct labor cost plus expenses.

1.02 RECORD DRAWINGS

A. The Record Drawings shall consist of the Contract Drawings and the approved Shop Drawings in reproducible form (3 mil mylar) and shall be submitted to the Engineer at any time upon request during construction. The reproducible form (3 mil mylar) of the Record Drawings shall be submitted to the Engineer upon completion of the construction.

B. Contract Drawings shall be legibly marked to record actual construction including:

1. All deviations in location or elevation of any underground installation from that shown on the Contract Drawings.

2. Any significant changes in above ground installations from approved Shop Drawings or Contract Drawings.

3. No such deviations from the Contract Drawings or approved Shop Drawings shall be made without approval by the Engineer.

C. Specifications and addenda shall be legibly marked up to record:

1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.

2. Changes made by Change Order or Field Order.

3. Other matters not originally specified

D. Shop Drawings shall be legibly annotated to record changes made after review.

E. Reproducible Record Drawings shall be submitted in accordance with the General Conditions, Supplementary Conditions, and General Requirements.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULING

PART 1: GENERAL

1.01 GENERAL

A. Construction under this contract must be coordinated to assure construction completion within the time allowed by the Contract Documents. The Contractor will also coordinate his activities with the Owner's operations and maintenance staff to enable proper access to all functioning areas of the plant, including providing for temporary access if required. The Contractor must submit to the Engineer a description and schedule as to how the common areas will be utilized, recognizing the required coordination with the Owner.

B. A Critical Path Method (CPM) construction schedule shall be used to control the work of this Contract and to provide a definitive basis for determining job progress. The construction schedule shall be prepared, computer mounted and updated by the Contractor. All work shall be done in accordance with the established CPM schedule and the Contractor and his subcontractors shall be responsible for cooperating fully with the Engineer and the Owner in effectively utilizing the CPM schedule.

C. When the work requires any existing facility or utility to be taken out of operation, temporarily or permanently, the Contractor should notify the Engineer and the Owner 14 calendar days in advance.

D. When the new plant is ready to be put into operation and begin receiving wastewater, the Contractor shall notify the Engineer and the Owner. They will notify the Contract 4A Contractor to begin the existing WWTP Closure Plan.

1.02 CONSTRUCTION SCHEDULING GENERAL PROVISIONS

A. Promptly after award of the Contract and within 10 calendar days after the effective date of the Agreement, prepare and submit to the Engineer estimated construction progress schedules for the work, with subschedules of related activities which are essential to its progress.

B. No partial payments shall be approved by the Engineer until there is an acceptable construction progress schedule submittal on hand.

C. No work shall be done between 7:00 P.M. and 7:00 A.M. nor on Sundays or legal holidays without the written permission of the Owner. However, emergency work may be done without prior permission.

D. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the commitments of the Contractor's schedule.

E. The Engineer's review of the schedule submittals will not relieve the Contractor from responsibility for any deviations from the Contract Documents unless the Contractor has in writing called the Engineer's attention to such deviations at the time of submission and the Engineer has given written concurrence to the Specific deviations. Nor shall any concurrence by the Engineer relieve the Contractor from responsibility for errors and omissions in the submittals. The Engineer's review of the schedule submittals will be for conformance with the information given in the Contract Documents only, and will not extend to the means, methods, sequences and techniques or procedures of construction or to safety precautions or programs incident thereto.

1.03 PROGRESS OF THE WORK

A. The work shall be executed with such progress as may be required to prevent any delay to the general completion of the project. The work shall be executed at such times and in or on such parts of the project, and with such forces, materials and equipment to assure completion of the work in the time established by the Contract.

B. If the Contractor for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit written notice to the Engineer and he shall allow ample time for satisfactory arrangements to be made for inspecting the work in progress. The Contractor shall reimburse the Owner for extra inspection required for work outside regular hours (as defined in Owner's Supplemental General Conditions. The Contractor shall light the different parts of the project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the municipality in which the work is being done.

PART 2: PROGRESS SCHEDULE SUBMITTALS

2.01 GENERAL

The Contractor shall submit a critical path schedule as described herein.

A. The critical path schedule requirement consists of an interim schedule, a detailed schedule, monthly status reports, and revisions to the networks and analyses as prescribed, a Start-up schedule, and an as-built schedule. The planning, scheduling, management, and execution of the work is the sole responsibility of the Contractor. The progress schedule requirement is established to allow Engineer to review Contractor's planning, scheduling, management and execution of the work; to assist

Engineer in evaluating work progress and make progress payments; to allow other contractors to cooperate and coordinate their activities with those of the Contractor; and to provide Owner with information about "construction schedule" and "cumulative outlay schedule".

B. Float or slack time is not for the exclusive benefit of either the Owner, Engineer or Contractor. Extensions of time for performance as specified in the General and Supplemental General Conditions will be granted only to the extent that equitable time adjustments for the network activity or activities affected exceed the total float or slack time along the affected network paths as shown in the graphic arrow diagram and computer printout report in effect at the instant of either: (a) a notice to proceed with a change, (b) a notice of suspension of work or possession, © detection of a subsequently acknowledged differing Site condition, or (d) occurrence of cause for an excusable delay. Further, use of float time in the schedule, or the allocation of float time to activities by means of Special logic restraints or imposed dates, shall be shared to the benefit of Owner, Engineer, Contractor, and his subcontractors and suppliers in proportion of their scope of responsibilities. Excessive use of float time to the detriment of succeeding activities may be cause for denying an extension of time if it can be demonstrated that the float along the network paths affected at the instant of the delaying condition would have been larger than the delay had it not been for the excessive and unreasonable float usage in violation of the sharing concept required by these Specifications.

C. Submittals which show completion ahead of the contract time shall include additional supporting data to explain the basis of the shorter time for performance. Such supporting data may include, but not be limited to, any deviations from the Contract Documents, quantities, production rates, activity man-day requirements, hours per shift which are proposed, the work days per week, and a listing of the major items of construction equipment planned for use on the work. The equipment listing shall include type, number of units, unit capacities, and a schedule showing the proposed time each piece of equipment shall be on the work, keyed to the activities on which the equipment will be used. Activities which may be expedited and accelerated by use of overtime or additional shifts shall be identified and explained. Upon receipt of supporting data, the Engineer will review and either concur or disagree with the submittal. Concurrence will recognize that the earlier finish date has float time with respect to the Contract time, but it will not constitute a basis for a change in Contract price and Contract time. However, should Contractor assert his right-to-finish early and request that the earlier completion be used as the date from which to assess damages for delay, then Owner will issue a Change Order pursuant to the change order clause in the General Conditions introducing an interim completion date and associated damages for delays if the work is not completed within the time specified by the Contractor's interim date. Damages for delay shall be in accordance with the Agreement.

D. The currently concurred Detailed Schedule shall have legal status as long as it is used by Contractor for planning, organizing, directing, managing, and executing the Work

in accordance with the Contract Documents. Legal status will also imply that Contractor will use the schedule to report progress and for determining delay(s) in achieving the Contract date(s) stipulated in the Agreement Subject to the requirements of this section of the General Requirements. Contractor acknowledges and agrees that actual slippage to the activities shall not be the basis for an adjustment in Contract Time unless the causes of slippages are excusable, and such slipped activities are on the critical path of the currently accepted work plan, or cause one or more new critical paths, precisely at the time of slippage cause, and result in a delay achieving the Contract date(s) specified in the Agreement.

E. Engineer will, within the period set forth in this section of the specifications after receipt of each schedule submittals, either indicate in writing a recommendation of concurrence and present the submittals to Owner, or return the submittals to Contractor, as set forth in this section of the specifications, indicating in writing Engineer's reasons for refusing to recommend concurrence. In the latter case, Contractor shall make the necessary corrections and resubmit. Failure by Contractor to provide submittals as set forth in this Section of the specifications will be reasons to Engineers for refusing to recommend payment.

F. Engineer's review of the schedule submittals shall be only for conformance with the information given in the Contract Documents and shall not extend to the means, methods, sequences and techniques or procedures of construction or to safety precautions or progress incident thereto. Engineer's review of the schedule submittals will be predicated on a Contractor's stamp of approval signed off by Contractor and those subcontractors and suppliers performing work under an appropriate agreement with Contractor with value in excess of 10% of the Contract Price. Contractor's stamp of approval on any schedule submittals shall constitute a representation to Owner and Engineer that Contractor has either determined or verified all data on the submittal, or assumes full responsibility for doing so, and that Contractor and his subcontractors and suppliers have reviewed and coordinated the sequences shown in the submittal with the requirements of the work under the Contract Documents.

G. This section of the specifications may be terminated in whole or in part by Owner in the event of substantial failure by Contractor to fulfill his obligation under this section of the specifications through no fault of Owner or Engineer, provided that the termination is not effected unless Contractor is given ten calendar day's written notice of intent to terminate, and an opportunity for consultation prior to the termination. Substantial failure may be taken to include, but not be limited to, failure by Contractor to submit the Interim Schedule within ten days after it is due, and/or the Detailed Schedule within 20 days after it is due, and/or the Startup Schedule within ten days after it is due, and/or three Monthly Status Reports within ten days after each is due. If termination for default is effected by Owner, an equitable adjustment in the price provided in the Agreement shall be made for the unperformed scope. Further, any payments due to Contractor at the time of termination may be adjusted to cover any additional costs to Owner because of the Contractor's default.

Subsequent to termination, Contractor will be required to comply with the Construction Schedules requirement in Article 3 of the General Conditions.

PART 3: EXECUTION

3.01 INTERIM SCHEDULE SUBMITTALS

A. Within ten days after the date of the Agreement, submittal shall include a time-scaled graphic diagram, computer reports, a detailed schedule of values, and interim status reports using the Notice to Proceed as the data date. Engineer shall have 20 calendar days after receipt of the Interim Schedule submittal to respond in writing. Upon receipt of Engineer's comments, Contractor shall make the necessary revisions and submit the revised Submittal within ten calendar days. If Contractor fails to provide an acceptable Interim Schedule submittal, he will be deemed not to have provided a basis upon which progress may he evaluated, which shall be reason for refusing to recommend payment.

B. Interim monthly status reports shall be submitted monthly at the monthly project meetings, based on progress as compared to the Interim Schedule, and continue through the first 120 calendar days or until the Detailed Schedule is concurred with by the Owner. Each submittal shall include a revised copy of the interim graphic diagram and a narrative detailing progress, problems, and proposed corrective actions on activities completed and/or started during the period, and activities scheduled for the next month. The revised graphic diagram shall show, for the currently accepted Interim Schedule, percentages of completion for activities, actual start or finish dates, and remaining durations as appropriate. Activities not previously included in the currently accepted interim schedule shall be added but contract dates shall not be changed except by Change order. During the initial 120-day period of the contract, a given monthly progress payment will be processed only after Engineer has received satisfactory supporting narratives and the revised graphic diagram for the period to which that progress payment corresponds.

C. All submittals shall be in quintuplicate.

3.02 DETAILED SCHEDULE SUBMITTAL

A. Submittal shall include a time-scaled graphic arrow diagram showing all Contract activities, computer printout reports, a supporting narrative, and an accumulative manpower Curve, manpower bell curve, and cost Curves. The initial Detailed Schedule submittal shall be delivered within 15 calendar days after the Notice to Proceed, and shall use the Notice to Proceed as the data date. Engineer will have 15 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall meet with Engineer and discuss an appraisal and evaluation of the proposed work plan. Necessary revisions resulting from this review shall be made by Contractor and the detailed schedule resubmitted within 15

calendar days after the meeting. The resubmittal, if concurred with by Owner, and unless subsequently changed with the concurrence of or at the direction of Owner, shall be the work plan to be used by the Contractor for planning, scheduling, managing, and executing the work. If Contractor fails to provide acceptable Detailed Schedule submittal, he will be deemed not to have provided a basis upon which progress may be evaluated, which will further constitute reasons far refusing to recommend payment.

3.03 MONTHLY STATUS REPORTS

A. Beginning with the first monthly project meeting, and monthly thereafter, Contractor shall submit to Engineer a Monthly Status Report (based on the Interim Schedule until the Detailed Schedule is concurred with, and based on the Detailed Schedule thereafter) with data as of the last day of the pay period. The Monthly Status Report shall include a revised copy of the currently accepted graphic diagram, computer printouts, a narrative, updated manpower, and cost curves. The Monthly Status Report will be reviewed by Engineer. The Contractor will address the Engineer's comments in the subsequent Monthly Status Report. If Contractor fails to provide acceptable Monthly Status Reports, he will be deemed not to have provided a basis upon which progress may be evaluated, which will be reason for refusing to recommend progress payments.

B. The revised diagram shall show, for the currently accepted detailed diagram, percentages of completion for all activities, actual start and finish dates, and remaining durations, as appropriate. Activities not previously included in the currently accepted detailed schedule shall be added, except that contractual dates will not be changed except by Change Order. Review of a revised diagram by the Engineer will not be construed to constitute concurrence with the time frames, duration, or sequencing for such added activities; instead the corresponding data as ultimately incorporated into an appropriate change order shall govern.

C. The narrative shall include the information shown in the following outline in a narrative form:

1. Construction progress (refer to activity number in the Detailed Schedule) including:

    a. Activities completed this reporting period
    b. Activities in progress this reporting period;
    c. Activities scheduled to commence next reporting period

2. Description of problem areas

3. Current and anticipated delays

a. Cause of the delay
b. Corrective action and schedule adjustments to correct the delay
c. Impact of the delay on other activities, on milestones, and on completion dates

4. Changes in construction sequence

5. Pending items and status thereof

a. Permits
b. Change Orders
c. Time extensions
d. Other

6. Contract completion date status

a. Ahead of schedule and number of days
b. Behind schedule and number of days

3.04 REVISIONS

A. All revised Detailed Schedule submittals shall be in the same form and detail as the initial submittal and shall be accompanied by an explanation of the reasons for such revisions, all of which shall be subject to approval by Engineer. The revision shall incorporate all previously made changes to reflect current as-built conditions. Minor changes to the approved submittal may be approved at monthly meetings. Changes to activities having adequate float shall be considered a minor change.

B. A revised detailed work plan submittal shall be submitted for review, when required by Engineer, for one of the following reasons:

1. Owner or Engineer directs a change that affects the date(s) specified in the Agreement or alters the length of a critical path.

2. Contractor elects to change any sequence of activities so as to affect a critical path of the currently accepted detailed schedule documents.

C. If, prior to agreement on an equitable adjustment to the Contract duration, Engineer requires revisions to the detailed schedule in order to evaluate planned progress, Contractor shall provide an interim revised submittal for review with change effect(s) incorporated as directed. Approved interim revisions to the documents will be incorporated during the first subsequent monthly Status Report.

3.05 START-UP SCHEDULE SUBMITTALS

A. At least 90 calendar days prior to the date of Substantial Completion, Contractor shall submit a time-scaled (from days after notice to proceed) graphic diagram detailing the work to take place in the period between 60 days prior to Substantial Completion and the date of Substantial Completion, together with a supporting narrative. Engineer shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall make the necessary revisions and submit the revised schedule within ten calendar days. If Contractor fails to provide acceptable Start-up Schedule Submittals, he will be deemed not to have provided a basis upon which progress may be evaluated, which will be reason for refusing to recommend payment.

B. The Startup Schedule may not be combined with the Detailed Schedule. The Startup Schedule is intended to show much greater detail than the Detailed Schedule for start-up activities. Typical information required includes, but is not limited to, the timing of vendor representatives, pre-op testing, individual equipment startups, Owner's training, and performance certification testing.

C. The graphic diagram shall use the currently accepted Detailed Schedule for those activities completed ahead of the last 60 calendar days prior to Substantial Completion, and detailed activities for the remaining 60-day period within the time frames outlined in the currently accepted Detailed Schedule.

D. Contractor will be required to continue the requirement for monthly reports, as outlined in Articles 3.03 and 3.04 above. In preparing these reports, Contractor must assure that the Detailed Schedule is consistent with the progress noted in the Startup Schedule.

E. In addition, Contractor will be required to submit a revised copy of the startup graphic diagram on a monthly basis with a startup narrative. This revised diagram shall highlight percentages of completion, actual start and finish dates, and remaining durations as applicable. Activities not previously included in the accepted detailed work plan shall be added in these submittals, except that contractual dates shall not be changed except by Change Order. Reviews of these submittals by Engineer will not be construed to constitute concurrence with the time frames, durations or sequence of work for each added activity.

3.06 AS-BUILT SCHEDULE

After Substantial Completion but prior to final payment, Contractor shall submit an as-built computer printout report, an as-built project S-curve and bell curve, and time-scaled as-built graphic diagram. The documents shall reflect all as-built critical path(s). The diagram shall include, but not be limited to the following:

A. All Contract activities, including all added activities, shall be shown.

B. Activity duration shall be the actual number of separate work days during which

work was performed on the activity, not the elapsed time between actual starts and finishes.

C. Total man-days for an activity shall be the actual number of man-days that were required to complete the activity.

D. The as-built graphics shall be plotted according to the dates the activity actually started and finished.

E. Contract milestone completions shall be plotted according to the date(s) of the Substantial Completion Certificate(s).

3.07 CONSTRUCTION PERIOD

A. The Contractor's attention is directed to the form of Agreement which specifies for Contract times for the Work.

B. Whenever it becomes apparent from the current monthly progress evaluation and updated schedule data that any milestone and/or Contract completion date will not be met, the Contractor shall take some or all of the following actions:

1. Increase construction manpower in such quantities and crafts as shall subsequential eliminate the backlog of work;
2. Increase the number of working hours per shift, shifts per work day, work days per week, or the amount of construction equipment, or any combination of the foregoing sufficient to substantially eliminate the backlog of work; and
3. Reschedule work items to achieve concurrence of accomplishment.

C. The addition of equipment or construction forces, increasing the working hours or any other method, manner, or procedure to return to the current Detailed Schedule shall be at the Contractor's own cost and shall not be considered justification for a Change Order or treated as an acceleration order.

END OF SECTION

SECTION 01400

SITE CONDITIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Existing utility facilities and structures are shown in accordance with the best available information. The Engineer will not be responsible for the completeness or accuracy thereof nor for any deductions, interpretations, or conclusions drawn therefrom. Forty-eight hours in advance of work in the vicinity of existing facilities, the Contractor shall notify "BUD" by calling 811 or 1-800-752-6007. The Contractor shall verify to his own satisfaction, the actual locations of existing facilities prior to construction in their vicinity.

1. Should the Contractor, in the course of his operations, encounter any underground utilities, the presence of which was not previously known or of a different type than shown, he shall immediately notify the Engineer and take all precautions necessary to support and protect the utility and maintain continuous service until said utilities can be adjusted by the appropriate owners or other corrective measures taken.

2. Relocations by others arranged by and for the convenience of the Contractor shall be at no additional cost to the Owner.

3. The Contractor shall be responsible for filing all requests with public utility corporations, jurisdictional agencies, or other owners to make all adjustments to public utility fixtures and appurtenances within or adjacent to the limits of construction. Furnish copies of all such requests and replies to the Engineer. The Contractor shall be responsible for coordinating his activities with said body. Additional costs resulting from a lack of coordination between the utilities and Contractor shall be at no additional cost to the Owner, and extension of time, therefore, will not be granted.

4. Damage caused to utilities either directly or indirectly by the Contractor shall be repaired and the facilities restored to their original condition to the satisfaction of the Engineer and the utility owner, at no additional cost to the Owner.

B. Work in Vicinity of Existing Utilities

1. At least 48 hours prior to starting work in the vicinity of utility structures and appurtenances, the Contractor shall notify "BUD" as stated hereinbefore. The Contractor, at his own expense, shall support and protect all utility structures and appurtenances in accordance with the Contract Documents and/or the County's requirements and shall take any other steps necessary to protect the structures from disturbance and damage.

C. Access to Utilities Facilities

1. The Contractor shall at all times permit free and clear access to the various affected facilities by personnel of the utility for the purpose of inspection, maintenance, providing additional service

requirements and the construction of new facilities. When personnel of the utility are working within the limits of work to be performed by the Contractor, the Contractor will not be relieved of his responsibility for the maintenance and protection of such facilities.

D. When local codes or laws require notification of work to agencies or departments, the Contractor shall be responsible for providing such notification.

END OF SECTION

SECTION 01500

BASIS OF PAYMENT

PART 1: GENERAL

1.01 SCOPE

A. The Contractor shall furnish all necessary labor, machinery, tools, apparatus, equipment, materials, services and other necessary supplies and perform all work shown on the Contract Drawings and/or described in the Specifications and Contract Documents at the lump sum price described.

1.02 PAYMENT FOR DOUGLAS WASTEWATER TREATMENT PLANT EXPANSION

A. BID ITEMS

Payment for the Douglas Wastewater Treatment Plant Expansion will be made at the Contract lump sum price for Items shown on the Bid Schedule, less such deductive alternates as OWNER elects to apply. This payment shall constitute full compensation for all work performed and material and equipment supplied in connection with this Contract including all associated site demolition, development and drainage work, structural, equipment, and mechanical work, together with all other appurtenant work shown on the Contract Drawings, and/or specified.

1.03 PAY ITEMS

A. The items listed hereinbefore refer to and are the same items listed in the Bid Schedule and shall constitute all of the Work in this Contract. Any other item of work listed in the Specifications or shown on the Contract Drawings shall be considered incidental to the above items.

1.04 RETAINAGE

A. Retainage shall be in accordance with the appropriate articles in the General Conditions.

1.05 PAYMENT EXCLUSIONS

A. No payment will be made under this Section for work performed by the Contractor to replace defective work, work which is not specified or ordered, or work outside the limits shown or ordered.

END OF SECTION

SECTION 01600

SPECIAL PROVISIONS FOR MATERIALS AND EQUIPMENT

1.01 SERVICES OF MANUFACTURERS' REPRESENTATIVE AND OPERATING MANUALS

A. Bid prices for equipment furnished under Divisions 11, 13, 14, 15 and 16, shall include the cost of written operation and maintenance instructions and the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct the OWNER'S operating personnel and the ENGINEER'S representative on operation and maintenance. This supervision and instruction may be divided into two or more time periods as required by the installation program, and shall be scheduled at the convenience of the OWNER.

B. Unless otherwise specified with the equipment, equipment manufacturers shall provide a minimum of 2 separate repeated training sessions for the OWNER'S staff. Each session shall be at least 2 hours in length, but not more than 4 hours. Manufacturer's agenda and schedule for the training shall be submitted to and approved by the OWNER prior to conducting the training. No training will be scheduled until the equipment has been installed, satisfactorily tested, and is ready for operation.

C. The manufacturer's representative shall have complete knowledge of the proper installation, lubrication, operation and maintenance of the equipment provided and shall be capable of instructing the representatives of the OWNER and ENGINEER on proper start-up, shut-down, on-line operations, lubrication and preventive maintenance of the equipment. Outlines of lesson plans and proposed training schedule shall be submitted to the ENGINEER for review 30 days prior to the desired instructional period. Specific requirements for furnishing the services of manufacturer's representatives are indicated under detailed Specifications. This work may be conducted in conjunction with Inspection and Testing, whenever possible, as provided under Part 3 of EXECUTION of detailed specification. Should difficulties in operation of the equipment arise due to the manufacturer's design or fabrication, additional services shall be provided at no cost to the OWNER.

D. A certificate from the manufacturer stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit shall be submitted to the ENGINEER.

E. For equipment furnished under other Divisions, the CONTRACTOR, unless otherwise specified, shall furnish the services of accredited representatives of the manufacturer only when some evident malfunction or over-heating makes such services necessary.

F. Four complete sets of operation and maintenance instructions covering all equipment furnished under Divisions 11, 13, 15 and 16, shall be delivered directly to the ENGINEER.

1. The manual for each piece of equipment shall be a separate document with the following specific requirements:

a. Contents:

Table of contents and index

Brief description of each system and components

Starting and stopping procedures

Special operating instructions

Routine maintenance procedures

Manufacturer's printed operating and maintenance instructions, parts list, illustrations, and diagrams. These shall be specific to the material supplied under the Contract, and not a manufacturer general brochure.

One copy of each wiring diagram

One final accepted copy of each shop drawing and each CONTRACTOR'S coordination and layout drawing

List of spare parts, manufacturer's price, and recommended quantity

Manufacturer's name, address, and telephone number

Name, address, and telephone number of manufacturer's local representative

b. Material:

Loose leaf on punched paper. Holes reinforced with plastic, cloth or metal. 8-1/2” x 11” paper size.
Diagrams and illustrations, attached foldouts as required of orginal quality, reproducible by dry copy method

Covers: oil, moisture, and wear resistant 9” x 12” size

c. Submittals to the ENGINEER:

(1) Three preliminary copies of manuals, no later than 15 days following final review of the shop drawings for each piece of equipment and 4 final copies of complete manuals prior to Field Tests.

1.02 INSTALLATION OF EQUIPMENT

A. Special care shall be taken to ensure proper alignment of all equipment with particular reference to the pumps, blowers and electric drives. The units shall be carefully aligned on their foundations by qualified millwrights after their sole plates have been shimmed to true alignment at the anchor bolts. The anchor bolts shall be set in place and the nuts tightened against the shims. After the foundation alignments have been reviewed by the ENGINEER, the bedplates or wing feet of the equipment shall be securely bolted in place. The alignment of equipment shall be further checked after securing to the foundations, and after conformation of all alignments, the sole plates shall be finally grouted in place. The CONTRACTOR shall be responsible for the exact alignment of equipment with associated piping, and under no circumstances, will "pipe springing" be allowed.

B. All wedges, shims, filling pieces, keys, packing, red or white lead grout, or other materials necessary to properly align, level, and secure apparatus in place shall be furnished by the CONTRACTOR. All parts intended to be plumb or level must be proven exactly so. Any grinding necessary to bring parts to proper bearing after erection shall be done at the expense of the CONTRACTOR.

1.03 GREASE, OIL AND FUEL

A. All grease, oil, and fuel required for testing of equipment shall be furnished with the respective equipment. The OWNER shall be furnished with a one year's supply of required lubricants including grease and oil of the type recommended by the manufacturer with each item of equipment supplied under Divisions 11, 13, 14, 15 and 16.

B. All lubricants and fuels shall be properly labeled, using an indelible marker and writing on the lubricant container or drum, specifying the type and brand name

of the lubricant supplied. A Master Lubrication list must be submitted to the ENGINEER for approval clearly stating which lubricants are to be used in the various pieces of plant equipment and the quantity supplied for one years' use by each unit.

1.04 TOOLS AND SPARE PARTS

A. Any special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, and maintenance of any equipment shall be furnished with the respective equipment.

B. All spare parts shall be properly protected for long periods of storage (contained in plastic bags or cardboard containers) and labeled for easy identification without opening.

1.05 MAINTENANCE AND LUBRICATION SCHEDULES

A. The CONTRACTOR'S attention is directed to the General Conditions and Section 01300 for all requirements relative to the submission of shop drawings for the mechanical equipment. For all mechanical and electrical equipment furnished, the CONTRACTOR shall provide a list including the equipment name, and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained. In addition, a maintenance and lubrication schedule for each piece of equipment shall be submitted along with shop drawings. Submission shall be in 4 copies.

1.06 STORAGE AND HANDLING OF EQUIPMENT

A. Special attention shall be given to the storage and handling of equipment. As a minimum, the procedure outlined below shall be followed:

1 . Equipment shall not be shipped until all pertinent shop drawings are reviewed by the ENGINEER.

2. All equipment having moving parts such as gears, electric motors, etc., and/or instruments shall be properly stored until such time as the equipment is to be installed.

3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

4. Manufacturer's storage instructions shall be carefully studied by the CONTRACTOR and reviewed with the ENGINEER. These instructions shall be followed and a written record of this kept by the CONTRACTOR.

5. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding." Upon installation of the equipment, the CONTRACTOR shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

6. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.

7. Prior to acceptance of the equipment, the CONTRACTOR shall have the manufacturer inspect the equipment and certify in writing that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a written certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the CONTRACTOR'S expense.

B. The OWNER reserves the right to withhold payment for any materials improperly stored and maintained.

1.07 PARTIAL UTILIZATION

A. During the course of construction partial occupation and utilization of completed portions of the work may be required.

B. When deemed necessary, the OWNER or the CONTRACTOR may request use of completed work.

1.08 EQUIPMENT WARRANTY

A. The CONTRACTOR shall provide the OWNER a minimum 1 year warranty on all equipment, or a warranty of the length as is specified in the specific equipment section of the Specifications, in accordance with the General Conditions. The warranty period for each item of equipment shall be a minimum of 1 year, or as specified otherwise, from the date of the OWNER'S acceptance of the equipment item.

1.09 ADJUSTMENTS AND CORRECTIONS OF EQUIPMENT AND APPURTENANCES DURING OPERATION

A. Some items of functional nature included in this Contract cannot be tested as to performance and quality at the time of completion of their installation. They must wait for necessary testing and proper performance until such functions are possible during later portions of this Contract. Such testing, specified performance and proper instructions to the OWNER's operators (as to their maintenance and operation) is deemed a portion of this Contract, and payment shall be retained by the OWNER for equipment delivered to the site and for Work completed to cover such service. Such service replacements and performance shall take precedence over expiration of the one year guarantee period.

B. The CONTRACTOR shall expedite the completion of such service by all Suppliers and Subcontractors and shall render competent supervision of such service. The CONTRACTOR shall also expedite the replacement of defective and unaccepted parts and equipment. Unnecessary delay in delivery and installation of corrective parts and equipment may constitute damage to the OWNER for which the CONTRACTOR can be held liable.

1.10 INSTALLING NEW EQUIPMENT IN EXISTING STRUCTURES

A. Where new equipment is planned and/or specified as being installed in existing structures, the CONTRACTOR shall verify all dimensions and locations of existing facilities prior to ordering the new equipment. Existing anchor bolts shall be used when possible, and new equipment shall be fabricated to conform to the existing dimensions, shapes, and locations as required.

END OF SECTION

SECTION 01650

EQUIPMENT AND FACILITY STARTUP

PART 1: GENERAL

1.01 EQUIPMENT AND FACILITY STARTUP

A. The overall responsibility for coordination of the startup of the Douglas Wastewater Treatment Plant (WWTP) will be the responsibility of the respective General Contractor. The Membrane Bioreactor (MBR) System Supplier (Ovivo) shall be responsible for commissioning all systems and equipment provided in the Procurement of MBR System Contract. The General Contractor shall be responsible for all work under the respective General Construction Contract as well as coordination of the startup of the Douglas WWTP. Ovivo shall ensure correct performance, function, and operation by performing procedures to activate, start, adjust, test, and demonstrate that the work is in operating order in accordance with the general requirements of the MBR System Contract.

B. Ovivo shall provide instruction for the maintenance of equipment. The General Contractor will maintain equipment until acceptance.

1.02 INITIAL STARTUP AND OPERATION OF FACILITIES

A. The existing treatment facilities at the Douglas WWTP will remain in operation until the MBR System has been successfully tested and is operating on a full time basis.

B. The following listing is a general sequence of startup activity steps to be used in placing equipment and facility systems into operation: Ovivo will conduct or assist the General Contractor to conduct the following:

1. Perform initial lubrication of equipment and check and adjust equipment. Provide all subsequent lubrication and maintenance, and such staff as required for test operation until the District assumes equipment maintenance responsibility after Step 14 below.
2. Perform satisfactory testing of electrical work required prior to energizing of the electrical system.
3. After completion of Step 2, perform satisfactory electrical testing required after energizing of the electrical system.
4. Complete calibration of instruments.
5. Satisfactorily complete system verification of instrumentation work.
6. After completion of Steps 1 and 3, perform a rotational test of equipment and

correct backward rotating drives.

7. After completion of Steps 5 and 6, test operate the equipment by manually initiating the operation. Where manual operation bypasses alarm or safety monitoring, provide continuous supervision of such parameters. Perform this step using water in lieu of chemicals or other process liquids. Use dry air or nitrogen in lieu of hazardous gases.
8. Concurrent with Step 7, perform operation, instrumentation and control testing and adjustments as related to the equipment being tested. Note: operational testing requires an approved test plan.
9. Concurrent with Step 7 and where possible at this stage of startup, complete the performance testing specified for the equipment.
10. Concurrent with Step 7, perform adjustments of the electrical equipment as related to the equipment being tested.
11. Repeat Steps 1 through 10 as required for other equipment items and plant systems until all plant process components and utility systems are ready for total plant operation.
12. Submit the required documentation of testing, calibration, and equipment affidavits.
13. Notify the District and the Engineer 45 days before total plant operational testing is to occur so that the District may order chemicals and make other arrangements for full-time operation. Notify the District and Engineer again, 7 days before total plant operational testing is expected to begin.
14. 30-Day Plant Acceptance Test shall be performed in accordance with Section 13030. Upon successful completion of all the above steps, the facility shall be started up and operated on a complete full time basis. The District will provide operating personnel, chemicals, and untreated water, and chemical analyses of wastewater, mixed liquor, and effluent, and other tests as may be reasonably requested by Ovivo. Ovivo shall have a competent field service technician(s) present as needed to make adjustments or correct problems for a minimum of five (5) consecutive days beginning with the start-up day, or longer as required to achieve satisfactory performance. Ovivo shall also provide personnel, on a 24-hour per day "on call" basis to adjust, repair, and correct deficiencies as required to keep the facilities in continuous operation for the remainder of the 30-Day Plant Acceptance Test.
15. After successful completion of the 30-Day Plant Acceptance Test, the District will take over maintenance duties as well as operation. Ovivo shall perform the Long-Term System Performance Test as specified in Section 13030 during this period. If continuous process operation is interrupted for a period of 48 consecutive hours or more due to a failure of the equipment or work provided, then the counting of the 5-day and/or 30-day periods, described in Step 13 above, shall be restarted at day one if these periods have not reached satisfactory completion.
16. Following the commencement of Step 13, satisfactorily complete equipment performance testing, electrical testing and adjustments, and

instrumentation/control testing and adjustments to the extent that such testing and adjustments could not be made prior to full plant operation.

17. Submit any remaining documentation of testing, balancing reports, and equipment affidavits before plant acceptance.

1.03 MANUFACTURER'S FIELD SERVICE AND AFFIDAVITS

A. Field Service: Where specified, manufacturers of equipment shall provide field service. Field service shall be provided by an authorized, factory-trained and qualified manufacturer's representative for the specific equipment. Equipment shall not be considered ready for full-time operation until after the manufacturer's representative has checked and adjusted the equipment, and certified by written affidavit that the equipment has been properly installed, tested, adjusted, lubricated, and calibrated and is ready for full-time operation.

B. Affidavits: Acceptable affidavits shall be submitted prior to the 30-Day Acceptance Test.

1. Affidavits shall contain the following specific wording:
"The [Name of Equipment] has been properly installed, tested, adjusted, lubricated, and calibrated and is ready for full-time operation. The installation has been inspected and has been found to be in conformance with our (the manufacturer's) standards and requirements."
2. No amplification, dilution, or modification of this specific wording will be permitted.
3. Ovivo will submit affidavits for equipment listed in its Scope of Supply.

END OF SECTION

SECTION 01656

DISINFECTION OF POTABLE WATER FACILITIES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, tools, equipment and related items required to disinfect the following potable water facilities:

1. Water piping.

PART 2: PRODUCTS

2.01 CHLORINE

A. Liquid chlorine shall meet the requirements of AWWA B3Ol.

B. Calcium hypochlorite shall meet the requirements of AWWA B300.

PART 3: EXECUTION

3.01 GENERAL

A. Piping shall be cleaned and disinfected in compliance with all applicable sections of AWWA Standard C-601 except as modified herein. All interior surfaces of pipelines shall be exposed to a 50 PPM chlorine solution for a minimum of 24 hours, after which the lines can be cleaned and flushed provided a 25 PPM residual is maintained after the 24 hour period. The lines shall be flushed clean until the chlorine concentration in the water leaving the lines is 1-2 PPM. Chlorine solution with a higher residual may remain in the line, without flushing, if approved by the Engineer and/or the Owner.

3.02 PROCEDURES

A. Pipelines

1. During installation, the interior of all pipe, fittings and other accessories shall be kept as free as possible from dirt and foreign matter at all times. If, in the opinion of the Engineer, the pipe contains dirt or foreign matter that could not be removed

during the flushing operation, the interior of the pipe will be cleaned and swabbed with a bactericidal solution. When pipe laying is not in progress, the open ends of pipe shall be sealed with watertight plugs.

2. After the Completion of hydrostatic pressure tests and prior to disinfection, the pipeline shall be flushed, as thoroughly as possible with the water pressure and outlets available. If feasible, flushing rate should develop a velocity in the pipeline of at least 2.5 fps. Since it is usually difficult to secure this minimum velocity in pipelines over 16 in. in diameter, the requirements of Paragraph 3.02 A.l above shall be rigidly enforced for the larger sizes of pipe. The minimum quantity of water used for flushing shall be in excess of the storage capacity of the pipeline, to insure that clean water has traversed the entire length of the line.

3. After flushing has been completed to the point that all apparent dirt and foreign matter have been removed from the pipeline, either liquid chlorine or calcium hypochlorite solution shall be injected into the pipeline as provided in AWWA Standard C-601.

4. Following chlorination, all treated water shall be flushed from the newly laid pipeline at its extremities until the replacement water throughout its length is proved by test to be: a) comparable in quality to the water served the public from the existing water supply system, or b) as approved by the public health authority having jurisdiction. The satisfactory quality of water delivered by the new pipeline shall continue for a period of at least two days. Samples will be taken from a tap located and installed in such a way as to prevent outside contamination. Unless otherwise directed, the sample tap shall either be a hose bib, a disconnected service tap or a 3/4" copper riser (with stopcock), which shall be provided by the Contractor. Should the initial treatment fail to achieve the satisfactory quality described above, the original chlorination procedure shall be repeated until satisfactory results are obtained.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This Section outlines the procedure to be followed in closing out the contract.

1.02 SUBSTANTIAL COMPLETION

A. The substantial completion date shall be established as stated in the AGREEMENT.

1.03 FINAL CLEANING

A. At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:

1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the Engineer.

2. All Subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.

3. The Contractor shall remove all temporary structures and all debris, including all dirt, sand, gravel, rubbish and waste material. All disposal must be off the Owner's property.

4. Should the Contractor not remove rubbish or debris or not clean the buildings and site as specified above, the Owner reserves the right to have the cleaning done at the expense of the Contractor.

B. Employ experienced workers, or professional cleaners, for final cleaning.

C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

D. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

E. In preparation for Substantial Completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

F. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces.

G. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

H. Remove snow and ice from access to buildings.

I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

a. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

1.04 FINAL INSPECTION

A. After final cleaning and restoration and upon written notice from the Contractor that the work is completed, the Engineer will make a preliminary inspection with the Owner and Contractor present. Upon completion of this preliminary inspection, the Engineer will notify the Contractor, in writing, of any particulars in which this inspection reveals that the work is defective or incomplete.

B. Upon receiving written notice from the Engineer, the Contractor shall immediately undertake the work required to remedy deficiencies and complete the work to the satisfaction of the Engineer.

C. When the Contractor has corrected or completed the items as listed in the Engineer's written notice, he shall inform the Engineer, in writing, that the required work has been completed. Upon receipt of this notice, the Engineer, in the presence of the Owner and Contractor, will make his final inspection of the project.

D. Should the Engineer find all work satisfactory at the time of his inspection, the Contractor will be allowed to make application for final payment in accordance with the provisions of the GENERAL CONDITIONS. Should the Engineer still find deficiencies in the work, the Engineer will inform the Contractor of the deficiencies and will deny the Contractor's request for final payment until such time as the Contractor has satisfactorily completed the required work.

1.05 FINAL SUBMITTAL

A. No application for final payment will be accepted until all submittals have been made and approved by the Engineer, including, but not limited to, the following:

1. Final shop drawings.

2. All information required to prepare record drawings.

3. All Operation and Maintenance Manuals (as required).

4. All required indices and schedules.

5. All Manufacturers' Certificates of Proper Installation.

6. All construction photographs, including those of the completed project.

1.06 ACCESSORY ITEMS

A. The Contractor shall provide to the Owner, upon acceptance of the equipment, all special accessories required to place each item of equipment in full operation. These special accessory items include, but are not limited to, the specified spare parts, adequate oil and grease as required for the first lubrication of the equipment, and other expendable items as required for initial startup and operation of all equipment.

1.07 GUARANTEES, BONDS, AND AFFIDAVITS

A. No application for final payment will be accepted until all guarantees, bonds, certificates, licenses, and affidavits required for work or equipment as specified are satisfactorily filed with the Engineer.

1.08 RELEASE OF LIENS OR CLAIMS

A. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the Owner as required by the GENERAL CONDITIONS.

1.09 FINAL PAYMENT

A. Final payment will be made to the Contractor in accordance with the GENERAL CONDITIONS.

END OF SECTION

SECTION 02055

DEMOLITION, MODIFICATIONS AND SALVAGE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to provide all dismantling, demolition, modifications, restoration, and salvage work required, as shown on the Drawings and Specified herein.

B. Comply with applicable laws, codes, ordinances and regulations. Obtain and pay for necessary permits.

C. Remove from site and legally dispose of dismantled materials, trash, debris, etc., except any items specifically indicated to be reused and any items designated in writing by the OWNER prior to beginning of dismantling operations to be salvaged for the OWNER'S purposes. Such items shall be carefully removed under the Contract and moved to designated storage areas on the project Site by CONTRACTOR.

D. All other materials removed under the demolition work and not called for to be re-used on the project shall be disposed of legally, off the site, by CONTRACTOR, who will, upon removal from site, have the rights of salvage of materials.

E. Carefully remove existing items to be re-used. Handle, remove, store, and reinstall in undamaged condition. Store items on site where directed and protect from weather, staining, construction damage, theft and vandalism. Arrange storage to facilitate inspection by ENGINEER.

F. Items designated to be re-used which, in ENGINEER's opinion become too damaged to be satisfactorily re-used shall be replaced with equivalent new items by CONTRACTOR without additional cost to the OWNER.

G. The CONTRACTOR shall visit the site of the work and examine the premises so as to fully understand all of the existing conditions relative to the work. No increase in cost or extension of performance time will be considered for failure to know the conditions of the Site and structures.

H. All piping, fittings, valves, pumps, motors, structural steel, etc., shown or indicated to be removed shall be removed prior to demolition, removal and modification.

I. The remaining open ends of all piping, valves, fittings, etc., that are removed shall be plugged with standard pipe plugs or closed with flanges so that there will be no leakage through the closure.

1.02 CARE, PROTECTION AND REPAIR

A. The CONTRACTOR is cautioned to exercise great care in protecting structures and property of the OWNER while proceeding with work of this Section and the entire Contract. All damage shall be repaired at once to the satisfaction of the ENGINEER. All such repairs shall be at the expense of the CONTRACTOR and no Claims for additional payment will be accepted.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 MANNER OF CONDUCTION WORK

A. Execute work in careful, orderly manner. Provide and maintain barriers, dust screens, warning lights as may be necessary to using tools and methods that will not transfer any heavy shocks to adjacent structures to remain in service and in place. Take all possible care to avoid vibration and other disturbance. Conduct work in manner giving prime consideration to, but not necessarily limited by:

1. Protection of public.
2. Protection from weather.
3. Control of noise, shocks, vibration.
4. Control of dirt and dust.
5. Orderly access.
6. Protection of existing adjacent structures.
7. Coordination and cooperation with the OWNER's operating agent through the ENGINEER.

B. Debris shall not be allowed to accumulate.

C. No fires will be permitted on site.

END OF SECTION

SECTION 02100

SITE PREPARATION

PART 1: GENERAL

1.01. CONTRACTOR shall verify existing grades prior to beginning site preparation. If existing grades are at variance with the Drawings, notify the OWNER's Site Representative and receive instructions prior to proceeding. No additional compensation resulting from grade variances will be considered once site clearing has commenced.

1.02. All bench marks and monuments shall be protected during construction. If disturbed or destroyed, replace in original position.

1.03 Construction stakeout shall be by a licensed surveying firm provided by the CONTRACTOR. Exact locations and grade points are to be staked or fixed by the surveying firm prior to construction.

1.04 Protect areas outside limits of construction from encroachment by outside construction personnel or equipment, regardless of property ownership. Access shall be by specific, written permission or easement only.

1.05 Existing utilities are indicated on the Drawings at approximate locations and reflect general ground surface observation. CONTRACTOR shall notify utility companies and coordinate exact location of all utilities prior to beginning site preparation.

1.06 Remove from the OWNER's property and legally dispose of all waste material at an approved landfill.

-- END OF SECTION --

SECTION 02110

SITE CLEARING

PART 1: GENERAL

1.01 SITE CLEARING

A. All trees and shrubs not designated "to remain" within the property limits, whether shown or not on the Drawings, shall be cut and the stumps shall be completely dug out. Materials of clearing shall be disposed off site. There shall be no on site burning.

B. All vegetation shown "to remain" shall be barricaded and protected during the construction process.

C. Strip topsoil to full depth encountered in areas indicated to be graded. Stockpile topsoil in designated storage area.

-- END OF SECTION --

SECTION 02115

REMOVAL AND DISPOSAL OF EXISTING BASINS

PART 1: GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required to remove and properly dispose of existing basins that will no longer be in use after startup of new plant.

B. Fill voids created as a result of removal of existing basins.

1.02 REGULATORY REQUIREMENTS

A. Conform to applicable local code for removal of structures, safety of adjacent structures, dust control, and runoff control.

B. Obtain required permits and licenses from appropriate authorities. Pay associated fees including disposal charges.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 PREPARATION

A. Provide, erect, and maintain erosion control devices, temporary barriers and security devices.

B. Protect existing landscaping materials, appurtenances, and structures which are not to be removed or demolished. Repair damages caused by removal operations at no cost to Owner.

C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as needed.

D. Mark location of utilities. Protect and maintain in safe and operable condition, utilities that are to remain. Prevent interruption of existing utility service, except when authorized in writing by authorities having jurisdiction.

3.02 TANK REMOVAL

A. Prior to removal of basin, all waste shall be removed by pumping and transported to the new wastewater treatment plant.

B. After removal of all waste from the basin, the basin shall be removed from the ground and disposed of in accordance with all local, state and federal regulations.

C. Following removal of the basin, the pit shall be backfilled in accordance with the technical specifications in order to bring the ground back to its original elevation.

END OF SECTION

SECTION 02220

STRUCTURE EXCAVATION AND BACKFILLING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to perform all excavation, backfill, fill, and grading required to complete the work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to, excavation for structures, all backfilling and fill, disposal of waste and surplus materials, and all related work such as pumping.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Trench excavation, backfilling, and compacting is included in Section 02221.

1.03 PROTECTION

A. Lateral Support of Excavation for Structures

1. Sheeting and bracing, if required, shall be as specified in Section 02221.

B. Control of Groundwater Level

1. The Contractor shall furnish, install, maintain, operate and remove a temporary dewatering system as required to lower and control the groundwater level so that the structures may be constructed in the dry. The Contractor shall, at his own expense, correct all damage resulting from inadequacy of the dewatering System or from flooding of the construction Site from other causes. Groundwater observation wells shall be installed in order to measure groundwater levels during construction

2 The dewatering system shall be adequate to drain any excavated area, to maintain the water at such a level as to permit construction in the dry, and to maintain the lowered watertable until the Structure has been completed to the required stages and has attained the design strength to support both the backfill material and hydrostatic forces from groundwater.

3. The Contractor shall maintain the water level below the specified elevations for the various phases of the work continuously and shall make such provisions as may be necessary to avoid interruptions due to weather, labor strikes, power failures, or other delays. He shall provide and have ready for

immediate use at all times diesel or gasoline powered standby pumping units to serve the system in case of failure of the normal pumping units.

4. Drainage water shall be disposed of in a manner acceptable to the Engineer so that flow or seepage back into the excavated area will be prevented.

5. Piping and boiling, or any form of uncontrolled seepage, in the bottom or sides of the excavation, shall be prevented at all times. If for any reason the dewatering system is found to be inadequate to meet the requirements set forth herein, the Contractor shall, at his own expense, make such additions, changes and/or replacements as necessary to provide a satisfactory dewatering system.

6. The depth of dewatering shall be limited in sand/gravel soil or in soil of high permeability (greater than 0.01 cm/sec) to one (1) foot below the foundation subgrade of the proposed structure.

7. Groundwater control shall be provided in expansive clay soils to maintain the natural state (wet or dry) of the clay below foundation slabs. For structures founded in clay below the groundwater table, the Contractor shall dewater a maximum of 6 inches below subgrade. For structures founded in clay above natural groundwater level, the Contractor shall maintain the dry state of the clay throughout construction period.

8. Removal of dewatering system shall be accomplished after the dewatering System is no longer required. The material and equipment constituting the system, including observation wells, shall be removed by the Contractor.

1.04 SUBMITTALS

The Contractor shall submit gradation of all materials to be used including structural fill and crushed rock. The submittal should also include the plasticity index of the materials.

PART 2: PRODUCTS

2.01 MATERIALS

A. Compacted granular fill, which will provide support for building or structure foundations, will be referred to as structural fill. Backfill, which is placed against the exterior side of the building walls, will be referred to as common fill.

B. Structural fill shall be #57 crushed stone where shown on the plans, or unfrozen, sandy gravel or gravelly sand free of organic material, loam, trash, snow, ice, or other objectionable material with a plasticity index between three and fifteen and shall be well graded within the following limits:

Sieve No. or Size	Percent Finer by Weight
3 inches	100
1-1/2 inches	80 to 100
# 4	50 to 100
# 16	40 to 90
# 50	10 to 60
#200	0 to 10

C. Crushed rock shall be as specified in ASTM C-33 for "coarse aggregate" and shall consist of crushed stone or gravel having hard, strong durable pieces free from adherent coatings, well graded and conforming to the following requirements:

Sieve No. or Size	Total Percent Passing by Weight
4"	100%
3"	90-100%
2-1/2"	25-60%
1-1/2'	0-15%
3/4"	0-5%

D. Screened pea gravel shall consist of hard, durable particles of proper size and gradation, and it shall be free from sand, loam, clay, excess fine, and deleterious material. The size of the particle shall be uniformly graded gravel in the following sizes:

Sieve No. or Size	Total Percent Passing by Weight
½"	100%
3/8"	85-100%
No. 4	10-30%
No. 8	0-10%
No. 16	0-5%

E. Common Fill shall be crushed #57 stone or consist of native soil free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than four (4) inches in largest diameter, granite blocks, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, or soil shall not be permitted.

F. Lean Concrete fill used for a working mat or seal slab shall be cast-in-place concrete meeting requirements of Section 03300, CAST-IN-PLACE CONCRETE, with the concrete compressive strength equal to a minimum of 2,500 psi.

G. Structural and common fills indicated to be #57 stone shall be coarse aggregate as specified in the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction.

H. The Contractor shall submit a representative sample of each type of fill, weighing approximately 50 pounds, at least five days prior to the date of anticipated use of such material.

EXECUTION

3.01 EXCAVATION BELOW GRADE

A. If the bottom of any excavation is taken below the limits shown on the Drawings, specified or directed by the Engineer, it shall be refilled at the Contractor's expense with concrete, 8-inch layers of compacted structural fill or other material satisfactory to the Engineer. The type of material to be used shall be at the Engineer's option.

B. If the Contractor does not maintain groundwater levels properly, or fails to postpone final excavation immediately above the subgrade until Shortly before placing of the new work thereon, or otherwise fails or neglects to conduct the excavation work properly so that the surface of the subgrade is in proper condition when he is ready for construction, the Contractor shall remove the unsuitable material and replace it with concrete, compacted structural fill, or other acceptable material at his own expense. The condition of the replaced subgrade shall be acceptable to the Engineer before any work is placed thereon.

C. Once excavation is complete, the base of the excavation shall be tested to determine its maximum dry density in accordance with ASTM Designation D-1557. The test results shall be submitted to the Engineer. If, in the opinion of the Engineer, the

material, in its undisturbed natural condition at or below the normal grade of the excavation, as indicated on the Drawings, is unsuitable for foundations, it shall be removed to such depth and width as he may direct and replaced with suitable material as directed by the Engineer. Over excavation required as stated in this paragraph will be paid in accordance with the General Conditions of this Specification.

3.02 STRUCTURE EXCAVATION AND COMPACTION PROCEDURES:

A. Excavation shall be made to such widths as will give suitable room for construction of the structures including bracing, supporting, pumping, and draining. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Engineer.

B. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Subgrade soils which become soft, loose, "quick,' or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering, or other construction methods shall be removed and replaced with structural fill as required by the Engineer at the Contractor's expense.

C. Dewatering shall be such as to prevent boiling or detrimental underseepage at the base of the excavation as specified above.

D. Excavation equipment shall be satisfactory for carrying out the work in accordance with the Specifications. In no case shall the earth be plowed,scraped, or dug with machinery so near to the finished subgrade as to result in excavation of, or disturbance of material below finished subgrade. The last of the excavated material shall be removed with pick and shovel just before placement of concrete floor slab or working mat.

E. When excavation for foundations has reached prescribed depths, the Engineer shall be notified and he will inspect conditions. If materials and conditions are not satisfactory to the Engineer, the Engineer will issue instructions as to the procedures to be taken. If additional costs are involved, adjustments of the contract will be made on the basis of prices agreed upon by the Owner and the Contractor in accordance with the provisions of the contract documents.

F. During final excavation to subgrade level, take whatever precautions are required to prevent disturbance and remolding. Material which has become softened and mixed with water, shall be removed. Hand excavation of the final 3" to 6" will be required to obtain a satisfactory undisturbed bottom The Engineer will be the sole judge as to whether the work has been accomplished satisfactorily.

G. Place structural fill in layers having a maximum thickness of 8" measured before compaction. Each layer of structural fill shall be compacted to a minimum of 95 percent of maximum dry density as determined by ASTM Compaction Test, Designation D-1557, by methods acceptable to the Engineer.

H. Structural fill shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice, or frozen earth be incorporated in the compacted fill.

3.03 EXCAVATION AND BACKFILLING FOR FOOTINGS

A. Excavation for all pipe lines beneath structures and excavation for all footings shall be carried out with the excavating equipment operating from the subgrade for the structure. The excavation shall be carried cut 'in-the-dry' and in a manner which will preserve the undisturbed state of the subgrade Soils. The excavations may be completed with shoring and bracing of open cuts as required.

B. All excavations beneath pipes under structures shall be backfilled with structural fill compacted as specified above and encased in concrete as shown on the Drawings.

C. Where it is impractical to use large equipment for compaction or -when such methods, in the opinion of the Engineer, are disturbing the surrounding natural subgrade, the fill shall be placed using hand-operated mechanical compactors. The lift thickness shall not exceed six (6) inches measured before compaction when hand-operated equipment is used.

3.04 BACKFILLING - COMMON FILL:

A. Common fill may be used as backfill against the exterior walls of the structures or in other areas as designated by the Engineer. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of eight (8) inches measured before compaction.

B. Common fill shall be compacted to a minimum of ninety-five (95) percent of standard proctor density with + 2 percent of optimum moisture content as determined by ASTM Compaction tests, Designation 0698-78, taking care to avoid over-compaction. Backfill behind walls shall be compacted by hand-operated tampers or light compaction equipment. Heavy roller compaction equipment shall not be allowed closer titan six (6) feet from the wall of any structure.

C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making due allowance for settlement of the material and for the placement of loam.

D. The surfaces of filled areas shall be graded to smooth true lines strictly conforming to grades indicated on the grading plan. No soft spots or uncompacted areas will be allowed in the work.

E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper Compaction.

-- END OF SECTION --

SECTION 02221

TRENCHING, BACKFILLING, AND COMPACTING

PART 1: GENERAL

1.01 SCOPE OF WORK

A Furnish all labor, materials, equipment, and incidentals necessary to perform all excavation, backfill, fill, and grading required to complete the work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to, excavation for pipelines below structures and footings, yard piping, vaults, ducts, pipes; all backfilling and fill of these excavations; disposal of waste and surplus materials; and, all related work such as sheeting, bracing, and dewatering.

1.02 RELATED WORK

A. Structure excavation and backfilling is included in Section 02220.

1.03 PROTECTION

A. Sheeting and Bracing in Trenches

1. Furnish, put in place, and maintain such sheeting and bracing as may be required to Support the sides of excavations to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect workmen and adjacent property and structures from undermining or other damage. If the Engineer is of the opinion that at any points sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor, and compliance with such order shall not relieve or release the Contractor from his responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled with sand or other suitable material and rammed.

2. The Contractor shall leave in place, to be embedded in the backfill, all sheeting and bracing which the Engineer may direct him in writing to leave in place at any time during the progress of the work for the purpose of preventing injury to structures, utilities, or property, whether public or private. The Engineer may direct that timber used for sheeting and bracing be cut off at any specified elevation.

3. All sheeting and bracing not left in place shall be carefully removed in such manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, by watering or otherwise as may be directed.

4. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.

5. No wood sheeting is to be withdrawn if driven below mid-diameter of any pipe, and under no circumstances shall any wood sheeting be cut off at a level lower than one foot above the top of any pipe.

B. Control of Groundwater Level

1. The Contractor shall maintain the groundwater level at, or below, the subgrade level so that all bedding material and pipe can be placed on a dry, firm subgrade.

2. Flotation shall be prevented by the Contractor by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages which may result from failure of this system.

3. Drainage water shall be disposed of in a manner approved by the Engineer so that flow or seepage back into the excavated area will be prevented.

4. Removal of dewatering system shall be accomplished after the dewatering System is not longer required: The material and equipment constituting the System, including observation wells, shall be removed by the Contractor.

PART 2: PRODUCTS

2.01 MATERIALS

A. Crushed Stone

1. Pipe bedding material shall be crushed stone chips made from crushing sound limestone or dolomite ledge rock. The material shall be hard, tough and durable.

2. Crushed stone bedding for piping 18-in diameter or less shall conform to the grading requirements of ASTM C-33, Size No. 8.

B. Sand

1. Sand shall have the gradation listed below:

GRADING REQUIREMENTS FOR PIPE BEDDING AND COVER SAND

STEVE SIZE	PERCENT PASSING BY WEIGHT
3/8-inch	100
No. 4	95-100
No. 8	80- 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 200	2 - 10

2. Rejected concrete sand is generally acceptable. The presence of fine clay or loam particles is desirable, but shall not exceed 6 percent by weight. Clay or loam lumps are not permitted.

3. The maximum moisture content shall not exceed 10 percent.

C. Backfill, which is placed as fill over pipelines, will be referred to as common fill. Common fill shall consist of mineral soil free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than two (2) inches in largest diameter, granite blocks, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, and frozen soil shall not be permitted.

PART 3: EXECUTION

3.01 EXCAVATING AND BACKFILLING PIPE TRENCHES UNDER STRUCTURES

A. Excavation for all pipe lines beneath structures shall be carried out with the excavating equipment operating from the subgrade for the structure. The excavation shall be carried out 'in-the-dry' and in a manner which will preserve the undisturbed state of the subgrade soils. The excavations may be completed with shoring and bracing of open cuts.

B. All pipelines beneath structures, not encased in concrete, shall be bedded in crushed stone and backfilled with common fill compacted as specified below. Where it is impractical to use large equipment for compaction or when such methods, in the opinion of the Engineer, are disturbing the surrounding natural subgrade, the fill shall be compacted using hand-operated mechanical compactors. The lift thickness shall not exceed six (6) inches measured before compaction when hand-operated 02221-3 equipment is used. Backfill shall be compacted to 95% Standard Proctor Density at optimum moisture content.

3.02 TRENCH EXCAVATION AND BACKFILLING FOR YARD PIPING

A. Excavation for all trenches required for the installation of pipes and ducts shall be made to the depths indicated on the Drawings and in such a manner and to such widths as will give suitable room for laying the pipe or installing the ducts within the trenches, for bracing and supporting, and for pumping and drainage facilities; and shall render the bottom of the excavation firm and dry and in all respects acceptable to the Engineer.

B. Rock shall be removed to a minimum clearance of six inches around the bottom and sides of all the pipe being laid.

C. Where pipe or ducts are to be laid in bedding or encased in concrete, the trench may be excavated by machinery to, or just below the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

D. Where pipes or ducts are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery, the last of the material being excavated manually in such a manner that will give a rounded, smooth bottom true to grade so that pipe or duct can be evenly supported on undisturbed material. Bell holes shall be made as required.

E. Backfilling over ducts shall begin not less than three days after placing concrete encasement.

F. Where pipe is to be installed in fill of any type, fill shall be placed and compacted to the total depth required (rough grade elevation) and then re-excavated for pipe installation.

G. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. If required, as shown on the Drawings, bedding material shall be placed around the pipe to a point as shown on the Drawings. As the material is placed, it shall be compacted by suitable tools.

H. After the bedding (if required) has been placed common fill shall be placed to a minimum depth of 2 ft. over the top of the bedding material. Common fill shall be thoroughly compacted by hand-tamping lifts not deeper than 6 inches to 90% of standard proctor density optimum moisture content.

I. The method and degree of compacting backfill as directed by the Engineer will be governed by the type of material and the extent to which any subsequent settlement can be permitted.

END OF SECTION

SECTION 02230

EROSION CONTROL

PART 1: GENERAL

1.1 EROSION CONTROL

1.1.1 The Project and the CONTRACTOR shall comply with all applicable state and local erosion and sedimentation control laws and ordinances.

1.1.2 The CONTRACTOR is responsible for maintaining all sediment and erosion control measures on the project site during construction. The CONTRACTOR is responsible for any damage caused due to failure to implement these requirements.

PART 2: REQUIREMENTS

1.2 REQUIREMENTS

1.2.1 The CONTRACTOR shall incorporate the following principles in his work:

1) The disturbed area and the duration of exposure to erosion elements should be minimized.

2) Stabilize disturbed areas immediately.

3) Detain run-off.

4) Retain sediment.

5) Do not encroach upon water courses.

1.2.2 All disturbed areas not receiving pavement shall be grassed by sodding or seeding, fertilizing, mulching and watering to obtain a ground cover which will prevent soil erosion.

1.2.3 A temporary construction egress pad shall be installed and maintained at any point where construction vehicles enter a public right-of-way, street or parking area. The pad shall be used to eliminate mud from the construction area onto public rights-of-way. The pad shall be constructed as shown on the Drawings. Any mud or debris tracked on streets shall be cleaned up immediately.

1.2.4 All measures installed for sediment control shall be checked at the beginning and end of each day when construction is occurring to ascertain that the measures are in place and functioning properly. Any damage observed will be repaired by the end of that working day. Measures shall be maintained until they are called to be removed on the Plans.

-- END OF SECTION --

SECTION 02513

ASPHALTIC CONCRETE PAVING

PART 1: GENERAL

1.1 SCOPE OF WORK

1.1.1 Provide labor, material, equipment and services necessary for proper and complete bituminous paving.

1.2 QUALITY ASSURANCE

1.2.1 All standards, materials methods of installation, equipment and construction shall be in accordance with the current edition of the Kentucky Department of Highways (KYDOH) publication "Standard Specifications for Road and Bridge Construction," except as modified herein.

1.3 GUARANTEES

1.3.1 Asphalt Paving Guarantee: Provide the OWNER with an unconditional guarantee, covering the workmanship and materials for the pavement base and asphaltic topping for a period of one (1) year after the date of acceptance. The actual starting of the work shall be construed to mean that the condition of the sub-base is acceptable and will fulfill all guaranteed requirements. Also maintain the paving including ordinary normal wear and tear for period of one (1) year after the date of acceptance. The OWNER shall be provided with one (1) year maintenance free guarantee from date of final acceptance of the asphalt pavement by the OWNER.

1.4 SUBMITTALS

1.4.1 Submit CONTRACTOR's guarantee.

1.4.2 Before placing any bituminous surface the CONTRACTOR shall submit the design plant mix for approval. This submittal shall address both the last date the mix was approved by the Kentucky Department of Highways and the location where the mix was most recently used.

1.4.3 Submit materials certificates signed by material producer and CONTRACTOR, certifying that each material item complies with, or exceeds, specified requirements.

1.4.4 Submit copies of all reports of testing performed pursuant to these specifications.

1.5 JOB CONTROL

1.5.1 Weather Limitations:

Apply tack coats only when the ambient temperature in the shade has been at least 50 degrees F for 12 hours immediately prior to application.

Do not conduct paving operations when surface is wet or contains excess of moisture which would prevent uniform distribution and required penetration.

Construct asphaltic surface courses only when atmospheric temperature is above 55 degrees F for 1" lift or 45 degrees F for 2" lift, when the underlying base is dry and when weather is not rainy.

Place base course when temperature is above 35 degrees F and rising.

1.5.2 Grade Control:

Maintain vehicular and pedestrian traffic during paving operations, as required, for other construction activities.

Provide flagmen, barricades, warning signs and warning lights as required for movement of traffic and safety and to cause the least interruption of work.

PART 2: PRODUCTS

2.1 MATERIALS

2.1.1 All materials indicated on the drawings, specified or required shall be in accordance with 1.2.1 unless specified otherwise hereafter.

2.1.2 Asphalt Paving Material

Materials selected shall be of highest quality. The OWNER's Site Representative shall be notified of all materials to be used according to Section 3.3 prior to commencement of work.

The aggregate base course shall be Dense Graded Aggregate (DGA) or Crushed Stone Base meeting the requirements of Sections 303 and 805 of the KYDOH.

Bituminous prime coat shall be Primer L meeting the requirements of Sections 407 and 806 of the KYDOH.

Bituminous base shall be Bituminous Concrete Base Class I. Bituminous Concrete Base Class I shall meet the requirements of Sections 403 and 401 of the KYDOH.

Bituminous tack coat shall be SS-1, SS-1h, CSS-1, CSS-1h, AE-60, RS-1 or CRS-1 meeting the requirements of Sections 407 and 806 of the KYDOH.

Bituminous surface shall be Bituminous Concrete Surface, Class I meeting the requirements of Section 401 and 402 of the KYDOH.

Rock Roadbed (when required) shall meet the requirements of Section 204 of the KYDOH.

PART 3: EXECUTION

3.1 INSPECTION

3.1.1 Establishing of Grade: The CONTRACTOR shall be responsible for his grade control.

3.1.2 Protection of Work by Others: Protect all work installed by others such as manholes, catch basins, sewer cleanouts, lighting posts and bases, sidewalks, etc. Damage to same shall be repaired at paving CONTRACTOR's expense.

3.2 INSTALLATION, APPLICATIONS

3.2.1 All materials shall be installed using equipment and procedures in accordance with the current Kentucky Department of Highway specifications as indicated in 1.2.1, except as hereafter specified.

3.2.2. Asphalt Pavement

Asphalt pavement shall consist of layered construction as indicated in the Paving Details provided in the Drawings.

3.2.3. Conditioning Existing Surface

The surface on which the bituminous plant mix is to be placed shall be cleaned and maintained free of accumulations of materials that would, in the judgement of the OWNER's Site Representative, contaminate the mixture, prevent bonding or interfere with the spreading operations. Where approved subgrade or pavement courses previously constructed under the contract become loosened, rutted or otherwise defective, the deficiency shall be corrected in accordance with the requirements for the item or items involved prior to the spreading of bituminous plant mix for a subsequent pavement course.

When a quantity of bituminous plant mix is specified for use in spot leveling or patching an existing pavement surface, the material needed to effect the corrections shall be spread and compacted as directed by the OWNER's Site Representative.

Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.

Where mixture is to be placed against the vertical face of an existing pavement structure, the vertical face shall be cleaned of foreign material and given an application of bituminous material in a manner which results in a coating of approximately 0.25 gallon per square yard.

When the surface course is not placed within 10 days after completion of the intermediate course, the CONTRACTOR shall provide a tack coat, at this own expense, as directed by the OWNER's Site Representative.

Preparation of Surface: The surface to be primed shall be shaped to the required grade and section, shall be free from all ruts, corrugations, segregated material or other irregularities and shall be smooth and uniformly compacted at the time of application of the bituminous material. The cleaning shall be done in such manner as to thoroughly remove all mud, earth and other foreign material. The sweeping on a waterbound surface shall be just sufficient to expose the pattern of the coarse aggregate. Special care shall be taken to clean the edges of road to be primed in order to insure uniform application of the bituminous material directly on the existing base or pavement surface. Material cleaned from the surface shall be removed and disposed of as directed by the Engineer.

Application of Bituminous Material: Bituminous material shall be applied in a uniform continuous spread to the width of the section to be primed by means of a pressure distributor. When traffic is maintained, not more than one half of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified amount. Excess bituminous material shall be squeegeed from the surface. Skipped areas or deficiencies shall be corrected.

When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the road bed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portions and the remaining width of the section shall be primed. The quantity, rate of application, temperatures and areas to be treated, shall be approved before application of the prime coat.

Bituminous prime coat shall be applied to the base course at the rate of .3 gal. per square yard.

Asphaltic concrete shall be installed in lifts. The average compacted thickness shall be equal to or greater than the thickness specified. No skin patching will be accepted. Compaction of the bituminous concrete shall be equal to 97% of that obtained in the laboratory. Asphalt concrete shall be rolled with a ten ton roller as soon after placing as is practicable.

Provide a slope for drainage as indicated on the Drawings and slope to catch basins as provided.

The surface of the finished pavement shall be free of roller depressions. When testing with water, the surface shall not contain any irregularities which will impede the water flow.

After final rolling, the surface shall be tested with a ten (10) foot straight edge. The variation of the surface from the edge of the straight edge between any two contact points shall not exceed 1/4".

3.3 QUALITY CONTROL

3.3.1 An independent testing laboratory meeting the requirements, sampling and testing procedures of the American Association of State Highway and Transportation Officials (AASHTO) and American Society for Testing Materials (ASTM) shall be retained by the OWNER to evaluate the asphalt paving tests for compliance with the requirements of the contract documents.

3.3.2 Testing During Construction

The aggregate course shall be tested for compliance with the specified requirements. The installation shall be observed for compacted thickness, cross section, and grade.

Field density shall be checked with nuclear gages for every 10,000 S.F. of DGA surface placed.

Bituminous concrete mix shall be tested for bitumen content and physical requirements. OWNER's Site Representative shall observe bituminous concrete placement for number of lifts, procedure employed and compliance with indicated cross sections and grade. The Engineer shall conduct field density tests and thickness checks in accordance with Section 403 of KYDOH.

The CONTRACTOR shall pay for and have testing agency take two 4" diameter cores for every 10,000 square yards of paved surface at locations selected by OWNER's Site Representative, for density and thickness tests. Repair holes resulting from coring to match existing paving prior to placing surface course. OWNER reserves the right to take additional cores and should testing show insufficient thickness, all defective areas shall be remediated. CONTRACTOR shall also pay all costs related to remediation including cost of additional testing.

Density: Compare density of in-place material against laboratory specimen of same mixture, subjected to 50 blows of a Standard Marshall hammer on each side of specimen. Minimum acceptable density of in-place material shall be 97% recorded laboratory specimen density.

3.3.3 Allowable Variation in Thickness

1) Base Course: plus or minus 1/2".

2) Intermediate Course: 1/4".

3) Surface Course: plus or minus 1/8".

3.3.4. Surface Smoothness: Test finished surface of each asphalt course for smoothness using a 10'-0" straight edge. Intervals of tests shall be as directed by OWNER's Site Representative. Surfaces exceeding the following tolerances will not be acceptable:

1) Base Course: 1/2" in 10'-0".

2) Intermediate Course: 1/4" in 10'-0".

3) Surface Course: 1/8" 10'-0".

3.3.5 CONTRACTOR's Testing Duties

Duties include:

1) Notifying laboratory of conditions requiring testing.

2) Coordinate with laboratory for field testing.

3) Paying costs for testing as well as for additional testing where initial test reveals non-conformance with specified requirements.

-- END OF SECTION --

SECTION 02600

PLANT PIPING - GENERAL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install the plant piping specified herein and as further specified in the Detail Piping Specifications hereinafter.

B. Material provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance and manufacturer's service.

1.02 RELATED WORK SPECIFIED

A. Trenching, backfilling, and compacting are included in Section 02221.

B. Concrete work is included in Division 3.

C. Painting is included in Division 9.

D. Pumps are included in Division 11.

E. Instrumentation is included in Division 13.

F. Valves are included in Division 15.

1.03 SUBMITTALS

A. In addition to the requirements of Section 01300 submittals the following information shall be provided:

1. A specific selection of pipe material and joint type for each pipeline.

2. Double-line drawings of each piping support system to the scale stated on the Contract drawings, locating each support and hanger, identifying by type by catalog number or shop drawing detail number, and showing anchor locations and identifying them by shop drawing detail number.

3. Detailed installation drawings, catalog information, and complete component selection list for metal framing pipe Support system in the pipe galleries, trenches, and other locations employing metal framing pipe support systems.

4. Pipe disinfection and leak test reports.

1.04 MANUFACTURER'S SERVICE

Not Used

1.05 PIPE IDENTIFICATION PAINTING

A. All non-submerged piping shall be painted, color coded, and labeled as specified in Section 09902, Finish Painting.

PART 2: PRODUCTS

NONE

PART 3: EXECUTION

3.01 PIPE PREPARATION AND HANDLING

A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

3.02 INSTALLATION OF BURIED PIPING

A. Preparation of Trench

1. Provide pipe bedding material under all pipe for the full width of the trench. Minimum depth of bedding material below the pipe barrel shall be as specified herein.

2. Depth of pipe bedding material under the pipe bell shall not be less than 3 inches under normal trench conditions and not less than 6 inches in rock excavation areas.

3. Hand-grade bedding to proper grade ahead of pipe laying operation. Bedding shall provide a firm, unyielding support along the entire pipe length.

4. If the trench has been excavated below the required depth for pipe bedding material placement without direction from the Engineer, fill the excess depth with the pipe bedding material specified herein and specified in Section 02221, to the proper subgrade. Place the pipe bedding or foundation stabilization material for the full width of the trench in layers not exceeding 6 inches deep and compact each layer, until the material does not yield or move, to the grade established for the pipe bedding. Where the distance to stable ground is excessive, the Engineer reserves the right to order as an extra, in writing, such other types of foundation or pipe supports as he shall deem necessary.

5. Pipe bedding material shall be crushed stone except for polyethylene wrapped ductile iron pipes which shall have sand bedding and cover material.

B. Line And Grade

1. Do not deviate more than 1 inch from line or 1/4 inch from grade established by the Engineer. Measure for grade at the pipe invert, not at the top of the pipe, because of variations in pipe wall thickness.

2. Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for gravel cushion when specified or indicated. Remove hard spots that would prevent a uniform thickness of bedding. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and Support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.

C. Bell (Joint) Holes

At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit easy visual inspection of the entire joint.

D. Removal of Water

1. Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench during the process of pipe laying.

The trench shall be kept dry until the pipe laying and jointing are completed. Removal of water shall be in conformance with specifications in Section 02221.

E. Prevent Trench Water And Animals From Entering Pipe

1. When the pipe laying is not in progress, including the noon hours, the open ends of pipe shall be closed by a plug or cap to prevent trench water, animals, or foreign material from entering the pipe.

F. Backfill In Pipe Zone

1. The pipe zone shall be considered to include the full width of the excavated trench from the bottom of the trench to 12-inch above the top outside surface of the barrel of the pipe.

2. Particular attention must be given to the area of the pipe zone from the flow line to the spring line of the pipe to insure that firm Support is obtained to prevent any lateral movement of the pipe during the final backfilling of the pipe zone.

3. Where the normal trench width below the top of the pipe is exceeded for any reason, the Contractor shall, unless the Engineer determines that the pipe being used is strong enough for the actual trench width, furnish an adequate support for the pipe. This may be accomplished by furnishing a stronger pipe or a concrete cradle, cap or envelope as approved.

4. For polyethylene wrapped pipe, place and carefully compact pipe with sand for the full width of the trench to the spring line of the pipe. Place the material around the pipe in 6-inch layers and thoroughly hand tamp with approved tamping sticks supplemented by compacting and slicing with a shovel to assure that all voids are filled. Special care shall be taken to avoid damage to the polyethylene wrap around the pipe during placement and compaction of the sand bedding and cover material.

G. Trench Backfill

1. Minimum pipe burial to the top outside surface of the pipe barrel shall be 4 feet unless otherwise noted. Trench backfill above the pipe cover material shall be common fill as specified in Section 02221.

3.03 INSTALLATION OF EXPOSED PIPING

A. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.

B. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle vertical centerline of pipes.

C. Unions shall be installed where required for piping or equipment installation, even though they are not shown on the plans.

D. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

E. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

F. Where valve handwheels are shown, valve orientation shall be as shown. Where valve handwheels are not shown, valves shall be orientated to permit easy access to the handwheels, and to avoid interferences.

3.04 INSTALLATION OF WALL PIPES AND PIPE SLEEVES

A. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as shown, and shall be coated with system for interior non-submerged ferrous metal as specified in Section 09902, Finish Painting. Support all pipes embedded in concrete walls, floors, and slabs with form work to prevent contact with the reinforcing steel.

3.05 INSTALLATION OF FLEXIBLE COUPLINGS, FLANGED COUPLINGS ADAPTERS, AND SERVICE CLAMPS

A. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed.

B. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends.

C. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches, of approved type.

3.06 INSTALLATION OF INSULATING FLANGES, COUPLINGS, AND UNIONS.

A. Install insulating flanges, couplings, and unions wherever copper and galvanized steel piping are connected, where stainless steel piping is connected to cathodically

protected mild steel piping, and wherever cathodically protected steel lines enter the buildings.

3.07 TESTING

A. General

1. Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests.

2. Unless otherwise noted, test pressures shall be as specified below:

All Pressure Lines	100 psig
All Gravity Lines	28 psig
All Chemical Piping	100 psig

3. New pipelines which are to be connected to existing pipelines shall be tested by isolating the new pipe with blind flanges.

4. Unless otherwise specified, all air and gas lines and exposed process piping shall be pneumatically tested and all other lines shall be hydrostatically tested.

5. Conduct final acceptance tests on buried piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed. Buried piping that is to be pneumatically tested shall have all joints exposed for the acceptance test.

6. Conduct the test on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors, but prior to insulation.

B. Hydrostatic Leak Tests

1. Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Approved graduated containers.
2	Pressure gauges.
1	Hydraulic force pump approved by the Engineer. Suitable hose and suction pipe as required.

2. Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Test water shall be acquired from a source within the plant as designated by the Owner's Operating Agent.

3. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents.

4. All parts of the piping system shall be subjected to test pressure specified hereinbefore.

5. Process Piping

   a. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 4 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 2 days.

   b. When testing cement-mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.

   c. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.

6. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

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

In this formula:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested in feet.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during the leakage test, in pounds per square inch.

7. The Contractor shall correct any leakage greater than the allowance determined under this formula at no additional cost to the Owner.

C. Pneumatic Leak Tests

1. Furnish the following equipment for the pneumatic tests:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105% of the required primary test pressure.
1	Calibrated test gauge.

2. Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Tests shall be performed only after the piping has been completely installed, including all supports, hangers and anchors, and inspected for proper installation. All parts of the piping system shall be subjected to the test pressure specified. The Contractor shall take all precautions to protect test personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenant instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to applying the test. Prior to starting the test, the Contractor shall notify the Engineer.

3. A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than ½ of the test pressure, after which the pressure shall be increased in steps of approximately 1/10 of the test pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be

necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence for leakage. Any visible leakage shall be corrected at no additional cost to the Owner.

4. Following pneumatic testing and final cleaning, lines which are to carry flammable gases shall be thoroughly purged with nitrogen or other approved gas to assure that no explosive mixtures will be present in the system during the filling process.

D. Initial Service Leak Tests

1. Equipment used for initial service leak testing may be the same as that specified under HYDROSTATIC AND PNEUMATIC LEAK TESTS hereinbefore, or the pump or compressor connected to the piping system.

2. The initial system leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at no additional cost to the OWNER.

E. Test Records

1. Records shall be made of each piping system installation during the test. These records shall include:

a. Date of test.

b. Description and identification of piping tested.

c. Test fluid.

d. Test pressure.

e. Remarks, to include such items as:

(1) Leaks (type, location).
(2) Repairs made on leaks.

f. Certification by Contractor and initialed acknowledgment by the Engineer.

3.08 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and fillings, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.09 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at a lower velocity. Accumulated debris shall be removed through drains 2-inch and larger or by dropping spools and valves.

B. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

END OF SECTION

SECTION 02670

PRESSURIZED POTABLE WATER SYSTEM LESS THAN 3” IN DIAMETER

PART 1: GENERAL

1.01 DESCRIPTION

A. Scope: Furnish all labor and materials necessary for proper construction of potable water conveyance lines and their appurtenances less than 3" in diameter.

B. The CONTRACTOR's responsibilities under this specification end five (5) feet from the building line.

C. Related work as called for on Drawings or specified herein.

1.02 QUALITY ASSURANCE

A. Each piece of pipe, fitting, valve or other appurtenance shall be marked to identify the manufacturer, pressure rating, material and compliance with any agency approval specification.

1.03 SUBMITTALS

A. Submit four copies of manufacturer's affidavit of compliance with the requirements of this section of the specifications.

B. Submit four copies of manufacturer's certification that valves hydrostatically tested to 200 percent of rated working pressure.

C. Submit four copies of report of successful hydrostatic test for pressurized lines.

D. Submit four copies of report of disinfection for potable water line.

PART 2: PRODUCTS

2.01 COPPER PIPE

A. Copper Pipe: All pipe less than 3" in diameter used for potable water transmission shall be considered service pipe. All service pipe shall be copper pipe, Type K per ASTM specification B88. Plastic service pipe will not be accepted.

2.02 FITTINGS FOR COPPER SERVICE PIPE

A. Fittings shall be fabricated for use with copper pipe and shall conform to AWWA C800 latest revision.

2.03 TAPPING SADDLES AND COCKS

B. Tapping saddles shall be of the double band type and shall be threaded to receive the corporation cock. The corporation cock shall meet AWWA C800 standards and shall have a compression outlet compatible with the diameter of copper service line to be employed.

PART 3: EXECUTION

3.01 INSTALLATION

A. The installation of water service lines and their appurtenances shall conform to the requirements of Part 3 of Section 02732 herein. The minimum depth of bury for water service lines is 30".

END OF SECTION

SECTION 02730

GRAVITY SANITARY SEWERS

PART 1: GENERAL

1.01 DESCRIPTION

A. Scope: Furnish all labor and materials necessary for proper construction of gravity sanitary sewer lines, manholes, and appurtenances.

B. The CONTRACTOR's responsibility under this specification ends five feet from the building line.

C. Related work as called for on Drawings or specified herein.

1.02 QUALITY ASSURANCE

A. CONTRACTOR shall provide the necessary leveling equipment to check the elevation of the pipe flowline.

B. Each piece of pipe, fitting, valve or other appurtenance shall be marked to identify the manufacturer, pressure rating, material and compliance with any agency approved SPECIFICATIONS.

1.03 SUBMITTALS

A. Certificates

1) Submit manufacturer's certificate(s) that proposed materials and products meet or exceed the requirements of these SPECIFICATIONS.

B. Test Results

1) Submit results of successful low pressure air test.

PART 2: PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE AND FITTINGS

A. PVC pipe and fitting shall be extruded from Type I, Grade 1, polyvinyl chloride material designated as PVC 1120, meeting ASTM Specifications D 3034, Type PSM, and a standard dimension ratio (SDR) of 35.

B. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions, or other defects.

C. The pipe shall be of bell and spigot construction. The spigot end shall have a ring painted around the pipe circumference to allow field checking of setting depth in pipe bell.

2.02 MANHOLES

A. Manholes for gravity sanitary sewers shall be constructed from 4 foot ID precast concrete rings conforming to ASTM C76, Class II, Wall B with a minimum concrete strength of 4000 psi, except that rings for manholes over 12 feet deep shall be Class III. O-ring gaskets shall be installed between connected ring sections.

B. A water proofing seal coating shall be applied to the exterior of all manhole ring segments.

C. Manhole inverts shall be U-shaped, formed and constructed of 2000 psi concrete for a smooth continuation of the pipe. The channel height shall be not less than three fourths of the diameters of the smaller pipe that is intercepted.

D. Manhole tops shall be of eccentric conical design for all manholes deeper than 6 feet. Shallow manholes shall have a flat slab top.

E. Manhole steps shall be made of steel reinforced polypropylene plastic.

F. Standard manhole castings shall consist of cast iron frames and 28 inch diameter covers, weighing not less than 385 pounds per frame and cover. Manhole covers must sit neatly in the rings, with contact edges machined for even bearing and tops flush with ring edge. They shall have sufficient corrugations to prevent a slipperiness. The lids shall have two pick holes about 1-3 inches wide and 2 inch deep and with 3/8 inch undercut all around.

PART 3: EXECUTION

3.01 GENERAL

A. The execution of the gravity sanitary sewer pipe installation shall conform to the requirements of Part 3 of Section 02720 of these specifications except as noted in the following.

3.02 TESTING

A. Lamping:

The CONTRACTOR shall rod out the entire system with appropriate tools for the removal of any and all dirt, debris, and trash.

The OWNER's Site Representative shall inspect each line from manhole to manhole by use of lights or other means to determine that the lines are true to line and grade.

The OWNER's Site Representative may require that the CONTRACTOR pass through the system under its own momentum, a wooden ball of a diameter one inch less than the nominal diameter of the pipe.

All lines, or sections thereof, that are found to be laid improperly, that contain broken or leaking sections or that are obstructed in any manner shall be removed and replaced. In no event shall infiltration exceed 250 gallons per day per inch diameter mile.

B. Low Pressure Air Test

Air tests shall be conducted in accordance with the latest edition of the UNI-BELL Plastic Pipe Association Standard UNI-B-6 "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe." The minimum test pressure shall be 4 psi greater than the backwater pressure of any groundwater that may submerge the pipe. If the time for a 1 psi drop is less than the time published in the referenced standard for a 1 psi drop, the test pipe reach shall fail the test. If the pipe reach fails the test, the CONTRACTOR shall take corrective action (at his expense) until the pipe reach passes the air test.

The CONTRACTOR shall furnish all equipment and materials required for the testing.

The results of the testing shall be submitted to the OWNER's Site Representative.

END OF SECTION

SECTION 02732

FORCE MAINS

PART 1: GENERAL

The Contractor shall furnish all labor, materials and equipment required to install the force mains as shown on the plans and as specified herein.

The pipe may be PVC pipe, ductile iron pipe, or polyethelene plastic pipe as shown on the plans.

The Contractor will be required to deliver all equipment and other materials and place same as and where required for installation. Care must be exercised in the handling of all materials and equipment and the Contractor will be held responsible for all breakage or damage to same caused by his workmen, agents, or appliance for handling or movina. Pipes and other castings shall in no case be thrown or dropped from cars, trucks, or wagons to the ground, but same shall be lowered gently and not allowed to roll against or strike other castings and unyielding objects violently. Pipe and special castings may be distributed at places that will not interfere with other building operations as unloaded, or yarded and distributed as required, as the Contractor may elect.

All equipment and materials subject to damage from the weather, dampness, changes in temperature, or exposure shall be protected by a dry, weatherproof enclosure until ready for installation or use.

PART 2: PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

Pipe and fittings shall meet or exceed all of the requirements of ASTM Specification D-3034 latest revision and ASTM 3033 and have an SDR and/or class rating as shown on the plans.

Provisions must be made for contraction and expansion at each joint with a rubber ring. The bell shall consist of an integral wall section stiffened with two PVC retainer rings which securely lock the solid cross section rubber ring into position at the factory. Standard lengths shall be 20 feet and 12.5 feet plus/minus 1 inch. All pipe shall be marked with the manufacturer's name, production lot number, ASTM designation, PVC and nominal diameter.

2.02 DUCTILE IRON PIPE

Ductile iron pipe installed underground shall be Class 51, unless otherwise shown on the plans, tar coated outside and inside in accordance with AWWA specifications. The joints

for ductile iron pipes shall be of the Push-on type and shall have an annular recess in the pipe to accommodate a single rubber gasket. Plain spigot ends shall be suitably beveled to permit easy entry into the bell. A gasket and annular recess of the socket shall be so designed and shaped that the gasket is located in place against displacement as the joint is assembled. The push-on type joint shall be "Tyton" or equal as approved by the Engineer.

Appropriate manufactured transition pieces shall be provided to connect ductile iron pipe to other pipe of other materials. These special transition pieces shall be included as incidental expenses and are not a separate pay item.

2.03 POLYETHYLENE PLASTIC PIPE

Pipe and fittings shall meet or exceed all of the requirements for Type III C5-P34 as tabulated in ASTM D-1248, latest revision (Ultra High Molecular Weight High Density Polyethylene Pipe) . All pipe shall be a minimum of schedule 40 if used for force main or as specifically noted on the PLANS. The pipe and fittings shall be pressure rated at 73.4° F and have a suggested design hoop stress of 730 psi.

All pipe shall be virgin quality, have a melt flow (Condition F) of less than 5.9 gms/10 min. (ASTM D1238) and shall exceed 1,000 hours on Environmental Stress Crack Resistance (ASTM D1693 Condition C.)

The polyethylene pipe shall have a manufacturer's recommended hydrostatic design stress rating of 730 psi based on a material with a 1,460 Psi design basis determined in accordance with ASTM D-2837, Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

The PE pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects. It shall be uniform in color, opacity, density and other physical properties.

Marking on the pipe shall include the nominal pipe size, the type of plastic material, the standard thermoplastic pipe pressure rating in psi for water at 73°F for low pressure 100 and 150 psi pipe (schedule 40 pipe is marked as such) and manufacturer's name or trade mark and code, at intervals of not more than five feet.

Fittings shall be molded or fabricated from high density polyethylene.

Molded fittings shall be molded from high density polyethylene of same material as main line.

Fabricated fittings shall be prepared from polyethylene pipe of same material as main line and by means of thermal fusion.

Pipe and fittings shall be joined to one another by the thermal butt fusion system.

Polyethylene pipe lengths, fittings and flanged connections to be fused shall be of the same type, grade and class of polyethylene compound.

PART 3: EXECUTION

3.01 INSTALLATION OF FORCE MAINS

A. General. Before any length of pipe is placed in the trench, make a careful inspection to see that no foreign material is in the pipe. In order to properly remove any foreign materials, a swab of necessary length is to be available at all times.

All pipe shall be lowered carefully into the trench, properly aligned and properly jointed by use of suitable tools and equipment, in such manner as to prevent damage to protective coatings and linings. Excessive scratching of the exterior surface of the pipe will be cause for rejection of the pipe.

Under no circumstances shall pipeline materials be dropped or dumped into the trench. The pipe and fittings shall also be inspected for the purpose of determining if they are sound and free from cracks. Laying of pipe shall be commenced immediately after excavation is started. Pipe shall be laid with bell ends facing in the direction of laying.

When pipe laying is not in progress, the open ends of pipe shall be closed to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, adequate backfill shall be deposited on the pipe to prevent floating. Any pipe which has floated shall be removed from the trench and installed properly. No pipe shall be laid in water or on frozen trench bottom or whenever the trench conditions or the weather are unsuitable for such work.

If any defective pipe and fittings shall be discovered after the pipeline is laid, they shall be removed and replaced with a satisfactory pipe or fitting without additional charge to the Owner. Open ends of unfinished pipelines shall be securely plugged or closed at the end of each day's work or when the line is left temporarily at any other time.

B. Cast or Ductile Iron Pipe. Cast or ductile iron bolted joint, rubber ring slip joint, and ball and socket river crossing pipe shall first be thoroughly cleaned at joints, then joined according to manufacturer's instructions. Three (3) copies of instructions shall be furnished the Engineer and one (1)

copy shall be available at all times at the site of the work. The lining inside cast iron or ductile pipe must not be damaged by handling.

All pipes must be forced and held together, or “homed" at the joints, before sealing or bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as is practical, and all curves and changes in grades must be laid in such a manner that the maximum deflection is not exceeded at any joint.

Cast iron or ductile iron pipe four inch diameter and larger, shall be laid on an evenly spread and compacted crushed stone cushion four inches deep above bottom of trench uniformly supporting the pipe. Six inches of crushed stone bedding shall be used in rock. When cast iron or ductile iron pipe less than four inch diameter is used, granular compacted earth may be substituted for crushed stone. Sufficient space (limited to two feet longitudinally) shall be left for tightening of bolts where bolted joints are used. No pipe shall be laid resting on rock, blocking, or other unyielding objects.

When using pipe with push-on joints, care must be exercised to make certain that the correct gasket is being used for the type of joint installed and that the gasket faces the proper direction. Before inserting the gasket, the groove and bell socket should be carefully cleaned of all dirt. If sand or dirt is permitted to remain in the groove, leaks may occur. Lubricant must be applied to bell socket, gasket and plain-end of pipe as required by manufacturer. Plain-end must be beveled before joint is made. Deflection required at the joint shall be obtained after the joint is made.

C. PVC Pipe. To make a clean and unobstructed joint, it is necessary to wipe the ring, groove and pipe spigot free from all foreign materials at the time of assembly (welded joints will be allowed only in special cases and will be required as shown on the plans). The ring must be positioned properly in the fitting to receive the pipe by a worker who is not in contact with the lubricant. In general, the lubricant is applied to the spigot. However,the manufacturer’s instructions are to be followed in all cases.

Where good bedding conditions are attained, PVC pipe smaller than four inches may be assembled outside the trench in longer sections (as conditions allow) and then lowered into the trench. At any time when improper bedding is discovered or the pipe is severely deflected the pipe will be removed from the trench and the condition corrected. Pipe in sizes four inch and above may be assembled outside the trench but must be lowered into the trench as each joint is assembled. Regardless of installation methods of couplings must be inspected after laying in trench

for proper insertion and alignment. Field cuts and bevels will be allowed in accordance with the manufacturer's instructions for these operations.

A new reference mark shall be installed before joining any field cut pipe. The same requirements for clearance from rock or other objects, thrust blocking and deflections shall apply to PVC pipe as for other pipe materials.

Installation of Polyethylene Plastic Pipe. The handling of the jointed pipeline shall be insuch a manner that the pipe is not damaged by dragging it over sharp and cutting objects.

Sections of the pipes with deep cuts and gouges shall be cut out and the ends of the pipeline rejoined.

The trench bottom shall be free of stumps, stones, boulders, rocks, frozen clods and similar objects.

Where the trench is made through rock, it shall be excavated below grade and backfilled to grade with compacted materials as directed by the Engineer.

Butt fusion of pipes and fittings shall be performed in accordance with the pipe manufacturer's recommendation as to equipment and technique.

3.02 THRUST BLOCKING AND ANCHORAGE

All angles or bends in the pipeline, either vertical or horizontal, shall be braced or anchored against the tendency of movement with concrete thrust blocking. Where joint harness is used, all component parts shall be stainless steel. Cost of installing concrete thrust blocking or joint harness materials shall be considered incidental to installing the line.

Thrust blocks for plastic pipe will not be attached to couplings.

3.03 PIPE BEDDING

A. Standard Pipe Bedding. The standard pipe bedding shall be evenly spread fine granular earth material or bank run sand and gravel or dense graded aggregate as shown on the PLANS.

B. Special Pipe Foundation. When ordered by the Engineer, yielding and mucking material in subgrade shall be removed below ordinary trench depth in order to prepare a proper bed for the pipe. In such locations, a

special pipe foundation shall be constructed utilizing encasement class concrete.

C. Standard Concrete Encasement. Concrete encasement of pipe shall be placed as directed by the Engineer. Concrete shall form a continuous bed under pipe. In tamping concrete, care should be taken not to disturb the grade or line of the pipe or injure the joints.

3.04 WATER LINE AND SEWER LINE SEPARATION

A. Parallel Water and Sewer Lines. Water lines must, if possible, be located a minimum lateral distance of 10 feet from any existing or future sewer lines measured from outside diameters. Where water lines and sewer lines must be placed in the same trench, the water line must be located above the sewer line such that there is a minimum of 18" vertical distance between the outside of the water line and the outside of the sewer line.

B. Crossing Water and Sewer Lines. Wherever sewer lines and water lines cross, it is desirable, if practical, that the sewer line be at least 24 inches below the water line.

Where it is not practical to provide such a separation, care shall be taken to ascertain that the existing water line or existing sewer line is in good sound condition and that no evidence of joint leakage is known in that vicinity. If any such evidence does exist, expose the existing line at least 10 feet on each side of the water line crossing. The Owner will arrange for examining and correcting any defects in the existing lines.

When the water line must be below or less than two feet above the sewer line, encase the water line five feet in each direction from the crossing.

3.05 BACKFILLING

Begin backfilling as soon as practicable after pipe has been installed, spade sand or earth around pipe as laying progresses to avoid danger of misalignment from slides, flooding or other causes. The backfill shall be free from debris, organic material and stones, placed simultaneously on both sides of pipe to the same level by hand.

The backfilling of the lower part of the trench beginning at the top of the bedding, the backfill material shall be carefully and solidly tamped by hand or acceptable mechanical methods in six inch layers around the pipe and up to a point eight inches higher than the top of the pipe. For PVC only the backfill shall be select material and may be walked-in. Walking or working on the completed pipeline, except as necessary in tamping or backfilling, shall not be permitted until the

trench has been backfilled to a point one diameter higher than the top of the pipe. The filling of the trench and the tamping of the backfill shall be carried on simultaneously on both sides of the pipe in such a manner that the completed pipeline will not be disturbed and injurious side pressures do not occur.

After the above specified backfill is hand placed, rock may be used in the backfill in pieces no larger than 18 inches in any dimension and to an extent not greater than one-half (1/2) the backfill materials used. Filling with rock and earth shall proceed simultaneously, in order that all voids between rocks may be filled with earth. Backfill material must be uniformly ridged over trench and excess hauled away, with no rock over 1-1/2 inch in diameter or pockets of crushed rock or gravel in top six inches of backfill. Confine backfill to the width of the trench and to the height sufficient for settlement of backfill. All rock, including crushed rock or gravel from construction, must be removed from yards and fields immediately following backfilling. Streets, roadways and walks shall be swept to remove all earth and loose rock immediately following backfilling.

In the case of street, highway, railroad, sidewalk and driveway crossings or within any roadway paving or about manholes, valve and meter boxes, the backfill must be machine tamped in not over 4-inch layers, measured loose in accordance with the Standard Details. Where backfill is under paved driveways, streets, highways, railroads, sidewalks, paved parking areas and other areas where settlement is not allowed, crushed stone or coarse sand backfill only shall be used up to the paving surface. Crushed stone shall be Kentucky Department of Highways Standards Specification No. 78 or finer. Tunnels shall be backfilled in not over 3-inch layers, measured loose, with selected material suitable for mechanically tamping. If material suitable for tamping cannot be obtained, sand, gravel or crushed rock (No. 78) shall be blown, packed or sluiced to completely fill all void spaces.

Coarse sand backfill shall be spread in layers not over four inches thick and thoroughly compacted. Sand may be moistened to aid compaction.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement, shall be supplied by the Contractor.

3 .06 Pavement Replacement

Where local conditions permit, pavement shall not be placed until 30 days have passed since placing backfill. Crushed stone as specified for roads and parking areas and sidewalks or their bases shall be placed and compacted to the top of trench. Backfill and temporary pavement shall be maintained easily passable to traffic at original ground level, until acceptance of project or replacement of paving or sidewalks.

3.07 Protection of Existing Structures

Protect all sewer, gas, electric, telephone, water and drain pipes or conduits, power and telephone poles and guy wires from danger of damage while pipelines are being constructed and backfilled, or from danger due to settlement of the backfill.

In case of damage to any such existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done.

3.08 Hydrostatic Tests

The Contractor will be required to test all pipelines and appurtenances with water at pressure class of pipe installed. The pipe shall be slowly filled with water, care being taken to expel all air from the pipes. If necessary, the pipe shall be tapped at high points to vent the air. Pressure at least equal to 150 PSI (or the operating pressure if higher) as measured at the point of lowest elevation shall be applied for not less than one hour and all pipes, fittings, valves, hydrants and joints shall be carefully examined for defects or leakage. Any observed leakage shall be corrected.

The pipe pressure must be held at 150 PSI for one hour before beginning the test for leakage. No pipe shall be accepted unless or until the leakage, determined by this test, is less than 10 U.S. gallons over 24 hours, per mile, per inch nominal diameter of pipe. The leakage test shall be applied to the pipe for a period of not less than 4 hours.

The test shall be made between valves as far as practical in sections of pipe and shall, in general, be made within twelve working days of the completion of each section of line.

Furnish a suitable pump, pressure gauge and water meter or other appliance for measuring the amount of water pumped. The instrument used to measure leakage shall be tested for accuracy. Furnish all necessary labor and materials to make the test and to perform any work incidental thereto. Where it is impractical to test between the valves, temporarily place caps and plugs on the lines and test sections of the new line.

Wherever practicable, corporation stops and service lines shall be installed before testing. If these items are installed after the main is tested, then a visual inspection of the tap and service line must be permitted while under pressure before backfilling service line.

Where any section of the main is provided with concrete thrust blocking, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction blocking was installed. If high early strength cement is

used in the reaction blocking, the hydrostatic pressure test shall not be made until at least two days have elapsed.

Should there be leakage over the allowable amount, the Contractor will be required to locate and repair the leaks and retest the section. It is suggested, but not required, that the Contractor have a geophone (underground listening device) on the job at the time of testing.

If the leakage of the section of pipeline being tested is below the allowable amount, but leakage is obvious due to water at the surface of the ground, or by listening the leak can be heard underground with a geophone, or any other means of determining a leak, the Contractor will be required to repair these leaks.

The Contractor shall furnish a meter or suction tank, pipe test plugs and by-pass piping and make all connections for conducting the above tests. The pumping equipment used shall be centrifugal pump, or other pumping equipment which will not place shock pressures on the pipeline. Power plunger or positive displacement pumps will not be permitted for use on closed systems for any purpose.

Inspection of pipe laying shall in no way relieve the Contractor of the responsibility for stopping leakage or correcting poor workmanship.

3.09 Final Clean-up

Before completion of contract, all backfill shall be reshaped, holes filled and surplus material hauled away, and all permanent walks, street, driveway and highway paving, and sod, replaced and reseeding performed.

The Contractor shall be responsible for clean-up, grading, seeding, sodding or otherwise restoring all areas that he disturbs, even if these areas are within the work limits of other contractors on this project.

The work shall not be accepted until the right-of-way of roads and all private property has been cleared of all rubbish and loose stone, and also all equipment, excess material and temporary structures. All property which has been damaged in the course of the work shall be restored in a manner fully acceptable to the property owner.

END OF SECTION

SECTION 02733

MANHOLES

1.01 SCOPE

Furnish all labor, material, equipment and incidentals required to install complete and ready for operation all manholes and appurtenances as shown on the Drawings and as specified herein.

1.02 QUALITY CONTROL

Submit five copies of the following:

A) Documentation of pre-cast components to be incorporated in manholes including bases, rings, tops, gaskets, exterior water-proofing coatings, and frame with lid.

1.03 MATERIALS AND INSTALLATION

Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment and at all intersections. Manholes of the form and dimensions shown on the approved plans shall be built as directed. The manhole proper shall be constructed of precast concrete rings. Manholes shall be constructed on 3500 psi concrete foundations. All manholes shall be waterproofed on the exterior.

1.03.1 Type "A" Manholes: The Type "A" manhole shall be a four foot diameter manhole five feet or more in depth, measured from the base of the cover frame to the lowest flowline elevation and shall be of eccentric cone top construction.

1.03.2 Type "AA" Manholes: The Type "AA" manhole shall be a five foot diameter manhole five feet or more in depth, measured from the base of the cover frame to the lowest flowline elevation and shall be of eccentric cone top construction.

1.03.3 Type "B" Manholes: Type "B" manholes shall be a four foot diameter manhole five feet or less in depth, measured from the base of the cover frame to the lowest flowline elevation and shall be of flat slab top construction.

1.03.4 Type "D" Manholes: A drop pipe shall be provided for a sewer entering a manhole at an elevation of 25 inches or more above the manhole invert and shall be built as a part of the standard manhole. The pipe shall be laid as shown on the Drawings and encased with 3500 psi concrete from the drop stack to the reinforced base of the manhole.

1.03.5 Precast Concrete Rings: Precast concrete rings for manholes shall conform to ASTM C478, Class II, Wall B, with a minimum concrete strength of 4,000 psi, except that rings for manholes over 12 feet deep shall be Class III. O-ring gaskets shall be installed between connected ring sections.

1.03.6 Manhole Inverts: Manhole inverts shall be formed from 3500 psi concrete. Inverts for a "straight-through" manhole shall be formed by laying the pipe straight through the manhole, pouring the concrete invert, and then cutting out the top half of the pipe. Curved inverts shall be constructed of concrete, as shown, and shall form a smooth, even half-pipe section as shown on the Design Drawings. The inverts shall be constructed when the manhole is being built using prefabricated forms.

1.03.7 Manhole Steps: Manhole steps shall be made of steel reinforced polypropylene plastic as the PSI manhole step manufactured by M.A. Inc., Inc. Peachtree City, Georgia, or any steel reinforced plastic step which produces equal or better performance.

1.03.8 Manhole Frames and Covers: Standard manhole castings shall consist of J.R. Hoe & Sons MC 385 frame and lid or approved equal.

Waterproof manhole castings shall consist of cast iron frames with machined bearing surfaces, gasket seal, and bolted lids. They shall be J.R. Hoe & Sons KY 510 or approved equal.

Manhole covers must sit neatly in the rings, with contact edges machined for even bearing and tops flush with ring edge. They shall have sufficient corrugations to prevent a slipperiness. The lids shall have two pick holes about 1-1/4 inches wide and 1/2 inch deep with 3/8 inch undercut all around. Lids on sanitary sewer manholes must not be perforated.

1.03.9 Backfilling: Manhole backfilling shall not commence until the ENGINEER has inspected the structure. The manhole backfilling methodology shall conform to the methodology employed for the gravity lines adjacent the structure. Backfilling shall occur in uniform horizontal lifts around the full circumference of the structure to avoid displacement by unbalanced loadings.

1.04 TESTING OF MANHOLES

The testing of sewer manholes shall be accomplished by the CONTRACTOR as described herein. All manholes shall be subjected to the following tests:

a. Visual Inspection/Test.
b. Leakage (when requested by ENGINEER, Exfiltration).

1.04.1 Test Methodologies - PVC & Ductile Iron Sewers

a. Preparation. Upon completion of backfilling and grading of the manhole, and immediately prior to testing activities, the CONTRACTOR shall clean the manhole of all debris and trash.

b. Visual Inspection/Test. The ENGINEER shall visually inspect the manhole barrel, in the presence of the CONTRACTOR, after CONTRACTOR completes the preparatory cleaning activities. If the Engineer's visual inspection reveals obvious defects such as a poorly formed invert, misaligned frame and lid, cracks, leakage, or if the inspection reveals that the CONTRACTOR has not constructed the manhole plumb, the ENGINEER shall notify the CONTRACTOR and OWNER in writing of the manhole's failing the visual inspection. The CONTRACTOR shall subsequently repair or replace all defective materials and/or workmanship, necessary to meet the visual test requirements, at no additional cost to the OWNER.

c. Leakage. The ENGINEER will direct the CONTRACTOR to conduct leakage tests if the manhole is located in an area of unusually high ground water, if the manhole is located within the limits of a stream course, or if, in the ENGINEER's opinion the manhole has not been constructed well. The CONTRACTOR shall subsequently conduct a leakage test in the presence of the ENGINEER. The leakage test shall be an exfiltration test conducted in accordance with ASTM C 969, Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines. The maximum allowable exfiltration rate shall be 0.1 gallon per foot of diameter, per foot of head, per hour. If the exfiltration rate exceeds this value, the CONTRACTOR shall make the necessary repairs, at no additional cost to the OWNER.

END OF SECTION

SECTION 02910

FINISH GRADING, SODDING AND SEEDING

PART 1: GENERAL

1.01. SCOPE OF WORK

A. Furnish all labor, materials, equipment and services necessary for, and incidental to the work of finish grading and seeding of the site in accordance with the drawings and specifications.

B. Finish grading and seeding is requested at all disturbed areas within the site boundaries, adjacent rights-of-way and slope easements not covered by building or paving (see Drawings), and shall be done after the completion of rough grading, paving, and installation of walks and utilities.

C. Two methods of seeding are identified on the Plans: Method 1 and Method 2. Method 1 requires placement of 6" of approved topsoil, seedbed preparation, seeding and application of a mulch and net cover. Method 2 requires seed bed preparation, hydroseeding and application of a blown or bituminous treated mulch.

D. Submittals

1) Copies of laboratory analysis of site soil for fertilizer and lime requirements shall be provided to the OWNER's Site Representative three weeks prior to seeding operations.

2) Copies of certificate that ground limestone delivered from quarry approved by Kentucky Department of Agriculture.

3) Tags from fertilizer bags.

4) Tags from seed bags showing that only Certified Blue Tag Class seed as classified by the Kentucky Seed Improvement Association was sown.

1.02 PRODUCT DELIVERY, STORAGE, HANDLING

A. Store topsoil, seeding materials and equipment in areas designated by the OWNER's Site Representative.

B. Sod shall be delivered to the job immediately after being cut and shall be installed within 12 hours after being delivered. Maintain proper moisture conditions for sod prior to installation to ensure its vitality and to prevent the dropping off of the soil in handling.

1.03 JOB CONDITIONS

A. Seedings shall not be placed on frozen soil or when the outside temperature is below 32 degrees F.

B. Topsoil shall not be spread or tillage done when conditions are such, by reason of drought or excessive moisture, that satisfactory results are not likely to be obtained.

1.04 GUARANTEE

A. Provide a one year guarantee but not less than one (1) full growing season that all seeded and sodded areas will have a 95 percent vegetative cover of lawn grasses free of noxious weeds.

B. OWNER and CONTRACTOR shall conduct three inspections to verify that Guarantee requirements are fulfilled. The inspections shall occur:

1) On completion of project and prior to final inspection,

2) Three months after acceptance of project by OWNER, and

3) Ten months after acceptance of project by OWNER.

PART 2: PRODUCTS

2.01 MATERIALS

A. Topsoil

There are no natural topsoils on site. The CONTRACTOR shall borrow a natural topsoil for seeding operations.

Topsoil shall be natural surface soil from well-drained areas and shall be fertile, friable and free of weeds.

Topsoil shall not be excessively acid or alkaline, nor contain toxic substances. It shall be without admixtures or sub-soil and shall be reasonably free of clay, stones, stumps, roots or other similar substances 1" or more in diameter, or any other object which may be a hindrance to the finish grading operation.

Topsoil shall be loam or sandy loam containing less than 24-20 percent silt, (0.002 to .05 mills) and less than 40 percent clay (.002 mills or less).

B. Super Phosphate: Composed of finely ground phosphate rock as commonly used for agricultural purposes and containing not less than 18% available phosphoric acid.

C. Lime: Ground limestone containing not less than 85% of total carbonates and shall be ground to such a fineness than 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve. Coarser materials will be acceptable, provided the specified rates of application are increased proportionately on the basis of quantities passing the 100 mesh sieve.

Ground limestone must be purchased from a quarry approved by the Kentucky Department of Agriculture.

D. Fertilizer:

Commercial fertilizer shall be a high density starter fertilizer with an analysis of 19-26-5. 19% total nitrogen (N), 26% phosphoric acid from ammoniated phosphate, 5% soluble potash from potassium sulfate. The OWNER's Site Representative may alter the fertilizer analysis if the results of soil tests indicate the site soils require a different mix.

The fertilizer shall be delivered to the site in the original unopened container which shall bear the manufacturer's guarantee of analysis.

E. Sod (Only Where Shown)

1) Sod shall be soil-grown grass recently mowed to 2-1/2" length. Sod to be free of clover, crabgrass, and noxious weeds.

2) Sod should be a certified blend of adelphi, baron, sydsport varieties of improved Kentucky bluegrass or same varieties of Kentucky bluegrass specified for seed. Sod should have good color, be free of weeds, insects and diseases.

a) Stakes: (For Slopes 3-1 or Greater)

1) Softwood, 3/4" diameter x 8" long or,
2) Steel, tee shaped pins, 4" head x 8" leg

2.02 GRASS SEED

A. Seed shall be composed of the required varieties which shall be mixed in the proportions and shall test the minimum percentages of purity and germination specified. See plan for seeding notes.

B. All seed shall be certified Blue Tag Class as classified by the Kentucky Seed Improvement Association.

C. Seed shall be fresh, clean, new crop seed. Seed may be mixed by the dealer. If the seed is mixed by the dealer, furnish to the OWNER's Site Representative the dealer's guaranteed statement of the composition of the mixtures and the percentages delivered before use.

D. Seed Mixture: The lawn seed shall be clean, fresh seed as follows:

NAME	LB. PER 1000 SQ. FT.	% OF PURITY	% OF GERMINATION
Kentucky Bluegrass (Combination of 2 varieties such as Windsor and Kenblue)	1	90	80
Tall Fescue (Kenwall Kenhy or Florie)	3	95	80
Annual Ryegrass	2	90	90

2.03 PROTECTION/EROSION CONTROL

A.. Method 1 - Areas designed for Method 1 Seeding shall be protected with clear straw mulch (2 tons/ac.) securely held in place by mulch netting.

B. Method 2 - Areas designated for Method 2 seeding shall be protected with a pneumatically applied bituminous treated mulch at a rate of 2 tons/acre.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify that rough grading has been completed and that there are no errors or defects which would result in poor application or cause latent defects in the finished grading or seeding.

3.02 PREPARATION OF FINISH GRADING

A. The rough grade, where compacted, shall be loosened to depth of two inches (2") and then regraded to maintain proper elevation. All stones over 2" in size, sticks, rubbish and any other extraneous matter shall be removed from rough grade before beginning finish grading.

3.03 FINISH GRADING AND *SOD* OR SEED BED PREPARATION

A. Spread topsoil over areas to receive finish grading as required to obtain a minimum 6" thick layer compacted measure and/or to bring these areas to finish grade. Care shall be taken in this operation not to compact the sub grade.

B. Tillage: Areas to be seeded shall be thoroughly tilled to a depth of 6" by plowing, discing, harrowing, etc.

C. Application of Lime as Required: Immediately following or simultaneously with the fertilizer, lime shall be distributed uniformly at a rate indicated in tests specified in Part 1 and shall be incorporated into the soil to a depth of at least four inches by discing, harrowing or other accepted methods. The incorporation of lime and fertilizer may form a part of the tillage operation specified above. Do not apply lime under trees.

D. Superphosphate: Apply at the rate of 20 pounds per 1000 square feet or at rate recommended by the soil test and work into top 4" of topsoil.

E. Commercial Fertilizer: Apply at rate of one bag (39-5/8 Pounds) per 1/4 acre. The fertilizer shall be applied to the area and thoroughly and evenly incorporated with the soil to the soil bed depth of two inches by discing or other approved method.

F. Leveling: Any undulations or irregularities in the surface resulting from tillage, fertilizing, liming or other operations shall be leveled out by use of a float before seeding operations are begun.

G. Rolling: Roll entire area with 200 pound roller after leveling.

H. Clean-Up: Prior to seeding, the surface shall be cleared of all stones, or other objects larger than one inch in thickness or diameter and of all roots, brush, wire and other objects that might be a hindrance to maintenance operations.

3.04 SEEDING

A. Seeding Seasons: Seed shall be sown only within the fall seeding season or the spring seeding season. The fall season shall be from the beginning of the first noticeable night dews until October first. The spring seeding season shall be from the time ground is in suitable working condition until June 15, unless otherwise directed by the OWNER's Site Representative.

The actual seeding shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions, and by accepted practice in this locality.

B. After the areas to be seeded have been brought to the approximate finished surface grade by the use of existing or hauled in topsoil, they shall be fine graded. All small areas or those adjacent to the trees, planted areas, buildings, walks or other structures shall be fine graded by hand tools, but larger areas may be fine graded by mechanical devices if done in a manner acceptable to the OWNER's Site Representative. No fine grading shall be done when the soil is frozen or muddy. Do not overwork the soil. A finely pulverized seed bed can soon develop a dusty mulch resulting in crusting after rain. It is more subject to wash and seed float. Soil clods ranging in size from grapes to walnuts would be ideal. After rain, the seed bed shall be prepared for sowing and repeated after each rain until lawn in completed.

C. Seed may be applied by drilling, broadcasting, or hydro-seeding.

D. Reseeding: All seeded areas which do not show satisfactory grass shall be reseeded as herein specified at intervals of 21 days, until a satisfactory turf is established.

3.05 SODDING

A. Prepare a sod bed that is tilled 6-8 inches deep, well firmed after tilling and well leveled.

B. Fortify the area to be sodded with fertilizer and lime. Soil test to establish proper rates. Uniform applications shall be worked into the top 3/4” of soil.

C. After all materials have been worked in, firm up the soil by rolling to assure that no soft spots remain that would settle later on.

D. Avoid laying sod on dry, powdery soil. Irrigate prior to laying sod. Soil shall be moist to a depth of six inches, but not saturated allowing the new roots to establish rapidly.

E. The ends of sod pieces shall be staggered to prevent lines across the turf.

F. Insure that edges of the sod are in good contact with each other, but not overlapping. Avoid stretching the sod or gaps will develop between the pieces when the sod dries.

G. On sloped area, peg sod strips with wood pegs to prevent slippage.

H. After laying sod, roll to insure good contact with the soil.

I. Soak sod once a day for the first week, then water twice each week until the sod is well-rooted. Maintenance shall continue for a minimum of six weeks.

J. Water from top of sodded slopes. Apply water at a low rate.

3.06 PROTECTION

A. The seeded area shall be protected by straw mulch and netting (Method 1) or by pneumatically applied bituminous mulch (Method 2).

3.07 MAINTENANCE

A. Maintenance shall begin immediately after each portion of lawn in planted, and shall continue for thirty days after the completion of the entire seeding project and as much longer as necessary to establish over the entire lawn areas a close stand of permanent grasses free of bare spots.

B. Lawns shall be maintained by watering, weeding, replanting, mowing, trimming and other necessary operations.

C. Lawns shall be protected against damage including erosion and washouts, damaged areas shall be promptly reseeded. Settled trenches or other areas and shall be filled and reseeded.

D. Final Seeding: After maintenance period is completed and lawn accepted, the CONTRACTOR shall apply a 10-6-4 organic fertilizer at the rate of 15 pounds per 1,000 square feet. The CONTRACTOR shall take necessary precautions against "burning" the grass.

3.08 CLEANING UP SITE OF THE WORK

A. Upon completion of the work, the CONTRACTOR shall remove from the site of all excess sub-soil, cordage, wrappings and other extraneous material. He shall remove all his tools, equipment and other material, except those necessary for maintenance. Litter developing by reason of the CONTRACTOR's maintenance shall be removed as it gathers.

3.09 INSPECTION

A. Inspection will be made as noted in 1.5 (Guarantees).

END OF SECTION

SECTION 03150

WATERSTOPS

PART 1: GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes application of hydrophilic rubber and injectable polyurethane foam waterstop to prevent leakage at construction joints and penetrations of concrete retaining and containment structures.

B. Work includes Cleaning of concrete surface, installation of permeable grout tubes, injection of grout tubes with sealing material, and installation of strip waterstops.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 03300 “Cast-In-Place Concrete” for forms and concrete placement.

1.3 SUBMITTALS

A. General: Submit according to Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each material and type of application required include product specifications and manufacturer’s written installation instructions and recommendations.

C. Warranty: Specimen of standard waterproofing warranty.

1. Upon completion of installation and injection of the injectable waterstop, manufacturer shall provide a five (5) year written guarantee that all work shall be watertight.

D. Injectable waterstop installation report: For each containment structure, report from manufacturer’s approved representative shall be submitted documenting installation of waterstop and approval to installation techniques and completed installation.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has specialized in installing injectable waterstop systems similar to those required for this Project and who is licensed by or otherwise acceptable to manufacturer of primary materials.

1. Components and installation procedures shall be in accordance with manufacturer’s printed specifications and recommendations.
2. Initial installation of Grout tubes shall be done under the supervision of an approved manufacturer’s representative.
3. Injection of sealing material shall be done by manufacturer’s Licensed Applicator.

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing an injectable waterstop system similar to that indicated for this Project and with a record of successful in-service performance.

C. Single-Source Responsibility: Obtain injectable waterstop system through one source from a single manufacturer. Obtain accessory products used in conjunction with injectable waterstops from sources acceptable to injectable waterstop manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers labeled with manufacturer's name and product identification.

B. Store materials in a dry, well-ventilated space.

C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

D. A sufficient quantity of injectable waterstop grout tubes and sealing material shall be stored on site or be readily available prior to stating the work to insure that the work will be continuous from start to completion without delay due to material shortage or unavailability.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Do not apply waterstop materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.

B. Comply with manufacturer's written instructions regarding weather conditions before and during waterstop installation, condition of the substrate to receive waterstop, and protection of the installed waterstop system.

PART 2: PRODUCTS

2.1 MANUFACTURERS

A. Hydrophilic Rubber Waterstop Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. 3/8" x ¾" Swellseal 2010, De Neef Construction Chemicals, Inc., Waller, TX (409) 372-9185 or approved equal.

B. Injectable Waterstop Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

1. Injecto System, De Neef Construction Chemicals (US) Inc., Waller, TX (409) 372-9185 or approved equal.

2.2 MATERIALS, GENERAL

A. Injectable Waterstop tubing shall be constructed to resist the pressures of freshly placed concrete, shall have a filter layer to prevent the entry of cement particles into the tube, yet allow the easy passage of the sealing material during injection over the total length of the

tube, shall have protection for the filter layer to resist the abrasive effects of the concrete aggregates, and shall be less than 3/4 inch overall diameter.

B. Injectable Waterstop sealant shall be a hydrophobic polymer of the isocyanate type which is installed by injection. The uncured polyurethane grout shall have a viscosity of 650 + 200 cps (at 68° F) and be 100% solids. When the sealant is mixed with approximately 10% water, the sealing material will expand and cure to a closed cell foam with a tensile strength of at least 150 psi (ASTM D412) and 250% elongation (ASTM 3574). The sealant shall have the ability to react in moving water and the viscosity shall remain the same until gelation occurs. The sealant shall also be resistant to the chemicals and microorganisms commonly found in wastewater and shall be essentially non-toxic.

PART 3: EXECUTION

3.1 LOCATION

A. Waterstop is required at all vertical and horizontal construction joints, penetrations, block-outs, and tie-ins in walls and slabs below the maximum fluid level or exterior grade, whichever is higher, in water and waste containment structures.

B. See structural drawings for type of waterstop (hydrophilic rubber or injectable) and location in concrete to be used for each structure.

3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of hydrophilic rubber or injectable waterstop.

3.3 PREPARATION

A. Surfaces shall be reasonably smooth and shall have either a formed or float finish. Where such a concrete surface is scheduled to be rough to facilitate interlocking with the adjacent concrete placement, a 2” (5.1 cm) wide ribbon of flat surface shall be tooled into the concrete surface. This will facilitate the proper installation of waterstop. Any irregularities in the concrete surface which would interfere with the waterstop being placed in intimate contact with the concrete surface shall be ground smooth prior to installation.

B. Clean concrete surface of dirt, laitance, corrosion or other contamination prior to installation of the grout tubes or hydrophilic rubber strip to insure direct contact with the concrete surface.

3.4 INSTALLATION OF HYDROPHILIC RUBBER WATERSTOP

A. Protect construction joints and penetrations with hydrophilic rubber preformed flexible waterstop strips. Either place concrete directly over flexible strips or press strips into preformed cavities. Comply with manufacturer’s written instructions for using preformed flexible waterstop strips.

3.5 INSTALLATION OF GROUT TUBES

A. Fasten grout tubes to clean concrete surface every 12 inches.

B. Install bent plastic ends to protrude through or under concrete forms.

C. Overlap ends of adjacent grout tubes so that ends cross and there will be no default in the injected zone.

D. Install tubing in maximum “one run lengths” of 25 feet between injection ends.

3.6 INJECTION OF SEALING MATERIAL

A. After the concrete has cured a minimum of 28 days, the grout tubes shall be injected with the sealing material to fill the construction joint and any honeycombs.

B. Prior to injection of the sealing material, water shall be injected into one end in order to provide water for the reaction process and to verify continuity between ends.

1. Water shall be injected into one end until it begins to flow from the other end of grout tube. If excessive amount of water needs to be injected or a blockage is encountered the location needs to be marked for consideration in the grouting procedure.

C. Start injection process at one end of grout tube run. As soon as sealant appears at far end of tube, close far end and increase pump pressure to manufacturer’s recommendation. Stop injection material when sealing material percolates out of joint or a substantial backpressure is built.

D. Patch injection ends with cementitious mortar.

END OF SECTION

SECTION 03200

CONCRETE AND MASONRY STEEL REINFORCEMENT

PART 1: GENERAL

1.01 SCOPE OF WORK

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

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Joint Accessories are included in Section 03250.

B. Cast-in-place Concrete is included in Section 03300.

C. Masonry units are included in Section 04200.

1.03 SUBMITTALS

A. SUBMITTALS shall be in accordance with Section 01300.

B. The following shall be submitted for review prior to the fabrication of reinforcement.

1. Placing drawings for steel reinforcement.

2. Bar bending details.

C. The fabricator shall certify the following on reinforcing shop drawings:

1. That the reinforcing steel supplied conforms to ASME A6l5 including Supplementary Requirement S1.

1.04 REFERENCE STANDARDS

A. Steel reinforcement in concrete shall conform to ACI 318 unless otherwise Specified.

1.05 PRODUCT DELIVERY AND HANDLING

A. Reinforcing shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.

B. Reinforcement shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same designations as shown on the submitted placing drawings.

C. Reinforcing steel shall be stored off the ground and shall be protected from moisture and kept free from dirt, oil, or other injurious contaminants.

PART 2: PRODUCTS

2.01 MATERIALS

A. Materials shall be new, shall be of domestic manufacture and shall conform to the following material specifications.

1. Deformed concrete reinforcing bars: ASTM A 615, Grade 60 including Supplementary Requirement SI for deformed bars.

2. Welded steel wire fabric: ASTM A615.

3. Stainless steel protected bar supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.

4. Precast concrete block bar Supports: CRSI Bar Support Specifications, Precast Blocks with Wires.

5. Tie wires for reinforcement: 16-gauge or heavier, black annealed wire.

2.02 FABRICATION OF REINFORCEMENT

A. Fabrication tolerances shall be in accordance with the CRSI, Manual of Standard Practice-Fabrication.

B. Bars shall be cold bent.

C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by the CRSI, Manual of Standard Practice Detailing. Hooks shall conform to the same Manual.

D. Bars that are to be butt spliced, placed through limited diameter holes in metal or have a threaded end shall have the applicable end(s) saw-cut.

PART 3: EXECUTION

3.01 INSTALLATION

A. Surface condition, bending, spacing, and tolerances of placement of reinforcement shall conform to the CRSI, Manual of Standard Practice-Field Erection.

B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:

1. Concrete cast against and permanently exposed to earth; 3-in.

2. Concrete surfaces in contact with soil, water, sewage, sludge or exposed to the weather; 2-in.

3. Concrete surfaces not in contact with soil, water, sewage, sludge or exposed to the weather:

    a. Beams, girders, columns: principal reinforcement, ties, stirrups or spirals - 1-1/2-inch
    b. Walls and bottom steel of slabs - 1-inch
    c. Shells and top steel of slabs - 3/4-inch

C. Reinforcement which is to be exposed for a considerable length of time after being placed shall be painted with a heavy coat of neat cement slurry.

D. No reinforcing bars shall be welded either during fabrication or erection unless specifically called for on the Drawings, specified herein, or with prior written approval of the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall conform to the AWS Structural Welding Code-Reinforcing Steel, D1.4.

3.02 REINFORCEMENT AROUND OPENINGS

A. Place an equivalent area of steel to that interrupted by an opening, pipe penetration, electrical conduit group or duct penetration around the opening or penetration. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

A. Except as otherwise indicated on the Drawings, compression embedment and lap splices shall be 30 diameters, but not less than 12 inches. The lap splice length for column vertical bars shall be based on the bar size in the column above.

B. Except as otherwise indicated on the Drawings, tension lap splices shall be in accordance with the applicable tables in the ACI 315 Detailing Manual. Class B splices shall be used.

C Mechanical connectors shall not be used for reinforcing bar splices unless prior written approval is obtained from the Engineer.

D. Splices in welded wire fabric shall be lapped not less than 1-1/2 courses or 12-in. The spliced fabrics shall be tied together with wire ties at least 24-in on Center.

3.04 ACCESSORIES

A. The Contractor is solely responsible for determining, providing and installing accessories such as chairs, chair bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the steel and the placement of concrete and to provide spacings of bars with adequate cover as shown on the Drawings or specified herein.

B. Precast concrete blocks with wires shall be used where the reinforcing steel is to be supported over soil.

C. Stainless Steel protected bar supports shall be used to firmly hold vertical reinforcement in position.

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

3.05 INSPECTION

A. In no case shall any reinforcing steel be covered with concrete until the amount and position of the reinforcement has been observed by the Engineer and his permission given to proceed with the concreting. The Engineer shall be given ample prior notice of the availability of set reinforcement for his review.

END OF SECTION

SECTION 03250

CONCRETE JOINT ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to make all joints tight in the concrete as detailed on the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-place concrete is included in Section 03300. Sealants and caulking are included in Section 07920.

1.03 SUBMITTALS

Manufacturer's product data for all materials required to establish compliance with these specifications shall be submitted in accordance with Section 01300.

PART 2: PRODUCTS

2.01 MATERIALS

A. Remolded joint filler for sealed, interior expansion joints shall be polyethylene, closed cell expansion joint filler. Thickness shall be 3/4-inch unless otherwise shown on the Drawings. The filler shall be resistant to oils, chemicals, ozone and weathering and shall be ultraviolet stable. Approved product is Sonoflex F by Sonneborn Building Products. Other products shall not be used without prior review and acceptance by the Engineer.

B. Remolded joint filler (PJF) for unsealed, exterior expansion joints shall be asphalt impregnated fiber board conforming to the latest revision of ASTM D 1751. Thickness of PJF shall be 3/4-inch unless otherwise shown on the Drawings. Manufacturers meeting the Specification requirements are: Sealtight Products by W. P. Meadows, Inc., P.O. Box 543, Elgin, IL 60120, (312) 683-4500 and Tex-Mastic Products by J&P Petroleum Products, Inc., P.O. Box 4206, Dallas, TX 75208, (214) 331-5401. Other products shall not be used without prior review and acceptance by the Engineer.

C. Backer-rod shall be high-grade extruded closed-cell polyethylene foam that is completely compatible with polysulfide and urethane type sealants. Backer-rod shall also be ultraviolet stable, resistant to oils, chemicals, ozone and weathering. The size of the rod shall be 1 inch diameter for 3/4 inch wide joints. To the extent possible only full length rods shall be used; Splices shall be minimized. Acceptable manufacturers are: Sonofoarn by Sonneborn Building Products, 7711 Computer Avenue, Minneapolis, MN 55435, (612) 835-3434 and Tex-Nastic Products by J&P Petroleum Products, Inc., P.O. Box 4206, Dallas, TX 75208, (214) 331-5401. Other products shall not be used without prior review and acceptance by the Engineer.

PART 3: EXECUTION

3.01 INSTALLATION

A. Remolded joint fillers shall be installed at all locations shown on the Drawings. Exterior asphalt impregnated fiberboard expansion joints do not require a joint sealer, but shall stop 3/4-inch from the concrete surface. Interior expansion joints shall be sealed as shown on the Drawings with sealants specified in Section 07920.

B. Concrete sidewalks and drives shall be provided with expansion joints at all intersections with other walks, at heads and bottoms of stoops or steps, at curbs, and at maximum 25-foot spacing along the run of the walk. Provide tooled or sawcut control joints between expansion joints to subdivide concrete into panels having a length to width ratio not greater than 2 to 1 and with an area not greater than 400 square feet.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to place all cast-in-place concrete, reinforcing steel, forms, and miscellaneous related items, including sleeves, reglets, anchor bolts, inserts and embedded items, as shown on the Drawings and as specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete Reinforcement is included in Section 03200.

B. Concrete joint accessories are included in Section 03250.

C. Concrete finishes are included in Section 03345.

D. Metal fabrications to be cast in concrete are included in Division 5.

E. Moisture Protection is included in Division 7.

F. Mechanical items including equipment anchor bolts to be cast in concrete are included in Division 15.

G. Electrical items cast into concrete are included in Division 16.

1.03 DESCRIPTION

A. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be ready-mixed concrete produced by a plant acceptable to the Engineer. All constituents, including admixtures, shall be batched at the central batch plant.

B. Reinforced concrete shall comply with ACI Specifications 318.

C. All concrete testing services required shall be provided by the Contractor using a testing laboratory acceptable to the Engineer and the Owner. Inspection or observations shall be provided by the Owner or the Owners' designated representative.

D. Samples of constituents and of concrete as-placed will be subjected to laboratory tests. All materials incorporated in the Work shall conform to accepted samples.

E. Under special circumstances, the Engineer may allow minor deviations from the material requirements specified, provided that the resulting concrete quality is not adversely affected or that a suitable adjustment in cement content is made to compensate for such deviations without cost to the Owner.

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval a proposed design mix for each concrete strength and type required by these Specifications. Information to be submitted for each type shall include the following items:

1. Source of concrete mix design components including course aggregate, fine aggregate, cement, water, admixtures, and pozzolans where included.

2. Concrete mix design

   a. Constituent quantities per cubic yard.
   b. Water content: gallons/100 pounds cementitious materials.
   c. Cement: type, manufacturer, and chemical analysis.
   d. Mix design slump.
   e. Average laboratory cylinder strength test results at 28 days for concrete mix design (include standard deviation). Provide results of seven and 14 day tests if available.

3. Laboratory sieve analysis and mechanical properties for course and fine aggregate.

4. Admixture types and chemical compositions. (Include certification of compliance with ASTM reference standards and confirmation of any supplementary requirements included in these Specifications).

5. Where pozzolans are used in combination with Type 1 cement, provide laboratory test results to certify compliance with ASTM reference Standards and supplementary requirements included in these Specifications.

B. An additional mix design for each type and strength of concrete to be placed by pumping shall be submitted to the Engineer for approval.

C. Failure to include any item of information noted in Article 1.04 A for a given concrete strength or type shall be cause for requirement of a resubmittal by the Engineer.

1.05 QUALITY ASSURANCE

A. The actual acceptance of aggregates and development of mix proportions to produce concrete complying with the specific requirements of this Section shall be determined by means of prior laboratory tests made with the constituents to be used on the Work.

B. Well in advance of placing concrete, the Contractor shall furnish samples of aggregate and cement jar testing, deliver them to the laboratory designated by the Engineer, and permit ample time for the laboratory to develop a proposed design mix or to modify the design of the mix within the limits of these Specifications.

C. The following limiting strengths, water contents and cement factors shall apply.

Table 03300-1

Minimum Compressive Strength,f'c (psi at 28 days)	Maximum Water Content* (gals./l00 lbs.)	Net Minimum Cement Factor*** (100 lbs./c.y.)
2500	7.4	4.3
4000	5.9	5.6

* Maximum: decrease if possible. This represents total water in mix at time of mixing, including free water on aggregates and water in admixture solutions.

** Minimum: increase as necessary to meet other requirements. These cement factors apply to controlled concrete subject to specific inspection.

1. Minimum compressive strength shall be as shown in Table 03300-1. The Contractor shall increase cement content or the combined cement plus fly ash content when fly ash is used, as required to meet strength requirements. The amount of fly ash used shall not exceed 25 percent nor be less than 15 percent of the total weight of fly ash plus cement.

2. When high early-strength Portland cement is permitted, the same strength requirements shall apply except that the indicated strengths shall be attained at seven days instead of 28 days.

D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.

E. If, during the progress of the work, the Contractor desires to use materials other than those originally accepted or if the materials from the sources originally accepted change in characteristics, the Contractor shall, at his expense, make new acceptance tests of aggregates and establish new design mixes. Such testing and design shall be accomplished with the assistance of a testing laboratory acceptable to the Engineer.

F. Consistency of the concrete as measured by the ASTM C 143, shall be as shown in Table 03300-2.

Table 03300-2

	Slump (inches) Portion of Structure	Recommended Range
Pavement and slabs on ground	2	1-3
Plain footings, gravity walls, slabs and beams	2-3	1-4
Heavy reinforced foundation walls and footings	3-4	2-5
Thin reinforced walls and columns	4	3-5

1. Concrete shall be of a consistency which can be readily worked into the corners and angles of the forms and around the reinforcement, inserts, and wall castings without permitting materials to segregate or free water to collect on the surface. Consideration shall be given to the proposed methods of placing and compacting in establishing the consistency of the concrete.

G. The entrained air, as measured by ASTM C 231, shall be as indicated in Table 03300-3.

Table 03300-3

Concrete Placement	Total Air Measured at Discharge from Truck (%)
Finished slabs	3.0 maximum
All other	3.5 - 5.0

1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C 231 to accurately determine air content, make special note of this requirement in the admixture submittal required under Article 1.04.

1.06 ACCEPTANCE TESTS

A. The actual proportioning of cement, aggregates, and water necessary to produce concrete complying with the requirements of Table 03300-1, shall be determined by tests made with representative samples of the materials to be used for the Work. Tests shall be made by a testing laboratory approved by the Engineer. Testing shall comply with ASTM C 39.

B. Cement shall be tested to Certify Compliance with the requirements of this Specification. Methods of testing shall comply with the appropriate Specifications, but the place, time, frequency, and method of sampling will be determined by the engineer in accordance with the particular need.

C. Samples of fine and coarse aggregates shall be furnished for examination and testing at least three weeks before the Contractor proposes to use them in the work.

D. Water content of the concrete shall be based on a curve showing the relation between water content and seven and 28-day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age, and shall have a range of values sufficient to yield the desired data, including all the compressive strengths called for on the Drawings, without extrapolation. The water content of the concrete to be used, as determined from the curve, shall correspond to the following test strengths of the laboratory trial mixtures:

Table 03300-4

Design Strength**	Min. 7 Days*	Lab. Strength 28 Days
2500 psi	2000 psi	2900 psi
4000 psi	3500 psi	4600 psi

* May be employed for preliminary designs
** To be used for final designs

E. In no case, however, shall the resulting mix conflict with the limiting values for maximum water content and net minimum cement factor as specified in Table 03300-1.

F. Testing under Section 1.06 to establish conformity of the various concrete mix components and the mix design with the provisions of this Specification shall be at the Contractor's expense.

PRODUCTS

2.01 MATERIALS

A. Materials shall comply with these Specifications and any State or local specification requirements.

B. Cement for all cast-in-place concrete shall be domestic Portland cement (ASTM C 150, Type II), high early strength portland cement (ASTM C 150, Type II) or ASTM C 150 Type I mixed with fly ash free from injurious water soluble salts or alkalies. Air entraining cements shall not he used. Cement brands shall be subject to approval by the Engineer.

1. Fly ash may be combined at the batch plant or during the production of cement. The type I cement and the fly ash shall comply with these Specifications individually and as a combination.

2. High early strength cement shall be used only after obtaining written approval from the Engineer.

C. Aggregates

1. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM C 33 and the following detailed requirements:

   a. Gradation:

Sieve (ASTM Specification E11)	Retained
3/8 in.	0%
No. 4	0-5%
No. 8	0-20%
No. 16	15-50%
No. 30	40-75%
No. 50	70-90%
No. 100	90-98%
Fineness Nodule	2.60-3.00
Organic	See Plate 2, ASTM C 33
Silt	2.0% maximum
Mortar Strength	95% minimum as per ASTM C 87 Section 10
Soundness	8% maximum loss, using magnesium sulfate, subjected to 5 cycles

2. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C 33, Class 5M, and the following detailed requirements.

Organic	See Table 1, per ASTM C 33
Silt	1.0% maximum
Soundness	8% maximum loss, using magnesium sulfate, Subjected to 5 cycles

3. Maximum coarse aggregate size shall be:

   2-inch for mass concrete
   1-inch for reinforced Section 10-in and over in thickness
   3/4-inch for reinforced sections less than 10~in thickness

The "Designated Size" and the corresponding gradations shown represent the end or combined gradation of the coarse aggregate to be used in the final concrete.

D. Water

1. Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

2. Mortar specimens made with the water under examination and normal Portland cement shall have at least 100 percent of the strength of similar specimens made with distilled water when tested for 26-day Strength in accordance with ASTM C 87.

3. Potable tap water will normally fulfill the requirements noted. Water from all other sources shall be tested and approved before use and shall not contain impurities in excess of the following limits:

   a. Acidity or alkalinity calculated in terms of calcium carbonate: 0.05%
   b. Total organic solids: 0.05%
   c. Total inorganic solids: 0.08%
   d. Total chlorides as sodium chloride: 0.05%

E. Admixtures

1. A water reducing agent such as pozzolan, WRDA or approved equal shall be used in all concrete. The admixture shall comply with ASTM Specification C 494, Type A or Type D, shall contain no chlorides, shall be nontoxic after 30 days, and shall be compatible with the air entraining admixtures. Proportioning and mixing shall be as recommended by the manufacturer.

2. Admixtures causing accelerated setting of cement in concrete shall not be used.

3. Air entraining admixtures compatible with the concrete mix shall be used in moderation along with the water reducing agent to obtain the specified percent air in the resultant concrete.

F. Pozzolan (Fly ash)

1. The pozzolan to be used in combination with Type I cement shall be Class C or Class F fly ash conforming to ASTM C 618, including the requirements of Table IA, and the following supplementary requirements:

a. Carbon Content by weight, Maximum 3%
b. Loss on Ignition, Maximum 3%
c. Water Requirement, Maximum, Percent of Control 100%
d. Fineness, Maximum Retained on a No. 325 Sieve 25%

2. The Engineer may require testing of the fly ash and/or the fly ash and Concrete mixture to provide test data confirming that the fly ash in combination with the Cement to be used meets all strength requirements, is compatible with air-entraining agents and other additives, and provides sulfate resistance equivalent to or better than that of Type II cement. The cost of such testing shall be at the expense of the Contractor.

a. Pozzolan shall be tested in compliance with ASTM C311 with the following restriction: A minimum of one sample weighing four pounds shall be taken from each 200 tons of pozzolan supplied for the project. The sample shall be tested and the pozzolan certified to meet the requirements previously noted. Such certification shall be presented to the Engineer prior to use of the pozzolan in the Work.

G. Non-Shrink Cement Grout: Non-shrink Cement Grout shall consist of cement, aggregate and additives formulated to meet the following volume change requirements. Early volume change (within 24 hours) as tested by ASTM C827 shall be limited to zero (0) percent shrinkage and four (4) percent maximum expansion. Long term volume change of hardened non shrink cement grout (after 1 day of cure) shall conform to the Corps of Engineers Specification for Non-Shrink Grout, CRD-C621-82B. Shrinkage shall be 0% and expansion limited to a maximum of 0.4% volume change. Cement additives required to meet this specification shall be recommended by the grout manufacturer but shall be non staining and non-metallic. Grout shall be equal to Five Star products by the U.S. Grout Corporation.

Grout shall be mixed as recommended by the manufacturer to give the necessary consistency for placing and to give a minimum compressive strength of 3000 lbs. per sq. inch in three (3) days.

PART 3: EXECUTION

3.01 MEASURING MATERIALS

A. Measure materials by weighing except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Scales shall have been certified by the local Sealer of Weights and measures within

one year of use, The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount.

B. Cement, fly ash when used, and each type of aggregate shall be weighed separately. Cement in standard packages (sacks) need not be weighed, but bulk cement and fractional packages shall be weighed.

C. Water shall be measured by volume or by weight. The water-measuring devices shall be capable of control to one-half percent accuracy. All measuring devices shall be subject to approval by the Engineer.

D. Admixtures shall be dispensed either manually with use of calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.

3.02 MIXING

A. Concrete shall be ready-mix concrete by equipment acceptable to the Engineer. No hand-mixing will be permitted. Adding water in controlled amounts during the mixing cycle shall be done only with the expressed approval of the Engineer and under his direction. The amount of water added shall be shown on each delivery invoice.

B. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities for the respective conditions as stated on the name plate. Discharge at the site shall be within 1 ½ hours after water was first introduced to the mix.

C. All central plant and rolling stock equipment and methods shall comply with the latest Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready-Mixed Concrete Association, as well as ASTM Standard 318 Section 5.2, and ASTM C 94.

D. Retempering of concrete or mortar which has partially hardened (that is, mixing with or without additional cement, aggregate, or water) will not be permitted.

E. Attention is called to the importance of dispatching trucks from the batching plant so they arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

3.03 FIELD TESTS

A. Sets of three field control cylinder specimens will be taken at random by the Engineer during the progress of the Work, in compliance with ASTM C 31; the total number of specimens taken on the project shall average one set per 150 cubic yards, and in general not less than one set of specimens shall be taken on any one day. When average 2-day compressive strength of control cylinders in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between seven and 28 day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.

B. The Contractor shall cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through his operations, and furnishing material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Contractor. Curing boxes shall be acceptable to the Engineer.

C. Slump tests shall be made in the field by a qualified representative of the testing laboratory.

D. Air entrainment shall be measured by the Owner's representative at the time the concrete is deposited in compliance with ASTM C 231.

3.04 INSPECTION AND CONTROL

A. The preparation of forms, placing of reinforcing steel, conduits, pipes, and sleeves, batching, mixing, transporting, placing and curing of concrete shall be at all times under the inspection of the Engineer.

B. The Contractor shall advise the Engineer of his readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment and tightness of form work. No placement shall be made without the inspection and acceptance of the Engineer.

3.05 CONCRETE APPEARANCE

A. Concrete for the Work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance.

B. Form work, mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing.

C. When concrete surfaces are stripped, the concrete when viewed in good lighting from 10 feet away shall be pleasing in appearance, and at 20 feet shall show no visible defects.

3.06 FORMS

A. Forms shall be used for all cast-in-place concrete including footings. Forms shall be constructed and placed so the resulting concrete will provide the shape, lines, dimensions, appearance, and elevations indicated on the Drawings.

B. Forms for all exposed exterior and interior concrete shall be new/unused Type A-C exterior grade plywood with "A" veneer exterior on casting side. Rustications shall be as located and detailed on the Drawings. Moldings for chamfers and rustication shall be milled and planed smooth.

C. Forms for all other cast-in-place concrete shall be made of wood, metal, or other acceptable material. Wood forms shall be constructed of sound lumber or plywood of suitable dimensions, free from knotholes and loose knots. Where used for exposed surfaces, boards shall be dressed and matched. Plywood shall be sanded smooth and fitted with tight joints between panels. Metal forms shall be of an acceptable type for the class of work involved and of the thickness and design required for rigid construction.

D. Edges of all form panels in contact with concrete shall be flush within 1/32-inch and forms for plane surfaces shall be such that the concrete will be plane within 1/16-inch in 4 feet. Forms shall be tight to prevent the passage of mortar, water and grout.

E. Molding or bevels shall be placed to produce a 3/4-inch chamfer on all exposed projecting corners, unless otherwise noted on the Drawings. Provide similar chamfer strips at horizontal and vertical extremities of all wall placements to produce 'clean' separation between successive placements as called for on the Drawings.

F. Forms shall be sufficiently rigid to withstand vibration and to prevent displacement or sagging between supports. Forms shall be constructed so that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.

G. Forms, including new pre-oiled forms, shall be oiled before reinforcement is placed, with an approved nonstaining oil or liquid form coating not having a paraffin base.

H. Before form material is reused, all surfaces in contact with concrete shall be thoroughly cleaned; all damaged places repaired; all projecting nails withdrawn; and all protrusions smoothed. Wood forms shall be pre-oiled before reuse.

I. Form ties encased in concrete other than those specified in the following paragraph shall be designed so that after removal of the projecting part, no metal shall be within one-inch of the face of the concrete. That part of the tie to be removed shall be at least ½-inch diameter or be provided with a wood or metal cone at least ½-inch diameter and one inch long. Form ties in concrete exposed to view shall be the cone-washer type equal to the Richmond "Tyscru".

1. Throughbolts or common wire shall not be used for form ties.

3.07 PLACING AND COMPACTING

A. Unless otherwise permitted, work begun on any day shall be completed in daylight of the same day.

B. Place no concrete until reinforcing steel, pipes, conduits, sleeves, hangers, anchors, and other work required to be built into concrete have been inspected and approved by the Engineer. Remove water and foreign matter from forms and excavation. Place no concrete on frozen soil, and provide adequate protection against frost action during freezing weather. All soil preparation below slabs and footings shall be approved by the Engineer before placing concrete.

C. Transport concrete from mixer to place of final deposit as rapidly as possible by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid rehandling. Deposit no partially hardened concrete.

D. "Cold Joints" are to be avoided unless called for on the Drawings. If they occur they are to be treated as bonded construction joints.

E. At construction joints, the surfaces of the concrete already placed, including inclined surfaces, shall be thoroughly cleaned of foreign materials, laitance, and weak concrete and roughened with suitable tools to expose a fresh face. At least two hours before and again shortly before the new concrete is deposited, the joints shall be saturated with water. After glistening water disappears, the joints shall be given a thorough coating of neat cement slurry mixed to the consistency of very heavy paste.

The surfaces shall receive a coating at least 1/8-inch thick, well scrubbed-in by means of stiff bristle brushes whenever possible. New concrete shall be deposited before the neat cement dries.

F. Deposit concrete to maintain, until the completion of the unit, a horizontal plastic surface. Vertical lifts shall not exceed 24-inches. Vertical lifts of 18 inches are preferable.

G. Chutes for conveying concrete shall be of U-shaped design to insure a continuous flow of concrete. Do not use flat (coal) chutes. Chutes shall be metal or metal-lined and each section shall have approximately the same slope. The slope shall not be less than 25 nor more than 45 degrees and shall be such as to prevent the segregation of the ingredients. The discharge end of the chute shall be provided with a baffle plate or spout to prevent segregation. If the discharge end of the chute is more than 5 feet above the surface of the concrete in the forms, a spout shall be used, and the lower end maintained as near the surface of deposit as practicable. When the operation is intermittent, the chute shall discharge into a hopper. Chutes shall be thoroughly cleaned before and after each run. Discharge debris and any water outside the forms. Concrete shall not be allowed to flow horizontally over distances exceeding 5 feet.

H. Pumping of concrete is an acceptable method of placement. The proposed pumping equipment and concrete mix shall be submitted to the Engineer prior to usage for approval.

I. Concrete shall be thoroughly compacted during and immediately after placement using suitable tools. Internal type mechanical vibrators shall be employed to produce the required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be of the duration required to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents or pumping" or migration of air. All vibrators shall be supplemented by proper wooden spades to prevent puddling adjacent to forms and to remove bubbles and honeycomb. This is essential for the top lifts of walls. All vibrators shall operate at minimum 10,000 rpm. At least one vibrator shall be used for every 10 cubic yards of concrete placed per hour. In addition, one spare vibrator in operating condition shall be on the site.

J. Concrete slabs on the ground shall be well-tamped into place. Foundation materials shall be wet, tapped, and rolled until thoroughly compacted prior to placing concrete.

K. Concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has sufficiently hardened to cause the formation of seams and planes of weakness within the section. If a section cannot be

placed continuously, construction joints may be located at points as provided for in the Drawings or as acceptable to the Engineer.

3.08 CURING AND FROST PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Concrete placed at air temperature below 40 deg F shall have a minimum temperature of 60 deg F. When the air temperature is below 40 deg F or near 40 deg F and falling, the water and aggregates shall be heated before mixing. Concrete shall be protected so the temperature at the surface will not fall below 50 deg F for at least 7 days after placing. The Contractor shall submit for acceptance by the Engineer the methods he proposes to use for concrete placement and curing during temperatures below 40 deg F. No salt, manure, or other chemicals shall be used for protection. Over heating or non-uniformity of heating shall be prevented. The surface temperature of the concrete shall not exceed 95 deg F during heating operations.

C. All concrete, particularly exposed surfaces, shall be treated immediately after concreting or cement finishing is completed to provide continuous moist curing above 50 deg F for at least 7 days, regardless of the ambient air temperature. Walls and vertical surfaces may be covered with continuously saturated burlap, or other approved means; horizontal surfaces, slabs, etc. shall be ponded to a depth of ½-inch or kept continuously wet by use of sprinklers.

D. In cold weather continuous warm curing (with supplementary heat when required) shall provide a total of 350 day-degrees (i.e., 5 days at 70 F, etc.) of heat.

E. Wherever possible, finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

F. Concrete deposited in hot weather shall have a placing temperature which will not cause a difficulty from loss of slump, flash set or cold joints. In any case the temperature of concrete being placed shall not exceed 90 deg F. If necessary the Engineer may direct the Contractor to immediately cover plastic concrete with polyethlene sheeting to prevent rapid loss of moisture due to excessive ambient temperature and/or low humidity. This work will be considered a part of the Contract price and not an extra payment item.

3.09 REMOVAL OF FORMS

A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 30 percent of the

28-day compressive strength prescribed by the design, and not before reaching the following number of day-degrees (whichever is the longer).

Forms for	Day-degree*
Beams and slabs	500
Walls and vertical surfaces	100

*Day-Degree: Total number of days times average daily air temperature at surface of concrete. For example, 5 days at a daily weighted average temperature of 60 F equal 300 day-degrees. Temperatures below 50 deg F not to be included.

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

3.10 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 03300-1, the Engineer shall have the right to require charges in proportions outlined to apply on the remainder of the Work, furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core boring and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with Sections 15 and l7 of ASTM C 94.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C 42 and C 39. In case of failure of the latter, the Engineer, in addition to other recourses, may require, at the Contractor’s expense, load tests on any one of the elements in which such concrete was used. Test need not be made until concrete has aged 60 days.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

3.11 PATCHING AND REPAIRS

A. It is the intent of these specification to require forms, mixture of concrete and workmanship so concrete surfaces, when exposed, will require no patching.

B. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled, and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.

C. Immediately after removal of forms remove plugs and break off metal ties as required by Article 3.06. Holes are then to be promptly filled upon stripping as follows: Moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1-1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of 'balling'). Hammer the grout into the hole until dense, and an excess of paste appears on the Surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.

D. When patching or repairing exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum Stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

E. Defective concrete and honeycombed areas as determined by the Engineer shall be chipped down reasonably square and at least 1-inch deep to sound concrete by means of hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly imbedded in the parent concrete, subject to Engineer's final inspection. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/6-inch wide all around the steel. For areas less than 1-1/2-inch deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-inch layers on successive days, each layer being applied (with slurry, etc.) as described above. To aid strength and bonding of the multiple layer repairs, the Engineer may order the use of non-shrink, non-metallic grout as specified.

F. Non-Shrink Grout (see material specification Article 2.01-G)

1. For small repairs and patching the grout shall consist of the following minimum cement/sand proportions plus the manufacturers recommended additives.

Material	Volumes	Weights
Cement	1.0	1.0
Sand	1.5	1.5

2. For very heavy (generally formed) patches; the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows: (Non-shrink additives by manufacturer).

Material	Volumes	Weights
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

3.12 MODIFICATION AND REPAIR TO EXISTING CONCRETE

A. Cut, repair, reuse, demolish, excavate or otherwise modify parts of the existing structures or appurtenances, as indicated on the Drawings, specified, or necessary to permit completion of the work. Finishes, joints, reinforcements, sealants, etc. are specified in respective sections of these specifications. All work shall conform with other requirements of this Section and as shown on the Drawings.

B. Demolition of Existing Concrete

1. Concrete shown to be removed on the Drawings shall be done by line drilling at limits followed by jack-hammering in areas where concrete is to he taken out. The Contractor shall be responsible for removing concrete in such a manner that surrounding concrete or existing reinforcing to be left in place and existing in place equipment is not damaged. Sawcutting at limits of concrete to be removed shall be done if indicated on the Drawings.

C. Connection to Existing Concrete

1. Roughen surface of existing concrete to be connected to new materials by sand-blasting, chipping, or scarifying. Thoroughly clean area of concrete to receive new materials of loose particles and dust or other contaminating objects.

2. Existing reinforcing to be left in place as shown on the Drawings shall be wire brushed to remove rust or concrete. The existing reinforcing shall be cut, bent, or lapped to new reinforcing as shown on the Drawings and provided with a minimum of one inch of cover all around and at ends of the bar. The reinforcing shall be thoroughly cleaned of loose particles and dust before incorporating in new materials.

3. Connection Methods

   a. Method A. After existing concrete surface at connection has been roughened and cleaned as specified above, thoroughly saturate and maintain saturation for a period of at least 12 hours. Brush on a 1/16 inch layer of cement and water mixed to the consistency of a heavy paste. Immediately after application of cement paste, place new concrete or grout mixture as detailed on the Drawings.

   b. Method B. After existing concrete surface has been roughened and cleaned as specified above, apply epoxy bonding agent at connection surface. The field preparation and application of the epoxy bonding agent shall comply strictly with the manufacturer's recommendations. Place new concrete or non-shrink grout to limits shown an the Drawings within time constraints recommended by the manufacturer.

   c. Method C for Dowels. Dowels and anchor bolts shall be set in existing concrete by the use of non-shrink cement grout in drilled holes. The diameter of the drilled hole shall be two inches larger than the diameter of the dowel or anchor bolt. The hole shall be thoroughly cleaned and non-shrink cement grout shall be placed in the bottom of hole. The dowel or anchor bolt is then inserted into place and the remaining void is filled by ramming in non-shrink cement grout. The dowel or anchor bolt shall have a minimum of 3/4-inches of grout between it and the drilled side of the hole. If the surface of the grout is to be exposed, the non-shrink grout shall be discontinued ½-inches from the surface and the remaining void filled with mortar matching the existing concrete as near as practical.

D. Where existing reinforcing is exposed due to saw cutting and removal of existing concrete, a coating or surface treatment of epoxy protectant shall be applied to the entire cut surface. The epoxy manufacturer shall submit to the Engineer for review specifications for the epoxy mortar material to be used. The epoxy protectant shall be formulated for the intended application.

3.13 INSTALLATION SCHEDULE

A. Concrete for all structures and sidewalks shall have minimum compressive strength at 28 days of 4,000 psi.

B. Concrete fill and duct encasement shall have a minimum compressive strength at 28 days of 2,500 psi.

3.14 FIELD CONTROL

A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete. The Contractor shall cooperate in obtaining cores by allowing free access to the Work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The Contractor shall repair all core holes. The work of cutting and testing the cores will be at the expense of the Contractor.

END OF SECTION

SECTION 03345

CONCRETE FINISHING

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to finish cast-in-place concrete surfaces as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Patching and repair of defective and honeycombed concrete is included in Section 03300.

B. Concrete curing is included in Section 03300.

1.03 SCHEDULE OF FINISHES

A. Concrete for the project shall be finished in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material under another section.

B. The base concrete for the following conditions shall be finished concrete as noted and as further specified herein:

1. Concrete where not exposed in the finished work and not scheduled to receive an additional applied finish or material - Off-form finish. See paragraph 3.01D.

2. Concrete for exterior walks, interior and exterior stairs - Broomed finish perpendicular to direction of traffic. See paragraph 3.02B.

3. Concrete to receive hardener - Wood float finish, non-slip. See paragraph 3.02A2. (Provide hardener at interior slabs.)

1.04 RESPONSIBILITY FOR CHANGING FINISHES

A. The surface finishes Specified for concrete to receive additional applied finishes or materials are the finishes required for the proper application of the actual products specified. Where different products are approved for use, it shall be the Contractor's responsibility to determine if changes in finishes are required and to provide the proper finishes to receive these products.

B. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer for acceptance.

PART 2: PRODUCTS

2.01 MATERIALS

A. Floor hardener shall be Frictex H aluminum oxide abrasive aggregate by Sonneborn, Minneapolis, Minnesota or equal as accepted by the Engineer.

PART 3: EXECUTION

3.01 FORMED SURFACES

A. Forms shall not be removed before the requirements of Section 03300-3.09A have been met.

B. Care shall be exercised to prevent damaging edges or obliterating the lines of chamfers, rustication or corners when removing the forms or doing any other work adjacent thereto.

C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to the satisfaction of the Engineer.

D. Concrete not exposed in the finished work shall have off-form finish with fins and other projections removed and tie cones and defects filled as specified under Section 03300.

3.02 FLOORS AND SLABS

A. Floated Finish:

1. Machine Floating:

Screed floors and slabs with straightedges to the established grades shown on the plans. Immediately after final screeding, a dry cement/sand shake in the proportion of 2-sacks of Portland cement to 350 pounds of coarse natural concrete sand shall be sprinkled evenly over the surface at the rate of approximately BOO pounds per 1,000 square feet of floor. Neat, dry cement shall not be sprinkled on the surface. When the concrete has hardened sufficiently to support the weight of the power float used without digging in or

disrupting the level surface, the shake shall be thoroughly floated into the surface with a heavy revolving disc type power compacting machine capable of providing a 200 pound compaction force distributed over a 24-inch diameter disc. This compacting machine shall be the ”Kelly Power Float” with “Compaction Control” as manufactured by Kelley Industries of SSP Construction Equipment, Inc.; P.O. Box 2038, Pomona, CA 91766; (714) 623-6184, or equal acceptable to the Engineer. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades shall not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing of a floor shall not be permitted.

Floating should start along walls and around columns and then move systematically across the surface leaving a matte finish.

NOTE: This operation (application of the cement/sand shake) may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity, and the need is not indicated.

2. Hand Floating:

In lieu of power floating, small areas as defined by the Engineer may be compacted by hand floating. The dry cement/sand shake specified in 1 above shall be used unless eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the plans. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than 1/4-inch indentation, wood float to a true, even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface.

3. Finishing Tolerances:

Floors and slabs shall be level with a tolerance of 1/8 inch when checked with a 10-foot straightedge placed anywhere on the slab in any direction, except where drains occur, in which case floors shall be pitched to drains such that there are no high spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction as directed by the Engineer.

B. Broom Finish:

1. Finish concrete as specified in paragraph 3.02A and, if required, 3.02D. Then draw a stiff bristle broom lightly across the surface in the direction of drainage, or in the case of walks and stairs, perpendicular to the direction of traffic to provide

a non-slip surface.

2. All outer edges of walks and drives including edges at expansion joints and grooves shall be rounded.

3.03 APPROVAL OF FINISHES

A. All concrete surfaces, when finished, will be inspected by the Engineer.

B. Surfaces which, in the opinion of the Engineer, are unsatisfactory shall be refinished or reworked until accepted by the Engineer.

C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in accordance with Section 03300 unless otherwise directed by the Engineer.

END OF SECTION

SECTION 03350

TESTING REINFORCED CONCRETE STRUCTURES FOR WATERTIGHTNESS

PART 1: GENERAL

1.01 SCOPE OF WORK

The tests included in this section are applicable to cast-in-place reinforced concrete water containment structures, including tanks, reservoirs, basins, conduits, etc. These tests are for structures containing water or wastewater.

1.02 OBJECTIVES

This section shall provide methods for watertightness testing of cast-in-place, reinforced concrete structures in order to determine whether or not they are acceptable.

1.03 BACKGROUND

The American Water Works Association Committee on Concrete Water-Holding Structures recommends a leakage allowance of 0.1 percent of total volume for 24 hours, as measured by the drop in water surface be used as a maximum allowable leakage rate.

PART 2: STRUCTURE QUALITY

2.01 LEAKAGE

A. Cracks: Cracks with visible water flow will not be allowed in the completed structure. The presence of fine non-visible cracks are considered in the watertightness criteria.

B. Joints: Waterstops placed in joints of structures shall minimize leakage. Care must be taken in placing concrete around the waterstop to prevent waterstop displacement and the formation of an escape path for the water by the presence of holes or voids. The probability of some loss of water around or through waterstops shall be considered in the watertightness criteria.

C. Permeability: The permeability of concrete normally used for structures shall result in a very small loss of water.

D. Fittings: Different materials inserted in, embedded in, or passing through the concrete have the potential for allowing water to follow along the contact surface between the fitting and the concrete. Acceptance or rejection of the work shall recognize this potential. The criteria shall not allow for visible leakage at fittings. One other factor that shall be considered in quantifying potential leakage is that metal fittings, unlike concrete, do not change in volume during wetting or drying.

2.02 CRITERIA FOR ACCEPTANCE OF STRUCTURES

The allowable leakage rate for concrete water containment structures shall not exceed 0.1 percent of the water volume in 24 hours.

PART 3: WATERTIGHTNESS TEST

3.01 GENERAL

A watertightness test shall be performed on concrete water containment structures to insure that incidental and undetected defects are not allowing undue leakage. The tested structures shall not have a leakage rate in excess of the criteria described above.

The tests shall be performed with potable water which is to be purchased by the CONTRACTOR from the local utility.

3.02 STRUCTURE CONDITION

The containment structure shall be structurally complete and capable of resisting the hydrostatic pressure of the test water. Backfill shall not be present around the structure. Visible leakage can then be observed and surface dampness can be determined. The ground water at the structure shall be below the containment floor and below any underdrain system. The CONTRACTOR shall provide continuous ground water pumping as required to insure this condition. The underdrain discharge line or point, adjacent to the structure, shall be exposed to view so that flow in the system, if present, can be monitored during the test. All temporary bulkheads, cofferdams, pipe blind flanges, and closed valves shall be checked to see that they form a complete seal at these outlets and, these outlets shall be observed during the actual test.

3.03 FACTORS AFFECTING THE TEST

A. Absorption: Water containment structures will absorb water into the concrete during and after filling. For concrete water containment structures, there shall be a 3-day interval between the time the structure is filled with water and the start of the watertightness test. At this time, the tank shall be refilled and the 24-hour testing period shall begin.

B. Evaporation and Precipitation: The test results shall be corrected for observations of the gain in water due to precipitation or the loss of water due to evaporation. This shall be accomplished with a partially filled, calibrated, transparent, floating, open container in the water containment structure. The container shall be positioned away from the sides of the structure and any overhead members that may shield or shade the container. The container shall have sufficient freeboard to accommodate the precipitation from normal rainfall and not be overtopped by waves generated by the wind.

3.04 TEST PROCEDURE

A. Test Preparation: Backfill shall not be placed around the water containment structure prior to the test. Inspection access points shall be open to all piping, channels, and conduits that leave the structure, including any underdrain outlets. When the structure has gained sufficient strength to withstand the test load and after all outlets have been securely sealed, the structure shall be filled with potable water. During filling, the outlets shall be monitored for watertightness, the underdrain outlet monitored for any increase in flow, and the structure, especially the concrete joints, monitored for any visible leakage from the structure. If any visible leakage from the structure or increase in flow from the underdrain system is observed, the condition may be corrected prior to the start of the test measurements. However, no allowance shall be made in the test measurements for uncorrected point source leakage. When the test preparations are acceptable, the structure shall be kept full of water for 3 days prior to starting the test.

B. Duration of Test: The test shall be continued for a period of time sufficient to produce at least a one-half- inch. drop in the water surface based on the leakage occurring at the maximum allowable rate.

This length of time shall be calculated by dividing 0.5 inch by the product of 0.1 percent and the side water depth of the tank in inches.

$$\text{Duration of Test in Days} = \frac{0.5 \text{ inch}}{(0.001)\ (\text{S.W.D.})}$$

If the length of the test calculated contains some fraction of a day, the test shall be continued until the end of the next full 24-hour period.

C. Test Measurements: The location of the water surface in new structures shall be measured at four points 90 degrees apart, at the start of the test. Measurements shall be taken at these locations in order to minimize the effect of differential settlement of a tank on the computed values. A partially filled, calibrated, open container for evaporation/precipitation measurement shall be positioned in uncovered water containment structures and the water level in the container recorded. The water

surface measurements in the structure shall be recorded at 24-hr. intervals. The structure exterior shall be inspected for indications of leakage.

At the end of the test period, the location of the water surface shall be recorded at the location of the original measurements. The water surface in the evaporation/precipitation measurement device shall be recorded. The leakage rate from the tank shall be computed and corrected for evaporation or precipitation as applicable. If the rate exceeds the amount stated in Part 2 above, the structure shall be considered to have failed the test. The structure shall also be considered to have failed the test if water is observed flowing from the structure or if moisture, other than from precipitation or condensation, can be transferred to a dry hand from the exterior surfaces.

Any structure failing the test shall be repaired and retested. The repair work shall include dewatering the structure and inspecting the interior for defects that cause leakage.

END OF SECTION

SECTION 03410

STRUCTURAL PRECAST CONCRETE – PLANT CAST

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes structural precast concrete units, plant cast, including the following:

1. Hollow-core slab units.
2. Solid slab units
3. Steel header members.
4. Steel connection plates and brackets.
5. Grouting and anchor bolting and welding.

B. Related Sections: The following sections contain requirements that relate to this section.

1. Division 1 Section “Structural Inspection.”
2. Division 3 Section “Cast-in-Place Concrete.”

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer, fabricate, and install structural precast concrete units to withstand design loadings indicated within limits and under conditions required.

1. The design of precast-prestressed hollow core slabs shall be in accordance with the latest recommendations of the PCI and ACI building code requirements.
2. Manufacturer shall use contract drawing information indicating depth and loading of member to design precast-prestressed hollow core slabs.
3. Design steel headers where required. Design shall comply with AISC specifications.

B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare design calculations, fire-resistance calculations, shop drawings, and other structural data.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data and instructions for manufactured materials and products.

1. Certification by paint and curing compound manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

C. Shop drawings detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections; locations, sizes, and types of reinforcement, including special reinforcement; estimated camber; and lifting devices necessary for handling and erection.

1. Include an erection plan indicating layout and dimensions, and identifying each precast concrete unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail loose, cast-in, and field hardware, inserts, connections, and joints, including accessories and construction at openings in precast units.
2. Shop drawings shall be signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation.
3. To the extent structural precast unit design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation. The calculations will be reviewed for design intent only. Engineering and detailing shall be solely the responsibility of the manufacturer and the professional engineer responsible for their preparation.
4. Computer generated electronic structural construction document files (ACAD R14) will be made available to the Contractor. The Contractor will be required to sign the Engineer's standard release of liability form and pay a handling fee of $50.00 per drawing prior to receiving the drawing files. Rules for use of said files shall be as defined in the CRSI "Code of Standard Practice" Sections 4.19 and 6.4.1.
5. Shop drawing resubmittals are reviewed for conformance with review marks only. Any changes or questions originating on a resubmittal shall be clearly clouded.

D. Design mixes for each concrete mix. Submit revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

E. Material test reports from a qualified independent testing agency evidencing compliance with requirements of the following based on comprehensive testing of current materials:

1. Concrete materials.
2. Reinforcing materials.
3. Prestressing strands.
4. Admixtures.
5. Bearing pads.

F. Material certificates in lieu of agency test reports, when permitted by Architect, signed by fabricator certifying that each material item complies with requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed structural precast concrete work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Firm experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units without delaying the Work.

1. Fabricator must participate in the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program and be designated a PCI Certified Plant.

C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the State of Kentucky and who is experienced in providing engineering services of the kind indicated that have resulted in the installation and successful in-service performance of precast concrete units similar to this Project in material, design, and extent.

D. Testing Agency: Owner may engage an independent testing agency to perform shop inspections and tests and to provide test reports. Manufacturer shall provide testing agency with access to places where structural precast concrete units are being fabricated so inspection and testing can be accomplished. Correction of deficiencies and additional testing to determine compliance of corrected work will be performed at Contractor's expense.

E. PCI Design Standard: Comply with recommendations of PCI MNL-120 "PCI Design Handbook – Precast and Prestressed Concrete" applicable to types of structural precast concrete units indicated.

F. PCI Quality-Control Standard: Comply with requirements of PCI MNL-116 "Manual for Quality Control Plants and Production of Precast and Prestressed Concrete Products," including manufacturing and testing procedures, quality-control recommendations, and camber and dimensional tolerances for types of units required.

G. ACI Publications: Comply with the following ACI publications applicable to types of structural precast concrete units indicated:

1. ACI 301 "Specifications for Structural Concrete for Buildings."
2. ACI 318 (ACI 318M) "Building Code Requirements for Reinforced Concrete."
3. ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
4. ACI 525 "Minimum Requirements for Thin-Section Precast Concrete Construction."

H. Welding Standards: Comply with applicable provisions of the following American Welding Society publications:

1. AWS D1.1 "Structural Welding Code – Steel."
2. AWS D1.4 "Structural Welding Code – Reinforcing Steel."
3. AWS D12.1 "Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so that markings are visible.

B. Lift and support units only at designated lifting or supporting points as shown on final shop drawings.

C. Deliver anchorage items that are to be embedded in other construction before starting such work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

D. Provide temporary lateral support during erection to prevent bowing and warping. Blocking and supports shall be clean, non-staining, and shall not prevent uniform curing of exposed surfaces.

PART 2 – PRODUCTS

2.1 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Steel-Welded Wire Fabric: ASTM A 185, welded steel wire fabric in sheets.

C. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use supports complying with CRSI recommendations.

1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are protected with plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.2 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A 416, Grade 250 or 270, uncoated, 7-wire, stress-relieved.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III.

1. Use only one brand and type of cement throughout Project, unless otherwise acceptable to Architect.

B. Fly Ash: ASTM C 618, Class C or F.

C. Silica Fume: ASTM C 1240, amorphous silica.

D. Normal-Weight Aggregates: ASTM C 33, Class 5S. Provide aggregates from a single source.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling or surface discoloration due to oxidation.

E. Water: Potable.

F. Admixtures, General: Provide admixtures for concrete that contain not more than 0.05 percent chloride ions.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

H. Water-Reducing Admixture: ASTM C 494, Type A.

I. High-Range, Water-Reducing Admixture: ASTM C 494, Type F or Type G.

J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

L. Corrosion Inhibitor: ASTM C494, Type C.

2.4 CONNECTION MATERIALS AND FINISHES

A. Steel Shapes and Plates: ASTM A 36.

B. Accessories: Provide clips, hangers, shims, and other accessories required to install precast concrete units.

C. Hot-Dip Galvanized Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by the hot-dip process, complying with the following requirements:

1. ASTM A 123 for galvanizing rolled, pressed, and forged shapes, plates, bars, and strips.

2.5 BEARING PADS

A. Provide bearing pads for precast concrete units as follows:

1. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.6 GROUT MATERIALS

A. Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2 ½ parts sand, by volume, with minimum water required for placement and hydration. Compressive strength of 3500 psi: 28 day strength or greater.

2.7 CURING MATERIALS

A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating not to exceed those allowable by jurisdictional regulations.

2.8 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect or qualified precast manufacturing plant personnel for preparing and reporting proposed mix designs. Trial batch and field experience tests shall have been performed within 12 months of submittal date.

1. Limit use of fly ash to less than or equal to 25 percent of cement content by weight.

B. Normal-Weight Concrete: Provide normal-weight concrete with the following properties:

1. Compressive Strength (28-Day): 5000 psi (34.5 MPa).
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.40.

C. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer’s prescribed rate to result in concrete at point of

placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure.

    a. 6.0 percent for 1-inch maximum aggregate.
    b. 6.0 percent for 3/4-inch maximum aggregate.
    c. 7.0 percent for 1/2-inch maximum aggregate.
    d. 7.5 percent for 3/8-inch maximum aggregate.

2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.

D. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures, as required, according to manufacturer's directions.

E. Concrete-Mix Adjustments: Concrete-mix design adjustments may be requested by precaster when characteristics of materials, project conditions, weather, test results, or other circumstances warrant as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in the work.

2.9 FABRICATION

A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.

1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's instructions.
2. Unless forms for precast, prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under prestress or movement during detensioning.

B. Built-In Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect the position of the main reinforcement or placing of concrete. Do not relocate bearing plates in units, unless acceptable to Architect.

C. Cast-in openings larger than 12 inches in diameter or 12 inches square according to final shop drawings. Other smaller holes may be field cut by trades requiring them, as acceptable to Architect. Trades field cutting holes shall locate holes so as to not cut prestressing tendons.

D. Reinforcement: Comply with the recommendations of CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers, as required.
3. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with wire.

E. Pretensioning: Pretension tendons for precast, prestressed concrete either by single-strand tensioning method or multiple-strand tensioning method. Comply with PCI MNL-116 requirements.

F. Concrete Mixing: Comply with requirements and with ASTM C 94. Following concrete batching, no additional water may be added.

G. Concrete Placement: Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast units. Comply with requirements of ACI 304R for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with ACI 309R.
2. Comply with ACI 306R procedures for cold-weather concrete placement.
3. Comply with ACI 305R procedures for hot-weather concrete placement.

H. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint casting date on each precast unit on a surface that will not show in the finished structure.

I. Cure concrete according to the requirements of PCI MNL-116 by moisture retention without heat or by accelerated heat curing, using low-pressure live steam or radiant heat and moisture.

J. Delay detensioning prestressed concrete units until concrete has attained at least 70 percent of its compressive strength as established by test cylinders cured under the same conditions as the concrete.

1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

K. Finish formed surfaces of precast concrete as indicated for each type of unit as follows:

1. Standard Finish: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, and form joint marks, and minor chips and spalls will be tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

L. Finish unformed surfaces by trowel, unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

1. Apply scratch finish to precast concrete units that will receive concrete topping after installation. Following initial strike-off, transversely scarify surface to provide ridges approximately ¼ inch deep.
2. Apply a nonslip broom finish to exterior precast concrete subject to pedestrian traffic. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route.
3. Where used as roof members, provide smooth, float top finish to precast units.

2.10 HOLLOW-CORE AND SOLID SLAB UNITS

A. Provide precast, prestressed concrete units with open, hollow cores running the full length of the slab units.

B. Provide solid, monolithic, precast concrete slab units where shown on drawings. Design and fabricate solid units to dimensions and details indicated as required for hollow-core slab units.

C. Furnish units free of voids or honeycombs.

D. Reinforce units to resist transportation and erection stresses.

E. Include cast-in weld plates where required.

F. Coordinate with other trades for installation of cast-in items.

G. Provide headers of cast-in-place concrete or structural steel shapes for openings larger than one slab width according to hollow-core slab unit fabricator's recommendations.

2.11 QUALITY CONTROL

A. The Owner may employ an independent testing agency to evaluate precast fabricator's quality control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.

B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL-116 requirements.

C. Strength of precast concrete units will be considered potentially deficient when precast concrete units fail to comply with requirements, including the following:

1. Fail to meet compressive-strength test requirements.
2. Reinforcement, and pretensioning and detensioning tendons of prestressed concrete do not conform to fabrication requirements.
3. Concrete curing and protection of precast units against extremes in temperature fail to meet requirements.
4. Precast units are damaged during handling and erecting.

D. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.

1. A minimum of 3 representative cores will be taken from precast concrete units of suspect strength, from locations directed by Architect.
2. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.
3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
4. Test results will be made in writing on the same day that tests are made, with copies to Architect, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete fabricator, name of concrete testing agency; identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength, compressive strength at break and type of break, corrected for length-diameter ratio, and direction of applied load to core with respect to horizontal plane of concrete as placed.

E. Patching: Where core test results are satisfactory and precast concrete units meet requirements, solidly fill core holes with patching mortar and finish to match adjacent concrete surfaces.

F. Dimensional Tolerances: Units having dimensions smaller or greater than required and not meeting tolerance limits may be subject to additional testing.

1. Precast units having dimensions greater than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to meet construction conditions.

G. Defective Work: Precast concrete units that do not conform to requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that meet requirements.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements, including installation tolerances, true and level bearing surfaces, and other conditions affecting performance of precast concrete units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Members shall bear the minimum length called for on contract or shop drawings. If no

B. earing length is specified, 3 ½ inches shall be considered the minimum.

C. Set vertical units dry, without grout, attaining joint dimension with lead or plastic spacers. Grout pack base of unit.

D. Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast units are placed. Concrete masonry units supporting precast concrete units shall be solid or grout filled to 8" minimum depth below bearing.

E. -Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed units, unless otherwise acceptable to Architect.

F. Erection Tolerances: Install precast units level, plumb, square, and true, without exceeding the recommended erection tolerances of PCI MNL-127 "Recommended Practice for Erection of Precast Concrete."

G. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.

H. Remove lifting hooks if necessary.

I. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints with cement grout.

1. Provide forms or other acceptable method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb, and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.
2. Level differential elevation of adjoining horizontal members with grout to maximum slope of 1:12.

3.3 CLEANING

A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.

1. Wash and rinse according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION

SECTION 04200

UNIT MASONRY

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to construct all masonry work as shown on the Drawings and specified herein.

B. The work under this Section includes, but is not necessarily limited to, the following:

1. Furnishing and installing the insulation filled concrete masonry, complete.

2. Furnishing and installing anchors, and reinforcement, and concrete and grout for embedding such reinforcement.

3. Furnishing and installing masonry lintels, sills, and other masonry trim to be built in the concrete masonry.

4. Installing loose steel lintels.

5. Building into masonry all bolts, anchors, nailing blocks, inserts, window, and door frames, vents, conduits, and related work to be built in, including items furnished and located by other trades or specified in other sections.

6. Furnishing and installing any bracing, forming, and shoring in conjunction with and in the course of constructing the concrete masonry and not provided in other sections.

7. Furnishing test specimens and samples of materials as specified.

8. Cleaning masonry and removal of surplus material and waste.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-in-place concrete is included in Section 03300.

B. Miscellaneous metals are included in Section 05500.

C. Flashings are included in Section 07600.

D. Caulking and sealants are included in Section 07920.

1.03 SUBMITTALS

A. Make submittals in accordance with the provisions of Section 01300.

B. Well in advance of construction, submit the following to the Engineer for review:

1. Manufacturer's certificates confirming that the materials furnished meet or exceed the standards specified.

2. Samples of masonry units for approval of type, color, and color variation.

3. Masonry reinforcement fabrication and placing drawings.

C. Before commencing with the laying of any architectural masonry, construct on the site where directed by the Engineer, a sample panel approximately 6 feet by 4 feet. Unless otherwise directed by the Engineer, this sample may be incorporated into the finished work of the project. Construct the panel using full size masonry units selected to show color and texture range and approved by the Engineer for incorporation into the panel. The sample shall show bond, mortar and joint tooling and upon acceptance shall become the standard workmanship for the remainder of the work.

1.04 PROTECTION OF MATERIALS

A. All masonry shall be shipped stacked with hay or straw protection or other suitable protective device, and shall be similarly stacked off the ground on the site. In addition, all masonry stored on the site shall be protected from the weather and staining with the use of tarpaulins or other covering acceptable to the Engineer.

B. Cementitious materials shall be stored under cover in a dry place.

C. Reinforcing and anchors shall be stored off the ground and protected from moisture or damage by contaminants. (See Section 03200 for additional requirements.)

1.05 COLD WEATHER CONSTRUCTION

A. Masonry construction in cold weather shall conform to the applicable requirements of the 1997 Kentucky Building Code, unless otherwise specified herein.

PART 2: PRODUCTS

2.01 MATERIALS

A. Masonry

1. Hollow, load bearing concrete masonry units (CMU) shall conform to ASTM C90, Grade N. Type I. Provide normal weight units.

a. Nominal face dimensions of CMU shall be 8 inches x 16 inches unless otherwise noted on the Drawings.

b. CMU shall be free of substances which will cause staining or pop-outs and shall have a fine, even texture with straight and true edges.

c. All units shall have been wet steam cured for at least 18 hours and then air cured in covered storage for not less than 28 days before delivery.

d. Units shall be obtained from one manufacturer to insure uniformity of color and texture.

e. Provide special units as shown on the Drawings including sash corner, jamb, lintel, bond beam or pilaster blocks.

B. Reinforcing Steel

1. Masonry reinforcing steel shall conform to ASTM A615 as specified in Section 03300.

C. Anchors and Miscellaneous Accessories

1. Rigid-steel anchors shall be 1-1/2 inches by 1/4 inch with ends turned up minimum 2 inches, not less than 24-inches long.

2. The Contractor shall provide and install miscellaneous and attachment members, required both for the anchorage of his own work and that of other trades requiring attachment to masonry, which are not specifically provided under separate sections.

D. Fill Insulation

1. Masonry fill insulation for CMU cells shall be vermiculite type equal to Zonolite by W.R. Grace Co., or perlite type equal to Permalite by Grefco, Inc. or equal. Insulation shall be treated to prevent moisture absorption. "U" value in 8-in filled lightweight CMU construction shall be 0.17, maximum.

2.02 MORTAR AND GROUT MATERIALS

A. Portland cement shall conform to ASTM C150 Type II. Masonry cements shall NOT be used.

B. Lime for masonry mortar shall be hydrated, conforming to ASTM C207, Type S.

C. Sand shall be clean, durable particles, free from injurious amounts of organic matter. The sand for mortar shall conform to the limits of ASTM C144. Sand for grout shall conform to ASTM C404.

D. Water shall be free from injurious amounts of oils, acids, alkalis or organic matter, and shall be clean and fresh.

E. Mortar shall conform to ASTM C 270, Type S, consisting of 1 part Portland cement, 1/2 part lime, 4-1/2 parts sand, or as otherwise acceptable to the Engineer. Ingredients shall be accurately measured by volume in boxes especially constructed for the purpose by the Contractor. Measurement by shovel will not be allowed.

F. Grout for bond beams, lintels, and reinforced cells of CMU shall conform to ASTM C 476, consisting of 1 part Portland cement, 1/10 part lime and 3 parts size No. 1 fine aggregate as specified in ASTM C404. Ingredients shall be accurately measured by volume in boxes especially constructed for the purpose by the Contractor. Measurement by shovel will not be allowed. Minimum 28 day compressive strength of grout shall be 3000 psi.

PART 3: EXECUTION

3.01 GENERAL

A. Masonry shall be plumb, true to line, with level courses accurately spaced, and built to the thickness and bond pattern indicated or specified. Concrete masonry units shall be dry when laid. Each unit shall be adjusted to final position in the wall while mortar is still soft and plastic. Any unit disturbed after mortar has stiffened shall be removed and relaid with fresh mortar. Vertical cells to be filled with grout shall be aligned to provide a continuous unobstructed opening of the dimensions shown. Chases shall be built in and not cut in. Chases shall be plumb and shall be a minimum of one-unit length from jambs of openings. Chases and raked-out joints shall be kept free from mortar or debris. Spaces around metal door frames and other built-in items shall be solidly filled with mortar as each course is laid. Anchors, wall plugs, accessories, flashings, and other items to be built shall be installed as the masonry work progresses. All cutting and fitting of masonry, including that required to accommodate the work of other sections shall be done by masonry mechanics with masonry saws.

3.02 MORTAR AND GROUT

A. Mortar and grout shall be machine mixed in an approved type of mixer in which the quantity of water can be accurately and uniformly controlled. The mixing time shall not be less than 5 minutes, approximately 2 minutes of which shall be for mixing the dry materials and not less than 3 minutes for continuing the mixing after the water has been added. Hydrated lime used for mortar or grout may be mixed by either using the dry-mix method or first converting the hydrated lime into a putty. Where the dry-mix method is employed, the materials for each batch shall be well turned over together until the even color of the mixed, dry materials indicates that the cementitious material has been thoroughly distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained. Mortar which has begun to "set" or is not used within two and one-half hours after initial mixing shall be discarded.

B. Grout for filling reinforced or unreinforced cells shall be consolidated and reconsolidated in place by vibration to insure complete filling of the cells or cavities.

C. Mortar boxes shall be cleaned out at the end of each day's work, and all tools shall be kept clean. Mortar that has begun to set shall not be used.

3.03 MASONRY - INSTALLATION

A. No material which is frozen or covered with frost or snow shall be used in the construction, and no antifreeze, salts or ingredients shall be mixed with the mortar. Masonry shall not be laid at temperatures below 40 degrees F, unless otherwise directed by the Engineer, and all work shall be done in such a manner as to insure the proper and normal hardening of all mortar. All masonry work shall be so protected and heated that the temperature at the surface will not fall below 50 degrees F for a period of 72 hours after placing. Any completed work found to be affected by freezing shall be taken down and rebuilt by the Contractor at his expense.

B. Hollow units shall be laid with full mortar coverage on horizontal and vertical face shells, except that webs shall also be bedded in the starting course on footings and where adjacent to cells or cavities to be reinforced and/or filled with grout. Butter the vertical joint of unit already set in the wall and all contact faces of the unit to be set. Each unit shall be placed and shoved against the unit previously laid so as to produce a well-compacted vertical mortar joint for the full shell thickness. Units shall set with all cells in a vertical position. The moisture content of the units when laid shall not exceed 35 percent of the total absorption as determined by laboratory test.

C. Solid units shall be laid with full head and bed joints.

D. Masonry units shall be laid in stretcher (running) bond unless otherwise shown. Tool dense and neat.

E. Sizes shall be as specified and called for on the Drawings, and where "Soaps" and "Splits" are used, the space between these members and the backup material shall be slushed full of mortar.

F. Joints of all masonry shall be tooled in accordance with the following:

1. Wait until mortar is thumb-print hard before tooling joint. This may require as much as 3 hours in the shade or 1 hour in the sun in the summertime. The required personnel of the Contractor shall be kept on the job after hours, if necessary, to properly tool joints.

2. Both vertical and horizontal joints shall be maintained uniform in spacing.

3. Joints for masonry shall be 3/8 in.

4. Mortar joints in exposed or painted exterior or interior surfaces shall be tooled when thumbprint hard with a round shaped jointer. Joints in unparged masonry below grade shall be pointed tight with a trowel. Mortar joints in surfaces to be plastered, stuccoed, or covered with other masonry shall be cut flush. Mortar protrusions extending into cells or cavities to be reinforced and filled shall be removed.

   Horizontal joints between top of masonry partitions and underside of concrete beams or slabs shall be filled with mortar unless otherwise indicated.

G. Install all frames required to be set in masonry, set masonry tightly against frames, build in all frame anchors, and fill frames with mortar.

H. All masonry slots, chases, or openings required for the proper installation of the work of other sections shall be constructed as indicated on the Drawings or in accordance with information furnished before the work is started at the points affected. No chase shall cut into any wall constructed of hollow units after it is built, except as directed by the Engineer.

I. Surfaces shall be brushed as work progresses and maintained as clean as it is practicable. Unfinished work shall be raked back where possible, and toothed only where absolutely necessary. Before leaving fresh or unfinished work, walls shall be fully covered and protected against rain and wind and before continuing work previously laid work shall be swept clean. The tops of walls or other unfinished work shall be protected against all damage by frost or the elements by means of nonstaining waterproof paper, tarpaulins, boards or other means acceptable to the Engineer. Covering shall extend minimum 2 feet down on each side of wall and be held securely in place.

J. The Contractor shall build in all miscellaneous items to be set in masonry for which placement is not specifically provided under separate Divisions, including regrets, lintels, ties, electrical panel boxes, sleeves, vents, grilles, anchors, grounds, and exterior electric conduits and fixtures, and shall cooperate with other trades whose work is to be coordinated with the work under this Section.

K. Anchorage

1. General--all structural elements depending upon one another for continuity or support shall be securely anchored to resist all forces which might tend to separate the structural elements.

2. Intersecting Walls and Partition-Masonry walls and partitions shall be securely anchored or bonded at points where they meet or intersect the following method.

a. Bonding--Walls may be bonded by (1) laying at least 50 percent of the units at the intersection in a masonry bond with alternate units having a bearing of not less than 3 inches upon the unit below, or (2) metal ties, joint reinforcement, or anchors as specified.

L. Loose steel lintels shall be furnished under Section 5500 and installed under this section. Loose lintels shall be set in a full bed of mortar and supported by solid or mortar-filled hollow concrete blocks as detailed on the Drawings.

M. Lintels - Furnish and place concrete masonry lintels of type and dimensions shown and of the quality specified herein. Lintels shall extend at least 8 inches beyond edge of opening and shall be firmly bedded at bearings in mortar of the same quality as used in laying the wall.

N. Bed and grout all steel, for equipment and machinery, and items coming in contact with masonry where grouting is required, including door bucks and frames set in masonry. The Contractor shall install all anchor bolts, base plates, and seats in masonry walls, and build in all items required for the completion of the building as they apply to masonry.

O. Insulation Installation

1. The insulation shall be installed in the following locations:

a. In the cores of all exterior and interior hollow masonry unit walls.

2. The insulation shall be poured directly into the wall at any convenient interval. Wall sections under doors and windows shall be filled before sills are placed.

3. All holes and openings in the wall through which insulation can escape shall be permanently sealed or caulked prior to installation of the insulation. Copper, galvanized steel, or fiberglass screening shall be used in all weep holes.

3. 04 REINFORCING

A. Vertical reinforcing steel, grouted for the full wall height, shall be provided where indicated on the Drawings. Masonry dowels shall be cast in the concrete base slab and fully grouted within the masonry wall to the top of the dowel. Masonry dowels shall be provided at all exterior building corners with one dowel in the corner coarse and one dowel in the adjacent coarse in each direction.

B. All bars shall be completely embedded in mortar. All reinforcement shall have a minimum coverage of one bar diameter over all bars, but not less than 3/4-inch except where exposed to weather or soil in which cases, the minimum coverage shall be 2 inches.

C. Splices in Reinforcement. Splices in vertical and horizontal reinforcement shall be at least 48 bar diameters. Provide corner bars for all horizontal reinforcement at corner sections. Corner bars shall be "L" shaped and the same size as horizontal reinforcement to which it is being spliced. The leg of each corner bar shall be the required tension lap length for the size of the corner bar as stated above.

3.05 CLEANING

A. All holes in exposed masonry shall be pointed, and defective joints shall be cut out and repainted with mortar of same color as that of the original and adjoining work.

B. Exposed masonry shall be protected against staining by wall coverings, and excess mortar shall be wiped off the surface as the work progresses.

C. All exposed masonry shall be thoroughly cleaned. Before applying any cleaning agent to the entire wall, it shall be applied to a sample wall area of approximately 20 sq. ft. in a location acceptable to the Engineer. No further cleaning work may proceed until the sample area has been accepted by the Engineer, after which time the same cleaning materials and method shall be used on the remaining wall area. If stiff brushes and water do not suffice, special cleaning procedures will be required. Such procedures shall be undertaken only upon approval by the Engineer. If masonry is cleaned with an acid solution, all sash, medial lintels and other corrigible parts shall be thoroughly protected.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Provide labor, material, equipment and services necessary for proper and complete installation of all structural steel components.

B. Related work as called for on Drawings or specified in this or other specifications.

1.02 QUALITY ASSURANCE

A. Comply with provisions of the following Codes, Specifications and Standards, except as indicated or specified otherwise.

1. A.I.S.C. "Code of Standard Practice for Steel Buildings and Bridges."

2. A.I.S.C. "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," including "Commentary" and Supplements thereto as issued.

3. A.I.S.C. "Specifications for Architecturally Exposed Structural Steel."

4. A.I.S.C. "Specification for Structural Joints Using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Structural Joint of the Engineering Foundation.

5. AWS D1.1 "Structural Welding Code."

6 ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.

B. Qualification for Welding Work

1. Qualify welding processes and welding operators in accordance with the AWS "Standard Qualification Procedure."

2. Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months for type of welding they will be preforming.

3. If recertification of welders is required retesting will be Contractor's responsibility.

1.03 SUBMITTALS

A. SHOP DRAWINGS

1. Submit shop and erection drawings to Engineer for review prior to fabrication. Allow appropriate time for Engineer 5 review as outlined in 01300.

2. Shop drawings shall include the following:

a. Complete details and schedules for fabrication of each member, and for shop assembly of members.

b. Complete details, schedules, procedures and diagrams indicating sequence of erection.

c. Mark each member indicated on shop drawings in such a manner than member designations on drawings coincide with member designation on member in field.

B. Submit test reports and other data as required to show compliance with Specification including certified copies of mill reports designating chemical and physical properties.

PART 2: PRODUCTS

2.01 MATERIALS

A. Rolled steel plates, beams, columns, bars, and Miscellaneous items shall be structural quality carbon steel complying with ASTM A 36 (minimum yield 36,000 psi).

B. Anchor bolts shall comply with ASTM A307. Nuts shall conform to ASTM A307, Grade B hexagon.

C. High-strength threaded fasteners shall be 3/4 inch heavy hexagon structural bolts, heavy hexagon nuts and hardened washers complying with ASTM A 325.

D. Electrodes for manual shield and metal-arc welding shall be covered mild steel electrodes complying with AWS Code and ASTM A588, or E70 as required.

E. Electrodes and flux for submerged arc welding shall be bare mild steel electrodes and fluxes complying with AWS Code and ASTM A588, or E70XX as required,

F. Shop applied primer shall comply with Section 09901

G. Corrosion-Resisting (Stainless) Steel

1. Plate, Sheet, Strip, Fasteners, Where No Welding Required: Per ASTM Al 67-81, Type 316 or 304.

2. Plate, Sheet, Strip, Fasteners Where Welding Required: Per ASTM A167-81, Type 316L or 304L.

PART 3: EXECUTION

3.01 SHOP PAINTING

A. All new structural steel shall be shop primed in accordance with Section 09901.

3.02 FABRICATION

A. Fabricate and assemble structural assemblies in shop to greatest extent possible, Fabricate items of structural steel in accordance with requirements of A.I.S.C. Specifications and as indicated on final shop drawings.

B. Where finishing is required, complete assembly, including welding of units before start of finishing operation. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

3.03 CONNECTIONS

A. Weld all shop connections to develop full strength of section.

B. Bolt field connections, except where welded connections are indicated. Details indicated on Drawings are to illustrate general methods of connection and do not necessarily include all minor pieces required to complete the work. Such pieces shall be provided as specified and required.

C. Connections for beams shall be designed to support a reaction equal to one half the total uniform load capacity for the shape, span and steel specification of the particular beam as tabulated in tables for "Allowable Loads on Beams" in the AISC Manual of Steel Construction, latest edition.

D. Install all high strength bolts in accordance with "Tightening by Use of a Direct Tension Indicator," of the Specification for Structural Joints Using ASTM A325 or A490 Bolts, latest edition, as I.-approved by Research Council on Riveted and Bolted Structural Joints and endorsed by American Institute of Steel Construction. Provide all bolts, nuts and washers as specified, as indicated on Drawings, and as required.

E. Welds shall be made only by operators who have been previously qualified by tests as prescribed in "Standard Qualifications Procedure" of American Welding Society. Fabricator shall provide Engineer with documents establishing qualifications of welders involved in work if so requested.

F. Punch holes for Connection of all structural steel work in shop. Clearly mark such holes on shop drawings. Additional holes not indicated on Drawings shall be approved by Engineer and shall be drilled in field.

3.04 ERECTION

A. All structural steel shall be accurately set and properly secured in place.

B. All bolted connections shall be bearing type with thread, excluded from bearing area and using Direct Tension Indicator.

3.05 FIELD PAINTING

A. Structural steel shall be field painted in accordance with Section 09902.

END OF SECTION

SECTION 05150

FURBISH EXISTING STEEL TANKS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Provide labor, material, equipment and services necessary for proper and complete restoration of all existing steel tanks and components which are to remain in service.

B. Related work as called for on Drawings or specified in this or other specifications.

1.02 QUALITY ASSURANCE

A. Comply with provisions of the following Codes, Specifications and Standards, except as indicated or specified otherwise.

1. A.I.S.C. "Code of Standard Practice for Steel Buildings and Bridges."

2. A.I.S.C. "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings," including "Commentary" and Supplements thereto as issued.

3. A.I.S.C. "Specifications for Architecturally Exposed Structural Steel."

4. A.I.S.C. "Specification for Structural Joints Using ASTM A325 or A490 Bolts" approved by Research Council on Riveted and Bolted Structural Joint of the Engineering Foundation.

5. AWS D1.1 "Structural Welding Code."

B. Qualification for Welding Work

1. Qualify welding processes and welding operators in accordance with the AWS "Standard Qualification Procedure."

2. Provide certification that welders to be employed in the work have satisfactorily passed AWS qualification tests within the previous 12 months for type of welding they will be preforming.

3. If recertification of welders is required retesting will be Contractor's responsibility.

PART 2: PRODUCTS

Not Used

PART 3: EXECUTION

3.01 METAL CLEANING, AND METAL REPAIR OR REPLACEMENT

A. All metal surfaces which are to remain in service shall be sandblasted and prepared for primer. Near white blast cleaning shall be done on all existing tanks and components.

B. A near white blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 5% of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale or stains of previously applied paint. Before blast cleaning, visible deposit of oil or grease shall be removed.

C. Lead paint is present on original surfaces. Removal and disposal shall be done with EPA approved methods as described in Section 09850.

3.02 METAL REPAIR AND REPLACEMENT

A. All welds and structural cracks are to be ground out in a “V” shape and re-welded.

B. Metal with severe rust or weakness is to be replaced in total with equal to or greater thickness metal.

3.05 FIELD PAINTING

A. Steel surfaces shall be prepared and field painted in accordance with Sections 09901 and 09902.

END OF SECTION

SECTION 05500

MISCELLANEOUS METAL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install covers, grates, frames, manhole rungs, catch basin castings and other miscellaneous metals as shown on the Drawings and specified herein. The miscellaneous metal items include but are not limited to the following:

1. Miscellaneous anchors or anchor bolts except those specified to be furnished with all equipment.

2. Cast iron frames, covers, grates, drain leaders and drains.

3. Steel plates, overhead steel door frames, angle frames, plates and channels.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Anchor bolts for equipment are included in the respective Sections of Divisions 11, 14 and 15.

B. Pipe hangers, supports and concrete inserts along with pipe sleeves, wall sleeves, and wall castings are included under Division 15.

1.03 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.04 SUBMITTALS

A. Detail shop drawings, as provided for in the General Conditions and Section 01300, showing sizes of members, method of assembly, anchorage, and connection to other members shall be submitted to the Engineer for approval before fabrication.

l.05 FIELD MEASUREMENTS

A. Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

1.06 REFERENCE SPECIFICATIONS

A. Unless otherwise specified, materials shall conform to the following:

Structural Steel	ASTM A36
Gray Iron Castings	ASTM A48, Class 30
Galvanizing, general	ASTM A123
Galvanizing, hardware	ASTM A153
Galvanizing, assemblies	ASTM A386
Bolts and Nuts for wood & concrete	ASTM A307
Bolts and nuts for steel members	ASTM A325-N
Stainless Steel - Bolts, nuts and washers	ASTM A276, Type 316
I-Welding Rods for Steel	AWS Spec. for Arc Welding

PART 2: PRODUCTS

2.01 ANCHORS, BOLTS, AND FASTENING DEVICES

A. Anchors, bolts etc., shall be furnished as necessary for installation of the work of this Section.

B. Compound masonry anchors shall be of the type shown or required and shall be equal to Star Slug compound masonry anchors manufactured by Star Expansion Industries. Anchors shall be minimum "two unit" type.

C. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum and stainless steel shall be attached to concrete or masonry by means of stainless steel machine bolts and iron or steel shall be attached with steel machine bolts unless otherwise specifically noted.

D. For structural purposes, unless otherwise noted, expansion bolts shall be Molly "Parabolts", Wej-it 'Ankr-Tite", Phillips Drill Co "Wedge Anchors", or Hilti Kwik-Bolt". When length of bolt is not called for on the Drawings, the length of bolt provided shall be sufficient to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete. Material shall be galvanized steel, unless otherwise noted On the Drawings.

2.02 ALUMINUM ITEMS

A. Miscellaneous aluminum shapes and plates shall be fabricated as shown. Angle frames for hatches, beams, grates, etc., shall be furnished complete with welded strap anchors attached. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall conform to the detail dimensions or the plans within the tolerances published by the Aluminum Association, Inc.

2.03 STEEL ITEMS

A. Sleeves shall be steel or cast iron pipe in walls and floors with end joints as shown on the Drawings. All pipe sleeves shall have center anchor around circumference as shown.

B. Structural steel angle along with channel door frames shall be A36 steel provided as shown on the drawings. Frames shall be galvanized and shall be fabricated with not less than three anchors on each jamb.

C. All miscellaneous structural steel lintels and closures whether or not shown on the Drawings shall be galvanized steel and shall be provided as a part of this Section and installed under Section 4200.

D. Miscellaneous steel pipe for sleeves and lifting attachments and other uses as required shall be Schedule 40 pipe fabricated according to the details shown on the Drawings.

E. Frames, covers and grates for manholes, catch basins and inlets shall be of a good quality, strong, tough even grained cast iron except as otherwise specified below. Castings shall be as manufactured by the Neenah Foundry, Mechanics Iron Foundry, or equal. Sizes shall be as shown on the Drawings. Covers to have letters “SEWER” or “DRAIN”, as applicable, embossed on top.

F. Miscellaneous steel shall be fabricated and installed in accordance with the Drawings and shall include; beams, angles, support brackets, closure angles in roof at edge of T-beam, base plates to support ends of T-beams, splice plates, anchor bolts (except for equipment furnished in Divisions 11, 13, 14 and 15), and any other miscellaneous steel called for on the Drawings and not otherwise specified.

G. Headed anchors shall be Nelson type H4L or 53L or equal, flux filled, welded to plates or other embeds as shown on the drawings. Studs shall be made from cold drawn steel grades C-1010 through C-1020 per ASTM A-l0B and shall be welded per the manufacturer's recommendations.

PART 3: EXECUTION

3.01 FABRICATION

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the latest edition of the AWS structural welding code for steel (Dl.l) or aluminum (Dl.2) as appropriate and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.

F. Ml aluminum finish exposed surfaces, except as specified below, shall have manufacturer's standard mill finish. A coating of methacrylate lacquer shall be applied to all aluminum before shipment from the factory.

G. Castings shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes, and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All finished surfaces shown on the Drawings and/or specified shall be machined to a true plane surface and shall be true and seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified or shown shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. The Contractor shall provide facilities for weighing castings in the presence of the Engineer showing true weights, certified by the supplier.

H. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter before shipment and shall be given one shop coat of primer compatible with finish coats specified in Painting Section after fabrication but before shipping. Preparation for shop painting shall be in accordance with Steel Structures Painting Council Specification SP-6. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces. Abrasions in the field shall be touched up with primer immediately after erection. Final painting is specified in Painting Section 09902.

I. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz per square foot of surface.

3.02 INSTALLATION

A. Install all items furnished except items to be embedded in concrete or masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted. All dimensions shall be verified at the site before fabrication is started.

B. All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

D. Where aluminum contacts masonry or concrete, apply a heavy coat of acceptable alkali resistant paint to the masonry or concrete.

E. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

F. High strength steel bolting may be visually inspected. All high strength bolts shall have the turned portion marked with reference to the steel being connected after the nut has been made snug and prior to final tightening. These marks shall be considered in the inspection. Rejected bolts shall be either replaced or retightened as required. In cases of disputed bolt installations, the bolts in question shall be checked by a calibrated wrench certified by an independent testing laboratory acceptable to the Engineer. The certification shall be at the Contractor's expense.

G. Any material or workmanship which is rejected by the Engineer either at the shop, mill, or buildings must be promptly replaced by the Contractor to the Engineer's entire satisfaction at no additional cost to the Owner. The fact that work has been accepted at the shop and mill shall not prevent its final rejection at the site, or even after it has been erected, if it is found to be defective in any way.

END OF SECTION

SECTION 05520

METAL FABRICATIONS/HANDRAILS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, and equipment required to construct and install metal fabrications as shown on the Drawings and specified herein. Included in this section are handrails, grating, nuts, bolts, anchors, hatches, ladders, and stairs.

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is included in Division 3.

B. Castings are included in Division 5.

C. Flashing and sheet metal work for roofing is included in Division 7.

D. Painting is included in Division 9.

1.03 QUALITY ASSURANCE

A. All fabricated materials shall be of the highest quality, free of structural, handling, and workmanship defects.

C. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.04 SUBMITTALS

A. Shop Drawings

1. The CONTRACTOR shall submit to the ENGINEER in accordance with Division 1, Section 01300 detailed shop drawings of all materials to be fabricated, and shall receive the Engineer’s certification of review before fabrication. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor bolt installation by others. Include any requirements for surface preparation, paint products, or grout.

2. Where materials or fabrications are indicated to comply with certain requirements for design loadings, include structural computations, material properties and other information needed for structural analysis. This shall not relieve the CONTRACTOR of responsibility for all errors, omissions, and deviations of his shop drawings from the Drawings and Specifications and from requirements of final results called for in the Drawings and Specifications.

B. Samples

1. The CONTRACTOR shall submit 2 sets of representative samples of materials and finished products as may be requested by the ENGINEER, or as specified herein.

PART 2: PRODUCTS

2.01 MATERIALS

A. Steel

1. Steel fabrication shall be done in conformity with the "AISC Load and Second Edition dated December 1, 1993, latest revision.

2. Prime and paint in accordance with Division 9, unless otherwise required or permitted.

3. Unless otherwise noted on the Drawings or in the Specifications, galvanizing shall be by hotdip process in accordance with ASTM A 525-93, Coating Designation G90 (previous Coating Class Commercial 1.25 oz. per sq. ft.).

4. Damaged zinc coating shall be repaired according to Federal Specification DOD-21035A (Galvanizing Repair Spec.) and ASTM A 780-93a as follows:

a. Remove foreign matter from both damaged and contiguous undamaged area by wire brushing and cleaning with metal conditioner recommended by cold galvanizing coating manufacturer.

b. Apply 2 coats of cold galvanizing coating to damaged area, ensuring an overlap of the surrounding undamaged galvanizing for continuity of galvanic protection. Cold galvanizing coating shall be Z.R.C. Chemical Products Co., "Z.R.C. Cold Galvanizing" or Galvicon Corp., "Cold Galvanizing," or equal.

B. Aluminum

1. Aluminum shall have a high resistance to corrosion and shall be Alloys 6061-T6, 6062-T6, 6063-T5, 6063-T6, or 6105-T5 for wrought products such as rods, bars, standard structural shapes, extrusions, and forgings; and Alloy 214 for castings, or equal.

2. Aluminum fabrication shall be in accordance with ASCE the Aluminum Association "Specifications for Aluminum Structures," latest revision. Welding shall be done by the argon-shielded tungsten-arc method or the automatic or semi-automatic argon-shielded consumable-electrode method, or equal. Welding rods and electrodes shall be in strict accordance with above specifications.

3. Where anodic coating is required and type is not specified or shown on the Drawings, coating shall be Class II Clear (204-R1). Anodic coatings shall conform to the following requirements:

a. Clear Anodic Coatings

(1) Class II Clear (204-R1) (0.4 Mil Coating)

(a) The exposed surfaces of aluminum shall be cleaned of all fabricating oils and foreign matter, given a medium caustic etch pretreatment.

(2) Class I Clear (215-R1) (0.7 Mil Coating)

b. Color Anodic Coatings

(1) All aluminum parts (both extrusion and sheet stock) shall be of a controlled aluminum alloy and temper suitable for receiving an electrochemically

produced hard anodic oxide coating. All aluminum parts (both extrusion and sheet stock) shall receive a caustic etch pretreatment to remove all surface foreign matter followed by an electrochemically produced anodic oxide coating having a minimum coating thickness of 0.7 mil. Color shall be specified by the OWNER and range samples shall be submitted to establish the upper and lower limits of color variations.

2.02 HANDRAILS AND TOEBOARDS

A. General

1. All handrail components and systems shall meet the requirements of Kentucky OSHA Standards for General Industry, ADAAG, and the Kentucky Building Code.

2. Handrail shall be the product of a company normally engaged in the manufacture of pipe railing.

3. Toeboards shall be provided on handrails as required by OSHA and as shown on the Drawings. (Examples of required locations are walkways, platforms, runways, and wherever tools, machine parts or materials are likely to be stored or fall to the next lower level.)

4. Openings in the railing shall be guarded by a self-closing handrail gate.

5. Handrail and toeboard finish shall be Aluminum Association Ml0-C22-A41 (215-R1). The pipe shall be plastic wrapped. The plastic wrap is to be removed after erection.

6. Aluminum surfaces in contact with concrete, grout or dissimilar metals shall be protected with a coat of bituminous paint or zinc chromate paint, mylar isolators, or other approved material.

7. The ENGINEER may request a vertical post sample. The sample shall include top and intermediate rail connections and base flange connection.

8. Shop drawing submittals shall include verification that all components, including base flanges, side mounting assemblies and anchor bolts, will meet required strength capacities. Anchorages shall be identical to those shown on the Drawings.

9. Acceptable manufacturers:

   a. Thompson Fabricating Company - Tuf Rail
   b. Hollaender Manufacturing Company - Interna-Rail
   c. A manufacturer providing an acceptable equivalent product.

B. Standard Aluminum Handrail

1. Handrail posts spacing shall be a maximum of 6'-0". Posts and railings shall be 1-1/2 inch diameter Schedule 40 aluminum pipe alloy 6061-T6, 6063-T6, or 6105-TS. The manufacturer shall show that their posts are of adequate strength to meet the loading requirements. If the manufacturer's posts are not of adequate strength, the manufacturer may reduce the post spacing or add reinforcing dowels or may do both in order to meet loading requirements.

2. Handrails and stair rails shall be designed to withstand a 200 lb. concentrated load applied in any direction at any point on the top rail. Hand-rails and stair rails shall also be designed to withstand a load of 50 lb./ft. applied horizontally to the top rail. The 200 lb. load will not be applied simultaneously with the 50 lb./ft. load. In addition, the handrails shall be designed to withstand a load of 100 lb./ft. applied vertically downward to the top rail and simultaneously with the 50 lb./ft. horizontal load. The 100 lb./ft. vertical load does not apply to stair rails.

3. The manufacturer shall submit calculations to the ENGINEER for review. Testing of base castings or base extrusions by an independent laboratory or manufacturer's laboratory (if manufacturer's laboratory meets the requirements of the Aluminum Association) will be an acceptable substitute for calculations. Calculations will be required for approval of all other design aspects.

4. The handrail shall be made of pipes joined together with component fittings. All components must be mechanically fastened with stainless steel hardware. Components that are pop-riveted or glued at the joints will not be acceptable.

5. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.

6. Standard fasteners into concrete shall be 1/2" x 6-3/8" minimum embedment, AISI 304 stainless steel adhesive anchors. Anchor bolts shall be furnished by the handrail manufacturer.

7. Toeboard shall conform to OSHA standards. Toeboard shall be 4 inches high and shall be an extrusion that attaches to the posts with clamps which will allow for expansion and contraction between posts. Toeboard shall be set 1/4 inch above the walking surface.

C. Performance

1. Handrail system design, construction and installation shall meet or exceed all applicable federal and state regulations. Handrail anchors, posts, rail and fabric shall be capable of withstanding a load of at least 200 pounds applied in any direction at any point on the top rail, with a minimum of deflection.

2. The manufacturer shall submit to the ENGINEER certified test data verifying the strength of his handrail system.

2.03 STEEL FRAMED STAIRS

A. General: Construct stairs to conform to sizes and arrangements indicated; join pieces together by welding unless otherwise indicated. Provide complete stair assemblies including metal framing, hangers, columns, railings, newels, balusters, struts, clips, brackets, bearing plates and other components necessary for the support of stairs and platforms and as required to anchor and contain the stairs on the supporting structure.

B. Stair Framing: Fabricate stringers of structural steel channels, or plates, or a combination thereof, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to strings, newels and framing members to strings and headers; fabricate and join so that bolts, if used, do not appear on finish surfaces. Where masonry walls support steel stairs, provide temporary supporting struts designed for erection of steel stair components before installation of masonry.

C. Steel Floor Plate Treads and Platforms: Provide raised pattern steel floor plate complying with FS QQ-F-461, Class I. Provide pattern indicated or, if not indicated, as selected from manufacturer's standard patterns. Provide plate manufacturer's standard abrasive granules, rolled into surface of steel plate, complying with ASTM A-283/A-283M-93, Grade A.

1. Form treads of 1/4 inch thick steel floor plate with integral nosing and back edge stiffener. Weld steel supporting brackets to strings and treads to brackets.

2. Fabricate platforms of steel floor plate of thickness indicated. Provide nosing matching that on treads at all landings. Secure to platform framing members with welds.

D. Galvanize all steel stair components.

2.04 STEEL PIPE RAILINGS AND HANDRAILS

A. Fabricate steel pipe railings and handrails to design, dimensions, and details indicated. Provide railing and handrail members formed of pipe of sizes and wall thickness indicated, but not less than that required to support design loading.

B. Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections provide coped joints.

2. Form bends by use of prefabricated elbow fittings and radius bends or by bending pipe, at fabricator's option.

3. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-connection of pipe throughout entire bend without buckling, twisting or otherwise deforming exposed surfaces of pipe.

4. Provide wall returns at ends of wall-mounted handrails, except where otherwise indicated.

5. Close exposed ends of pipe by welding 3/16 inch thick steel plate in place or by use of prefabricated fittings.

6. Toe Boards: Where required, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use a 4" high x 1/4" plate secured to each railing post and intermediate brackets, as required, with stainless steel fasteners. Provide for thermal expansion and contraction, as necessary, through elongated fastener holes, or equal.

C. Brackets, Flanges, Fittings and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

1. For railing posts set in concrete, provide sleeves of galvanized steel pipe not less than 6 inches long and with an inside diameter not less than 1/2 inch greater than the outside diameter of pipe. Provide steel plate closure welded to bottom of sleeve and of width and length not less than 1 inch greater than outside diameter of sleeve.

2. Provide friction fit, removable covers designed to keep sleeves clean and hold top edge of sleeve 1/2 inch below finished-surface of concrete.

D. Galvanize steel railings, including pipe, fittings, brackets, fasteners and other ferrous metal components.

2.05 GRATINGS

A. Gratings shall be the dimensions required on the Drawings and as required to meet deflection specs. below and of aluminum Alloy 6063-T5, 6063-T6, or 6061 -T6, or equal. Gratings shall be designed for an allowable uniformly distributed load of 200 lbs./s.f. and a concentrated load of 400 lbs./ft. of width with less than 0.25 inch deflection.

B. Gratings shall be IKG Industries "IBar," Reliance "ILok," or equal.

2.06 NUTS AND BOLTS

A. Unless otherwise shown on the Drawings or required in other parts of these Specifications, all nuts and bolts shall be in accordance with ASTM A 307-93a, Grade A and shall be electrogalvanized according to ASTM B 633-85 (1994).

B. All nuts, bolts, washers and accessories in contact with water, in any moist atmosphere or damp area such as occurs above water, or embedded in concrete exposed to the weather, shall be Type 302 or 304 stainless steel. Stainless steel nuts, bolts, and washers shall be used to fasten aluminum to all materials including aluminum.

2.07 CONCRETE ANCHORS

A. Sizes and spacings or numbers of anchors shall be shown on the Drawings and materials shall comply with exposure requirements listed under Nuts and Bolts above. All anchors used for securing moving or vibrating equipment (pumps, motors, gears, sluice gates, conveyors, etc.), shall be of the cast-in-place type.

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B. The size and number of anchors shall be approved by the equipment manufacturer.

C. Unless specifically noted otherwise on the Drawings or Specifications, concrete anchors for other applications shall be chemical grout-type anchors equal to Hilti "HVA Adhesive Anchor," or Ramset "Chemset Chemical Anchors." Installation shall be in strict accordance with the manufacturer's recommendations which shall be available on the job site.

2.08 ALUMINUM LADDERS

A. Aluminum ladders shall be fabricated as detailed on the Drawings.

2.09 HATCHES

A. Metal hatches shall be fabricated as detailed on the Drawings.

2.10 GUARD POST

A. Concrete filled, steel posts shall be as shown on Drawings.

PART 3: EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall be responsible for all errors, omissions, and deviations of the shop drawings from the Drawings and Specifications. Any errors or omissions shall be brought to the attention of the ENGINEER whose interpretation and instructions shall be received before proceeding with the fabrication of that portion of the work.

B. Manufacturers' printed installation instructions shall be strictly followed and any conflicts with the shop drawings and/or Contract Drawings shall be directed to the ENGINEER for resolution before proceeding with installation.

C. All base plates, inserts and anchorages shown embedded in concrete shall be accurately located and secured before placing concrete as per a manufacturer supplied template. All structural members and components shall be accurately leveled, plumbed and secured at locations shown on the Drawings.

D. Painting

1. Cleaning and painting of all fabricated materials shall be in strict accordance with Division 9, of these Specifications.

E. Steel

1. All fabrication and erection shall be done in conformity with the "AISC Load and Resistance Factor Design Specification for Structural Steel Buildings," Second Edition dated December 1, 1993, latest revision.

2. Refer to Article 2.01 A. of this Specification Section for repair of galvanized surfaces.

F. Aluminum

1. The contact surfaces of aluminum with steel, dissimilar materials, concrete and/or masonry shall be protected from corrosion by a coating of coal tar, Kop-Coat Bitumastic Super Service Black, or equal.

2. Aluminum surfaces embedded in concrete shall be protected from corrosion by a tightly adherent coating of 2 applications of zinc chromate primer.

3.02 HANDRAILS

A. General

1. Shop drawings and handrail manufacturer’s printed instructions shall be closely followed during handrail installation. Posts shall be installed plumb and rails parallel.

2. Required anchorages shall be strictly followed.

B. Workmanship

1. All rail and post cuts shall be square and accurate for minimum joint gap, clean and straight, and free of burrs and nicks.

2. In exterior and high humidity interior fabricated fitting installations, provision shall be made to drain entrapped water from inside the railing system to prevent electrolysis and/or damage from freezing. Manufacturer's printed instructions shall be strictly followed.

3. Welds and damaged areas shall be finished and coated according to Article 2.02, this Section.

4. Where required, holes shall be drilled and countersunk the correct size for proper fit of all components.

5. In aluminum handrail systems where protection is applied for prevention of electrolysis from dissimilar materials, visibility of protective material shall be minimized.

6. Handrail system surfaces shall be protected from physical damage and discoloration during storage, assembly and installation. manufacturer's coverings to protect anodized finishes shall be left intact until damage from construction operations no longer exists.

C. Rigidity

1. Posts shall be continuous from mounting surface to top rail.

2. Top and bottom rails shall be unspliced lengths between posts except as covered under expansion joints.

3. Railing manufacturer's instructions shall be strictly followed regarding torqueing and tightening of fittings, and type and materials of fasteners.

4. Only stainless steel fasteners shall be used in aluminum installations, unless otherwise noted.

D. Expansion Joints

1. To prevent excessive stresses and misalignment in standard aluminum handrail systems, expansion joints and gaps shall be provided in top and bottom rails. Joints shall be located within 8

inches of posts and supports and the top and bottom rail joints shall be in vertical alignment. In fence-type handrail systems, top rail couplings shall be furnished with galvanized expansion compression spring as required in PART 2, this Section.

2. Where sleeve-type expansion joints are used, fasten only one side of sleeve to rail and allow other side of sleeve to slide on adjacent rail in standard aluminum handrail systems.

3. Gaps shall be provided according to the table below which is based on coefficients of expansion of 0.000013 inch/°F for aluminum and 0.0000065 inch/°F for steel; a temperature difference of 120 degrees Fahrenheit less the minimum listed temperature; and an expansion joints spacing of 24'-0" on centers for aluminum and 40'-0" on centers for steel. Where it is known that other temperature differentials and/or expansion joint spacings will be experienced, gap dimensions can be determined by: gap in inches = (coefficient of expansion) x (temperature difference from maximum to minimum) x (distance in inches between expansion joints).

EXPANSION JOINTS GAP TABLE

	Gap Dimension Required at Each Expansion Joint	
Temperature (°F) at Time of Installation	Aluminum Railing with Expansion Joints on 24-'0" Centers	Steel Railing with Expansion Joints on 40'-0" Centers
-20 to 0	1/2"	7/16"
0 to 20	7/16"	3/8"
20 to 35	3/8"	5/16"
35 to 50	5/16"	1/4"
50 to 70	1/4"	1/4"
70 to 90	3/16"	3/16"
90 to 120	1/8”	1/8”

3.03 GRATINGS

A. Grating frames shall be installed flush with the floor surface. Adequate blocking shall be provided to hold corners square during placing concrete and exposed aluminum surfaces shall be protected to prevent pitting from the concrete. Surfaces embedded in concrete shall be protected as covered under Article 3.01, this Section.

3.04 NUTS AND BOLTS

A. Bolts embedded in concrete shall be secured with templates at the time of pouring concrete. Bolts shall be suitably protected from damage throughout the construction period.

B. Damaged galvanized surfaces on nuts and bolts shall be repaired according to Article 2.01, this Section.

3.05 CONCRETE ANCHORS

A. Concrete anchors shall be installed strictly in accordance with manufacturer's printed instructions which shall be available on the job site.

B. Refer to Division 15 for supporting small pipe.

3.06 LADDERS

A. Install ladders as herein specified and as detailed on the Drawings.

3.07 HATCHES

A. Install hatches as herein specified and as detailed on the Drawings.

3.08 GUARD POSTS

A. Set in concrete as indicated. Fill cores solidly with air-entrained concrete having a 28-day minimum compressive strength at 3,000 psi.

END OF SECTION

SECTION 05526

ALUMINUM GRATING

PART 1: GENERAL

1.01 SCOPE OF WORK

Provide all labor, materials, equipment and services required to furnish and install metal bar grating where shown on the Plans.

1.02 RELATED WORK

Section 05500 – Miscellaneous Metal

1.03 REFERENCES

A. Design, fabrication and installation of grating shall be in accordance with the Metal Bar Grating Manual, Latest Edition, published by National Association of Architectural Metal Manufacturers.

B. ASTM B-221

1.04 SUBMITTALS

A. Submit shop drawings as described in Section 01300.

B. Indicate areas to receive grating details and dimensions, and material specifications.

C. Show anchorage details and locations.

PART 2: PRODUCTS

2.01 GRATING: Aluminum Rectangular Bar SG Series by Ohio Gratings, Inc., or approved equal.

2.02 BEARING BARS: Rectangular Bar on 1-3/16” centers maximum.

2.03 CROSS BARS: Locked at right angles to bearing bars at a maximum of 4” on center.

2.04 SURFACE: Plain

2.05 LOADING: Grating to carry a pedestrian loading equal to a uniform load of 100# per square foot over the required clear span with deflection not to exceed ¼".

2.06 FINISH: Mill finished.

2.07 FABRICATION AND TOLERANCES: In accordance with the NAAMM Metal Bar Grating Manual.

PART 3: EXECUTION

3.01 INSTALLATION

A. Grating shall be set with full and uniform end bearing to preclude rocking; do not use wedges or shims.

B. Anchor grating with saddle clips in accordance with manufacturer's recommendations or as detailed on the Drawings.

C. Provide openings for the passage of pipe, valve and equipment operators, conduit, stems and similar work; openings for circular obstructions shall be at least 2 inches larger in diameter than the obstruction. All openings shall be banded.

END OF SECTION

SECTION 05531

ALUMINUM ACCESS HATCHES

PART 1: GENERAL

1.01 SCOPE OF WORK

Provide all labor, materials, equipment and services required to furnish and install aluminum access hatches grating where shown on the Plans.

1.02 RELATED WORK

Section 05500 – Miscellaneous Metal

1.03 SUBMITTALS

A. Submit shop drawings as described in Section 01300.

B. Indicate areas where the hatches are to be used.

C. Show installation details.

D. Indicate coordination with equipment suppliers where openings for such equipment are required.

PART 2: PRODUCTS

2.01 CHANNEL FRAME ACCESS HATCHES

The hatches shall be as manufactured by the Bilco Company (or equal). Double leaf access hatches shall be Type JD and single leaf access hatches shall be Type J where channel frame installations are required. The size of the hatches shall be as shown on the Plans or of a size which is adequate for removal of the equipment below. Door leaf shall be ¼" aluminum diamond pattern plate to withstand a live load of 300 lb/ft^2 with a maximum deflection of 1/150th of the span. Channel frame shall be ¼" aluminum with an anchor flange around the perimeter and have a minimum cross-section area of 7-1/2 in^2 to allow for adequate water drainage. A Sch. 40 PVC pipe shall be attached to the channel frame to allow water to drain to the outside of the structure to a crushed stone french drain. Door shall be equipped with heavy forged brass hinges having 3/8" minimum diameter stainless steel pins and pivot so that the cover does not protrude into the channel frame. Compression spring operators

enclosed in telescopic tubes shall be provided for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature. The door shall automatically lock in the vertical position by means of a heavy steel hold-open arm with release handle. A Type 316 stainless steel snap lock with a gasketed cover plug and a removable turn handle shall be provided. A 1-1/2" drainage coupling shall be located in the front right corner of the channel frame. Hardware shall be zinc plated and chromate sealed and all fasteners shall be Type 316 stainless steel. Finish shall be a Mill-finish with bituminous coating applied to exterior of the frame.

2.02 TEE FRAME ACCESS HATCHES

The hatches shall be as manufactured by the Bilco Company (or equal). Double leaf access hatches shall be Type KD and single leaf access hatches shall be Type K. The size of the hatches shall be as shown on the Plans or of a size which is adequate for removal of the equipment below.

Frame shall be ¼" extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior. Door leaf shall be ¼" aluminum diamond plate to withstand a live load of 150 lb/ft^2 with a maximum allowable deflection of $1/150^{th}$ of the span. Cast steel cam-action hinges shall be bolted to underside and pivot on torsion bars for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature. Doors shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release the cover for closing. A Type 316 stainless steel snap lock and removable turn handle shall be provided. Aluminum shall be mill finish, with bituminous coating to be applied to exterior of frame by manufacturer. Hardware shall be zinc plated and chromate sealed.

PART 3: EXECUTION

3.01 INSTALLATION

Installation shall be in accordance with manufacturer's instructions.

END OF SECTION

SECTION 06112

FRAMING AND SHEATHING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wall, and roof framing; built-up structural beams and columns; diaphragm trusses; floor, wall, and roof sheathing; sill gaskets and flashings; preservative treatment of wood; fire retardant treatment of wood; miscellaneous framing and sheathing; telephone and electrical panel back boards; and concealed wood blocking for support of toilet and bath accessories wall cabinets and wood trim.

1.2 REFERENCES – use as appropriate to selected materials.

A. American National Standards Institute:

1. ANSI A135.4 - Basic Hardboard.

2. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. American Wood-Preservers' Association:

1. AWPA C1 - All Timber Products - Preservative Treatment by Pressure Process.

2. AWPA C20 - Structural Lumber - Fire-Retardant Treatment by Pressure Processes.

C. National Institute of Standards and Technology:

1. NIST PS 20 - American Softwood Lumber Standard.

D. Northeastern Lumber Manufacturers Association:

1. NELMA - Standard Grading Rules for Northeastern Lumber.

E. National Lumber Grades Authority:

1. NLGA - Standard Grading Rules for Canadian Lumber.

F. The Redwood Inspection Service:

1. RIS - Standard Specifications for Grades of California Redwood Lumber.

G. Southern Pine Inspection Bureau:

1. SPIB - Standard Grading Rules for Southern Pine Lumber.

H. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard Grading Rules for West Coast Lumber.

I. Western Wood Products Association:

1. WWPA G-5 - Western Lumber Grading Rules.

1.3 SUBMITTALS

A. Shop Drawings For Site Fabricated Truss Frame: Indicate dimensions, wood species and grades, component profiles, drilled holes, fasteners, connectors, erection details and sequence.

B. Product Data: Submit technical data on insulated sheathing, wood preservative materials, and application instructions.

C. Samples of Exposed To View Wood Members: Submit two samples, illustrating wood grain, stain, and finish.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the following:

1. Lumber Grading Agency: Certified by NIST PS 20.

2. Wood Structural Panel Grading Agency: Certified by EWA - The Engineered Wood Association.

B. In lieu of grade stamping exposed to view lumber and wood structural panels, submit manufacturer's certificate certifying Products meet or exceed specified requirements.

C. Design structural site or shop fabricated trusses under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Kentucky.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect trusses from warping or other distortion by stacking in vertical position, braced to resist movement.

PART 2 PRODUCTS

2.1 LUMBER MATERIALS

A. Lumber Grading Rules: AF&PA.

B. Beam Framing: Stress Group D, 19 percent maximum moisture content.

C. Joist Framing: Stress Group D, 19 percent maximum moisture content.

D. Rafter Framing: Stress Group D, 19 percent maximum moisture content.

E. Non-structural Light Framing: Stress Group D, 19 percent maximum moisture content.

F. Studding: Stress Group D, 19 percent maximum moisture content.

G. Miscellaneous Framing: Stress Group D 19 percent maximum moisture.

2.2 SHEATHING MATERIALS

A. Wood Structural Panel Roof Sheathing: Oriented Strand Board; Exposure Durability 1 exterior.

B. Telephone and Electrical Panel Boards: Plywood, fire retardant treated.

2.3 SHEATHING AND UNDERLAYMENT LOCATIONS

A. Sloped Roof Sheathing: 1/2 inch thick, 48 x 96 inch sized sheets, square.

B. Above Grade Wall Sheathing: 1/2 inch thick, 48 x 96 inch sized sheets, square edges.

2.4 ACCESSORIES

A. Fasteners and Anchors:

1. Fasteners: Hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.

2. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete.

B. Structural Framing Connectors: Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.

C. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, plate width closed cell polyethylene foam from continuous rolls.

D. Sill Flashing (Under Sill Gasket): 6 mil thick, galvanized steel.

E. Building Paper: No.15 asphalt felt.

F. Termite Shield: Galvanized sheet steel.

2.5 FACTORY WOOD TREATMENT

A. Wood Preservative (Pressure Treatment): AWPA Treatment C1 using water borne preservative with 0.25 percent retainage.

B. Wood Preservative (Surface Application): colored.

PART 3 EXECUTION

3.1 FRAMING

A. Set structural members level and plumb, in correct position.

B. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

C. Place horizontal members, crown side up.

D. Construct load bearing framing and curb members full length without splices.

E. Double members at openings. Space short studs over and under opening to stud spacing.

F. Place full width continuous sill flashings under framed walls on cementitious foundations. Lap flashing joint 4 inches.

G. Place sill gasket directly on sill flashing. Puncture gasket clean and fit tight to protruding foundation anchor bolts.

H. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.

I. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant and parapet construction.

3.2 SHEATHING

A. Secure roof sheathing with longer edge (strength axis) perpendicular to framing members and with ends staggered and sheet ends over bearing.

B. Use sheathing clips between sheets between roof framing members.

C. Secure wall sheathing with long dimension parallel to wall studs, with ends over firm bearing.

D. Place wood structural panel sheeting at building corners for horizontal distance of 48 inches.

E. Place building paper horizontally over wall sheathing; weather lap edges and ends.

F. Install telephone and electrical panel back boards with sheathing material where required. Size back boards 12 inches beyond size of electrical panel.

3.3 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment.

B. Brush apply one coats of preservative treatment on wood in contact with cementitious materials and roofing and related metal flashings. Treat site-sawn cuts.

C. Allow preservative to dry prior to erecting members.

3.4 TOLERANCES

A. Framing Members: 1/4 inch from indicated position, maximum.

B. Surface Flatness of Floor: 1/4 inch in 10 feet maximum, and 1/2 inch in 30 feet maximum.

END OF SECTION

SECTION 06170

SHOP-FABRICATED WOOD TRUSSES

PART 1: GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fabrication and erection of wood trusses, truss girders, and jacks and other falsework, as shown on drawings including schedules, notes, and details showing size and location of members, typical connections, and types of trusses required.

1. Prefabricated wood trusses include planar structural units consisting of metal plate connected members which are fabricated from dimension lumber and which have been cut and assembled prior to delivery to the Project site.

B. This Section includes open web wood trusses, end anchorages, bracing and connections.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer wood trusses, anchorages, and connections to support all superimposed dead, live and wind loads as indicated on the drawings. Design shall comply with applicable requirements of the "National Design Specification for Wood Construction" and its "Supplement" published by the American Forest & Paper Association, American Wood Council, 2005 and "Specifications for Metal Plate Connected Wood Trusses" published by the Truss Plate Institute. See drawings for loading criteria.

B. Engineering Responsibility: Engage a manufacturer who utilizes a qualified professional engineer to prepare calculations and truss layout diagrams for wood trusses.

C. Specify the location of all required permanent bracing for individual compression web members and truss chords (when in compression). The number of braces, location, and required minimum brace capacity of shall be specified on the truss design drawings.

1. The Contractor shall coordinate quantity of bracing with the truss

manufacturer prior to bid. The exact quantity of bracing runs can only be determined by the truss manufacturer once the trusses are designed, detailed, and approved.

D. Design trusses to withstand design loads without deflections greater than the following:

1. Roof trusses: Vertical deflection of 1/360 of span due to 100% live load and 1/240 of span due to 100% total load.
2. Scissor roof trusses: Horizontal deflection at supports of 3/4 inch due to 100% live load and 1 1/4 inches due to 100% total load.

E. Trusses may not be designed to transfer flexural moment across connection plates. Locate splices in chords subjected to flexural moment at joints.

1.4 SUBMITTALS

A. General: Furnish submittals in quantity, format, and other Conditions of the Contract and as specified elsewhere in the Project Manual.

B. Product Data for each type of product specified. Include manufacturer's specifications, installation instructions, laboratory test reports, and other data to show compliance with the specifications (including specified standards).

C. Shop Drawings detailing fabrication and erection of wood trusses.

1. Provide erection plans and details to show location and spacing of each truss and all truss support members (beams, walls, etc.); splice details; and bearing, anchorage, and truss/rafter to truss girder connection details. Include product data sheets showing configuration and capacity of all premanufactured connection material.
2. Shop drawings which show the Architect's or Engineer's title block, logo and/or seal will be rejected and returned unchecked.
3. Computer generated electronic structural construction document files will be made available to the Contractor. The Contractor will be required to sign the Engineer's standard release of liability form and pay a handling fee of $50.00 per drawing prior to receiving the drawing files.
4. Shop drawing resubmittals are reviewed for conformance with review marks only. Any changes or questions originating on a resubmittal shall be clearly clouded.

D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Structural Calculations.

1. Furnish five (5) copies of structural calculations of all wood trusses at

time of Shop Drawing submittal.

2. Show loading, section modulus, assumed allowable stress, stress diagrams and calculations, maximum axial compressive and tensile forces in truss members, calculated deflection ratio for live and total load, and similar information needed for analysis and to ensure that trusses comply with requirements.
3. Provide truss layout diagrams to show pitch, span, camber, and configuration for each type of truss required; location of any required continuous bracing; species, sizes, and stress grades of lumber to be used; manufacturer, type, size, gauge, material, finish, design values and orientation, and location of metal connector plates.
4. Calculations shall be signed and sealed by a qualified professional engineer licensed to practice in the State of Kentucky.
5. Architects and Engineers review of the calculations is for general conformance with the contract documents. Actual calculations are the responsibility of the wood truss design engineer and shall not be reviewed for content or accuracy by the Architect or Engineer.

F. Building Permit Issuance: Contractor shall submit wood truss design drawings and calculations which meet the requirements of IBC section 2304 to the Building Official. Submittal must be signed and sealed by a professional engineer registered in the state where the project is situated. Submittal typically must be received prior to processing of the building permit by the plans reviewer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed wood truss work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Engage a firm experienced in fabricating wood trusses similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate wood trusses without delaying the Work.

1. Fabricator must participate in the TPI “Quality Control Inspection Program” as a licensee authorized to apply TPI marks to trusses and which involves inspection by an independent inspection and testing agency acceptable to the Architect and authorities having jurisdiction.

C. Connector Plate Manufacturer’s Qualifications

1. Connector plate manufacturer shall be a member of the Truss Plate Institute and shall comply with TPI quality control procedures for manufacture of connector plates published in TPI “Quality Standard for Metal Plate Connected Wood Trusses.”

D. Comply with applicable provisions of the following specifications and documents:

1. Truss Plate Institute (TPI) publications

a. Design Specification for Metal Plate Connected Wood Trusses.
b. Commentary and Recommendations for Handling and Erection Wood Trusses.
c. Commentary and Recommendations for Bracing Wood Trusses.
d. Quality Standard for Metal Plate Connected Wood Trusses.

E. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the State of Kentucky and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with wood truss framing that are similar to that indicated for this Project in material, design, and extent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood trusses to Project site in such quantities and at such times to ensure continuity of installation.

B. Handle and store trusses with care, and in accordance with manufacturer's instructions and TPI recommendations to avoid damage from bending, overturning, or other cause for which truss is not designed to resist or endure.

C. Trusses shall be unloaded on level ground to avoid lateral strain. Trusses shall be protected from damage that might result from on-site activities and environmental conditions. Prevent toppling when banding is removed.

D. Report truss damage to Engineer prior to installation.

E. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying work of other trades.

PART 2: PRODUCTS

2.1 MANUFACTURER

A. Metal Connector Plates.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

a. Alpine Engineered Products, Inc.
b. Georgia-Pacific Corp.

c. Inter-Lock Steel Company, Inc.
d. MiTek Industries, Inc.
e. Robbins Engineering, Inc.
f. Tee-Lok Corporation.
g. Truss Connectors of America.
h. Trusswall Systems Corporation.

B. Metal Framing Connectors.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

a. Silver Metal Products, Inc.
b. Simpson Strong-Tie Company, Inc.
c. Southeastern Metal Manufacturing Co., Inc.
d. United Steel Products Co.

2.2 DIMENSION LUMBER

A. Lumber Standards

1. Manufacture lumber to comply with PS 20 “American Softwood Lumber Standard” and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee’s (ALSC) Board of Review.

B. Inspection Agencies.

1. Inspection agencies and the abbreviations used to reference them to lumber grades and species include the following:

a. NLGA - National Lumber Grades Authority (Canadian).
b. SPIB - Southern Pine Inspection Bureau.
c. WCLIB - West Coast Lumber Inspection Bureau.
d. WWPA - Western Wood Products Association.

C. Grade Stamps.

1. Factory mark each piece of lumber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

D. Nominal sizes shall be indicated, except as shown on detail dimensions.

E. Provide lumber manufactured to actual sizes required by PS 20 to comply with requirements indicated below:

1. Dressed, S4S, unless otherwise indicated.
2. Moisture Content: Seasoned, with 7 percent minimum and 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.

F. Species and Grade.

1. Provide dimension lumber of any species, graded visually or mechanically stress- rated, and capable of supporting required loads without exceeding allowable design values defined in Table 8.1.a of the "National Design Specification" and its "Supplement" for single members.

2.3 METAL CONNECTOR PLATES

A. Fabricate connector plates from metal complying with the following requirements:

a. Hot-Dip Galvanized Steel Sheet: Structural (physical) quality steel sheet complying with ASTM A 446, Grade A; zinc coated by hot-dip process to comply with ASTM A 653, G60 coating designation; Grade 33 of minimum coated metal thickness indicated, but not less than 0.036 inch.

b. Electrolytic Zinc-Coated Steel Sheet: Structural (physical) quality steel sheet complying with ASTM A 591, Coating Class C, and for structural properties, with ASTM A 446, Grade A; zinc-coated by electro-deposition; 33,000 psi minimum yield strength with minimum coated metal thickness indicated, but not less than 0.047 inch.

2.4 METAL FRAMING ANCHORS

A. Provide metal framing anchors fabricated from hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation, and of structural capacity, and type indicated that comply with requirements specified, including the following:

1. Current Evaluation/Research Reports: Provide products for which model code evaluation/research reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with the building code in effect for this Project.
2. Allowable Design Loads: Provide products for which manufacturer publishes allowable design loads that are determined from empirical data or by rational engineering analysis and that are demonstrated by comprehensive testing performed by a qualified independent testing laboratory.

2.5 FASTENERS

A. Provide all fasteners required to properly and completely erect, anchor, and connect the truss work for this Project, including, but not limited to, nails, spikes, screws, lag screws, bolts, nuts, washers, and similar items, whether specifically mentioned herein or not.

B. Rough hardware and accessories used in pressure treated wood or exposed to weather, in ground contact, or in areas of high relative humidity, shall be hot-dipped galvanized per ASTM A 153.

C. Fasteners shall be proper type, size, material, and finish for each application and conform with the following:

1. Nails, Wires, Brads, and Staples: FS FF-N-105.
2. Wood Screws: FS FF-S-111.

2.6 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close fitting joints with wood-to-wood bearing in assembled units.

B. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required for types of joint designs indicated.

C. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with close fitting joints. Position members to produce design camber indicated.

D. Connect truss members by means of metal connector plates accurately located and securely fastened to each side of wood members by air or hydraulic press.

PART 3: EXECUTION

3.1 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep wood trusses secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports as required when permanent wood trusses, connections, and bracing are in place.

3.2 ERECTION

A. Splice trusses delivered to site in more than one (1) piece before installing.

B. Erect and brace trusses to comply with recommendations of manufacturer and the Truss Plate Institute.

C. Erect trusses with plane of truss webs vertical (plumb) and parallel to each

other, located accurately at design spacing indicated.

D. Hoist units in place by means of lifting equipment suited to sizes and types of trusses required, applied at designated lift points as recommended by fabricator, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

E. Do not place concentrated loads (including roof sheathing bundles) atop trusses until all specified bracing has been installed and roof sheathing is permanently nailed in place.

F. Anchor trusses securely at all bearing points to comply with methods and details indicated.

G. Install permanent bracing and related components to enable trusses to maintain design spacing, withstand live and dead loads including lateral loads, and to comply with other indicated requirements.

H. Do not cut or remove truss members.

3.3 QUALITY CONTROL

A. General: The Owner will engage an independent testing and inspecting agency to perform inspections and tests and to prepare test reports. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements. Failure to detect any defective materials shall not prevent later rejection when such defect is discovered, or obligate the Architect or Owner for final acceptance.

1. Provide access for testing agency to places where prefabricated wood truss work is being installed so that required inspection and testing can be accomplished.
2. The General Contractor shall provide the testing agency a complete set of approved shop drawings.
3. Reports will be delivered to the Architect, Engineer, Truss Erector, and the General Contractor within one week of inspection.
4. Deviations from requirements of the contract documents will be reported in writing to the General Contractor within 24 hours.

B. Correct deficiencies in or remove and replace wood trusses that inspections and test reports indicate do not comply with specified requirements.

END OF SECTION

SECTION 07100

WATERPROOFING AND DAMPPROOFING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all materials, labor, equipment, and incidentals required to provide a vapor barrier for the concrete slab and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Sealants and caulking are included in Section 07920.

1.03 SUBMITTALS

A. Submit to the Engineer for approval as provided in Section 01300, detailed information on materials proposed and installation methods.

B. Submit two sets of representative samples of any or all other proposed materials required for the work of this Section as requested by the Engineer.

PART 2: PRODUCTS

2.01 MATERIALS

A. Vapor barrier shall be 10 mil thick polyethylene sheet with a vapor transmission rating of 0.20 perms or less.

PART 3: EXECUTION

3.01 INSTALLATION

A. Vapor Barrier

1. Vapor barrier shall be installed under interior slab on-grade where shown. Laps between adjacent sheets shall be 10-in. minimum. Vapor barrier will be carefully inspected prior to concrete placement by the Engineer. Additional polyethylene sheet required for repair and replacement of damaged vapor barrier shall be furnished and installed by the Contractor as directed by the Engineer at no additional cost to the Owner.

END OF SECTION

SECTION 07200

INSULATION

PART 1: GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including the General Conditions – Section 00700.

1.02 DESCRIPTION OF WORK

A. Extent of insulation work is shown on drawings and indicated by provisions of this section.

B. Applications of insulation specified in this section include the following:

1. Insulation under slabs-on-grade.

2. Foundation wall insulation (supporting backfill).

3. Blanket-type building insulation.

1.03 QUALITY ASSURANCE

A. Fire Performance Characteristics: Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.

1. Surface Burning Characteristics: ASTM E 84.

2. Fire Resistance Ratings: ASTM E 119.

3. Combustion Characteristics: ASTM E 136.

B. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.04 DEFINITIONS

A. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product literature and installation instructions for each type of insulation and vapor retarder material required.

B. Certified Test Reports: With product data, submit copies of certified test reports showing compliance with specified performance values, including r-values (aged values for plastic insulations), densities, compression strengths, fire performance characteristics, perm ratings, water absorption ratings and similar properties.

C. Research reports or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence compliance of plastic foam insulation with building code in effect for Project.

D. Samples for verification purposes in full-size units of each type of exposed insulation indicated for each color specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General Protection: Protect insulations from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

B. Protection for Plastic Insulation:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver plastic insulating materials to project site ahead of installation time. Complete installation and concealment of plastic materials as rapidly as possible in each area of work.

C. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Manufacturers of Extruded Polystyrene Board Insulation:
   Dow Chemical U.S.A.
   UC Industries.

2. Polyisocyanurate Board Insulation:
   Celotex: Building Products Div., The Celotex Corporation.

3. Manufacturers of Glass Fiber Insulation:

   CertainTeed Corp.
   Manville Corp.
   Owens-Corning Fiberglass Corp.

2.02 INSULATING MATERIALS

A. General: Provide insulating materials which comply with requirements indicated for materials, compliance with referenced standards, and other characteristics.

1. Performed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths and lengths.

B. Extruded Polystyrene Board Insulation: Rigid, cellular thermal insulation with closed-cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C 578 for Type indicated; with 5-year aged r-values of 6.8 and 10 at 40 and 75 degrees Fahrenheit (4.4 and 23.9 degrees Celsius), respectively; and as follows:

1. Type IV, 1.6 lb./cu. ft. min. density, unless otherwise indicated.

2. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 75 and 450, respectively.

C. Polyisocyanurate Board Insulation: Rigid, cellular thermal insulation with glass-fiber-reinforced polyisocyanurate closed-cell foam core and aluminum foil facing laminated to both sides; complying with FS HH-l-1 972/1, Class 2; aged r-values of 8 and 7.2 at 40 and 75 deg F (4.4 and 23.9 deg C), respectively; and as follows:

1. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 20 and 200, respectively.

D. Faced Mineral Fiber Blanket/Batt Insulation: Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type Ill, Class A (blankets with reflective vapor-retarder membrane facing with flame spread of 25 or less); Kraft vapor-retarder membrane on one face, respectively with R-values as indicated on the drawings; and as follows:

1. Mineral Fiber Type: Fibers manufactured from glass.

2. Combustion Characteristics: Unfaced blanket/batt passes ASTM E 136 test.

3. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.

E. Flanged Units: Provide blankets/batts fabricated with facing incorporating 4-inch wide flanges along their edges for attachment to framing members.

2.03 VAPOR RETARDERS

A. Polyethylene Vapor Retarder: ASTM D 4397, 6.0 mils thick, with a maximum permeance rating of 0.13 perms.

2.04 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation or mechanical anchors securely to substrates indicated without damaging or corroding either insulation, anchors, or substrates.

B. Mechanical Anchors: Type and size indicated or, if not indicated, as recommended by insulation manufacturer for type of application and condition of substrate.

C. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints between units and filling voids in work.

PART 3: EXECUTION

3.01 INSPECTION AND PREPARATION

A. Require Installer to examine substrates and conditions under which insulation work is to be performed. A satisfactory substrate is one that complies with requirements of the section in which substrate and related work is specified. Obtain Installer's written report listing conditions detrimental to performance of work in this section. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

B. Clean substrates of substances harmful to insulations or vapor retarders, including removal of projections which might puncture vapor retarders.

C. Close off openings in cavities receiving poured-in-place insulation to prevent the escape of insulation. Provide bronze or stainless steel screen (inside) where openings must be maintained for drainage or ventilation.

3.02 INSTALLATION, GENERAL

A. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.

B. Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.

C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of insulation.

B. Protect below-grade insulation on vertical surfaces (from damage during backfilling) by application of protection board. Set in adhesive in accordance with recommendations of manufacturer of insulation.

C. Protect top surface of horizontal insulation (from damage during concrete work) by application of protection board.

3.04 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.

C. Set vapor retarder faced units with vapor retarder to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure air-tight installation.

D. Set reflective foil-faced units accurately with not less than 0.75-inch air space in front of foil as indicated.

E. Stuff loose glass fiber insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40% of normal maximum volume (to a density of approximately 2.5 lbs. per cu. ft.).

3.05 INSTALLATION OF VAPOR RETARDERS

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16 inches oc.

C. Seal overlapping joints in vapor retarders with adhesives or tape per vapor retarder manufacturer's printed directions. Seal butt joints and fastener penetrations with tape of type recommended by vapor retarder manufacturer. Locate all joints over framing member or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with tape of type recommended by vapor retarder manufacturer to create an airtight seal between penetrating objects and vapor retarder.

F. Seal overlapping joints in vapor retarders with adhesives per vapor retarder manufacturer's printed directions. Seal butt joints and fastener penetrations with tape of type recommended by vapor retarder manufacturer. Locate all joints over framing members or other solid substrates. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

G. Seal joints caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with cloth or aluminized tape of type recommended by vapor retarder manufacturer to create an air-tight seal between penetrating objects and vapor retarder.

H. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with tape or another layer of vapor retarder.

3.06 PROTECTION

A. General: Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07530

EPDM ADHERED ROOFING SYSTEM

PART 1 GENERAL

1.01 GENERAL NOTES

A. Preceding job start up, contractor shall decide to his satisfaction that all specifications contained herein are workable.
B. Contractor will perform all work by competent, trained, and properly equipped personnel in strict accordance with good roofing practices and applicable industry standards.
C. Contractor will observe all published safety prevention policies and practices relating to application of roofing system and related work. All federal, state, and local codes shall be followed.

1.02 WORK INCLUDED

A. Work under this section covers the installation of a new FULLY ADHERED EPDM ROOFING SYSTEM. In addition, contractor shall include all related items of work as noted herein or indicated on the drawings or otherwise required to complete the specified elements of work and provide the necessary warranties for this work.

1.03 SECTION INCLUDES

A. Substrate preparation.
B. Wood nailer installation.
C. Membrane installation.
D. Membrane flashing installation.

1.04 RELATED SECTIONS

A. Section 02055 - Demolition
B. Section 07200 - Insulation
C. Section 07600 - Sheet Metal
D. Section 07900 - Sealants and Caulking
E. Section 15400 - Building Drainage and Plumbing System

1.05 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.
B. American Society for Testing and Materials (ASTM): 1916 Race St., Philadelphia, PA 19103

1.06 SYSTEM DESCRIPTION

A. .060 LSFR elastomeric sheet roofing that is adhered to acceptable substrate with system manufacture's bonding adhesive.

1.07 SUBMITTALS

A. Product Data:
   1. Submit copies of technical information sheets for primary products used including roof membrane, splice tape, fasteners, and batten strip.
B. Samples:
   1. Submit samples of roof membrane, fasteners, and walkway pads
C. Application Information:
   1. Submit copy of application specification.
   2. Submit copy of job related details including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, drains, and any other relevant details
E. Warranty: Submit warranty sample.

1.08 QUALITY ASSURANCE

A. Manufacturer:
   1. Company specializing in manufacturing the roofing membrane specified in this Section with ten years of manufacturing experience.
   2. System supplier must have ISO 9002 certification.
   3. Manufacturer must be able to provide the project with the membrane and Isocyanurate insulation that is produced in their facilities.
B. Applicator:
   1. Shall have at least five years experience in installing specified system.

1.09 REGULATORY REQUIREMENTS

A. Conform to applicable local building code requirements.
B. Underwriters Laboratories, Inc. (UL): Class A Fire Hazard Classification.

1.10 QUALITY INSPECTION/OBSERVATION

A. Inspection by Manufacturer: Provide a final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer.
   1. Technical representative shall not perform any sales functions.
   2. Contractor shall complete any necessary repairs required for issuance of warranty.

1.11 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original containers dry, undamaged, seals and labels intact and legible.

B. Store all materials clear of ground and moisture with weather protective covering.
C. Keep all combustible materials away from ALL ignition sources.

1.13 ENVIRONMENTAL REQUIREMENTS

A. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice.
B. Do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application. Consult manufacturer on cold weather application.

1.14 WARRANTY

A. Type/Term:
   1. Manufacturer shall provide 20-year warranty. Warranty shall include membrane, roof insulation and membrane accessories.
B. Coverage
   1. Warranty:
      a. Limit of liability: No Dollar Limitation
      b. Scope of coverage
         Repair any leak in the EPDM Roofing System caused by the ordinary wear and tear of the elements, manufacturing defect in materials, and the workmanship used to install these materials.

PART 2 PRODUCTS

2.01 NAILERS FOR FLANGES AND ROOF ACCESSORIES

A. Description: Structural Grade No. 2 or better Southern Pine, Douglas Fir or Exterior Grade plywood. All wood shall be pressure treated for rot resistance.
   1. Nailer width: Minimum 3-1/2 in. (nominal) wide or as wide as the nailing flange of each roof accessory.
   2. Nailer thickness: Thickness of roof insulation.
B. Reference Standards:
   1. Southern Pines: PS 20; SPIB Grading Rules.
   2. Western Woods: PS 20; WWPA Grading Rules
   3. Plywood: PS 1; APA Grade Stamps.
   4. Pressure preservative treatment: AWPB LP2.

2.02 MANUFACTURERS - MEMBRANE MATERIALS

A. Firestone Adhered single-ply membrane system: .060 LSFR elastomeric sheet roofing that is adhered to acceptable substrate with manufacturers bonding adhesive.
B. Approved Equal

2.03 ELASTOMERIC SHEET ROOFING AND FLASHING MEMBRANE

A. Description: Non-reinforced, cured, synthetic single-ply membrane composed of Ethylene Propylene Diene Termolymer (EPDM) conforming to the following physical properties:
   1. Membrane Type: .060 LSFR

Property:	Specification:
Specific Gravity	1.15 +/- 0.05
Tensile Strength, Minimum, psi (Mpa)	1425 (9.8)
Elongation, Minimum, %	475
Tear Resistance, lbf / in (N / M)	210 (933)
Ozone Resistance, 166 hours @ 100 pphm @ 104ºF with 50% extension	No Cracks
Heat Aging, 28 days @ 240ºF	
Tensile Strength, Minimum psi (Mpa)	1415 (9.8)
Elongation, Minimum %	310
Brittleness Point, max., ºF, ºC	-49 (-45)
Water Absorption, change in weight after immersion in water for 166 hours @ 158ºF, %	< 2.0
Tolerance On Nominal Thickness, %	+/- 10
Water Vapor Permeability, Perm-Mils	2.0

B. Reference Standards:
   1. ASTM D4637-96: Standard Specification for EPDM Sheet used in single-ply roof membrane
   2. ASTM D297: Methods for Rubber Products, Chemical Analysis.
   3. ASTM D412, Die C: Test Methods for Rubber Properties in Tension.
   4. ASTM D471: Test Methods for Rubber Property, Effect of Liquids.
   5. ASTM D573: Test Method for Rubber, Deterioration in an Air Oven.
   6. ASTM D624, Die C: Test Method for rubber property-Tear Resistance
   7. ASTM D746: Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   8. ASTM D751: (Grab Method) Method of Testing Coated Fabrics.
   9. ASTM D816: (Modified) Methods of Testing Rubber Cements.
   10. ASTM D1149: Test Method for Rubber Deterioration, Surface Ozone Cracking in a Chamber.
   11. ASTM D2240: Test Method for Rubber Property - Durometer Hardness.
   12. ASTM E96: Test Methods for Water Vapor Transmission of Materials.

C. Product/Producer:
   1. RubberGard® EPDM membrane by Firestone, or approved equal.

2.04 INSULATION PRODUCTS

POLYISOCYANURATE ROOF INSULATION

A. BASE LAYER
   1. Description: Roof insulation consisting of closed cell polyisocyanurate foam core and a perforated black glass reinforced mat laminated to the face.
      a. Thickness: 2.0”
      b. Nominal Size 48 in x 96 in
   2. Reference Standards:
      a. FS HH-I-1972/Gen.
      b. FS HH-I-1973/3.
      c. ASTM C 209 - Water Absorption.
      d. ASTM E 96-Water Vapor Transmission of Materials.
      e. ASTM D 1621 - Compressive Strength.
      f. ASTM D 1622 - Density
      g. ASTM D 2126 - Dimensional Stability.
      h. ASTM E 84 - Flame Spread.
   3. Product/Producer: ISO 95+ Polyisocyanurate Insulation by Firestone, or approved equal.

B. INTERNMIDATE LAYER

   None

C. TOP LAYER
   1. Description: Roof insulation consisting of closed cell polyisocyanurate foam core and a perforated black glass reinforced mat laminated to the face.
      a. Thickness: 2.0”
      b. Nominal Size 48 in x 96 in
   2. Reference Standards:
      a. FS HH-I-1972/Gen.
      b. FS HH-I-1973/3.
      c. ASTM C 209 - Water Absorption.
      d. ASTM E 96-Water Vapor Transmission of Materials.
      e. ASTM D 1621 - Compressive Strength.
      f. ASTM D 1622 - Density
      g. ASTM D 2126 - Dimensional Stability.
      h. ASTM E 84 - Flame Spread.
   3. Product/Producer: ISO 95+ Polyisocyanurate Insulation by Firestone, or approved equal.

TOP LAYER INSULATION FASTENERS

Description: Heavy duty threaded fastener with 3-coat waterborne fluorocarbon polymer coating and drill point tip capable of penetrating 20-gauge steel. Fastener shall meet minimum thread size of .260” and 13 threads per inch. Length shall be sufficient to

penetrate deck a minimum of ¾" for steel and 1" for wood and concrete. Structural concrete decks must be pre-drilled with a 7/32" carbide drill bit to a depth ½" deeper than the fastener engagement.

1. Reference Standard: SAE 1022, Heat Treated
2. Product/Producer:
   a. Heavy Duty (HD) fasteners by Firestone, or approved equal.

2.05 ELASTOMERIC SHEET ROOFING SYSTEM COMPONENTS

A. Roof Flashing (Gravel Stops):
   1. Description: Semi-cured 45 mil EPDM membrane laminated to 35 mil EPDM tape adhesive
   2. Product/Producer:
      a. QuickSeam™ Flashing by Firestone, or approved equal.

B. Elastomeric Uncured Flashing:
   1. Description: Non-reinforced, self curing, synthetic, single-ply flashing composed of Ethylene Propylene Diene Terpolymer (EPDM) conforming to the following physical properties as indicated by ASTM D4811-90 standard specification for Non-vulcanized rubber sheet used as roof flashing.
      a. Nominal Thickness: .060 inch

Property:	Specification:
Thickness	0.055
Green Strength Modulus 100% @ 75°F(psi)	25-250
Elongation, (Ultimate), %	400
modulus 100% @ 122°F(psi)	12
Elongation (Ultimate) %	200
Shelf Stability: Modulus 100% at 75°F(psi)	250
Elongation, min, %	400
Vulcanizability: Tensile strength, min, (psi)	406
Elongation, min, %	400
Tensile Set: min, %	80
Dimensional Stability, max, %	+/- 10
Weatherability , no cracks or crazing	pass
Water Vapor Permeability, Perm-Mils	2.0

      b. Reference Standards:
         1. ASTM D412:Test Methods for Rubber Properties in Tension
         2. ASTM D471:Test Methods for Rubber Property-Effect of liquids
         3. ASTM D573:Test Methods for Rubber-Deterioration in Air oven
         4. ASTM D624:Test Methods for Rubber Property-Tear Resistance
         5. ASTM D1149:Test Method for Rubber Deterioration-Surface Ozone Cracking in a chamber
         6. ASTM D1204:Test Method for Linear Dimensional Changes on a Non-rigid Thermoplastic Sheeting or Film at Elevated Temperatures

7. ASTM D2137:Test Methods for Rubber Property-Brittleness Point of Flexible Polymers and Coated Fabrics

2. Product/Producer:
   a. EPDM FormFlash™ flashing membrane by Firestone, or approved equal.

C. Lap Splice Tape:
1. Description: 35 mil EPDM-based, formulated for compatibility with EPDM membrane and high-solids primer.
2. Product/Producer:
   a. QuickSeam™ Splice Tape by Firestone, or approved equal.

D. Adhesive Primer:
1. Description: High-solids, butyl based primer formulated for compatibility with EPDM membrane & tape adhesive.
2. Product/Producer:
   a. QuickPrime™ by Firestone, or approved equal.

E. Batten Covers:
1. Description: Cured 60 mil EPDM membrane laminated to 35 mil EPDM tape adhesive.
2. Product/Producer:
   a. QuickSeam™ Batten Cover by Firestone, or approved equal.

F. Splice Adhesive:
1. Description: Butyl-based, formulated for compatibility with EPDM membrane.
2. Product/Producer:
   a. RubberGard® Splice Adhesive by Firestone, or approved equal.

G. Bonding Adhesive:
1. Description: Neoprene-based, formulated for compatibility with EPDM membrane & a wide variety of substrate materials, including masonry, wood, and insulation facings.
2. Product/Producer:
   a. RubberGard® Bonding Adhesive by Firestone, or approved equal.

H. Pourable Sealer:
1. Description: 2-Part urethane, 2-color for reliable mixing.

I. Seam Plates, Batten Strips and Insulation Plates:
1. Description: Steel with a Galvalume® coating.
2. Reference Standard: Corrosion-resistant to meet FM-4470 criteria.

J. Termination Bar:
1. Description: 1.3" X 0.10" thick aluminum bar with integral caulk ledge.
2. Product/Producer:
   a. Termination Bar by Firestone, or approved equal.

2.06 METAL FLASHING

A. Edge Metal and/or Coping:
1. Description: Provide shop fabricated 24 gauge Steel with finish in manufacturers standard colors matching the existing as close as possible as selected by owner.
2. Product/Producer: Firestone, or approved equal.

PART 3 INSTALLATION

3.01 EXAMINATION

A. Examine roof deck to determine that it is sufficiently rigid to support roofers and their mechanical equipment and that deflection will no strain or rupture roof components or deform deck.
B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.
C. Examine roof substrate to verify that it is properly sloped to drains.
D. Start work with sealants and adhesives at 60° - 80° F.
E. Fumes from adhesive solvents may be drawn into the building during installation through rooftop intakes. Appropriate measures must be taken to assure that fumes from adhesive solvents are not drawn into the building through air intakes.
F. For reroofing applications only: remove existing roof system components as specified.
G. The surface must be clean, dry, smooth, free of sharp edges, fins, loose or foreign materials, oil, grease and other materials that may damage the membrane, all roughened surfaces, which could cause damage, shall be properly repaired before proceeding.
H. All surface voids of the immediate substrate greater than 1/4" wide must be properly filled with an acceptable insulation or suitable fill material.

3.02 PROTECTION OF OTHER WORK

A. Protect metal, glass, plastic, and painted surfaces from adhesives and sealants.
B. Protect neighboring work, property, cars, and persons from spills and overspray from adhesives, sealants and coatings and from damage related to roofing work.
C. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trade.

3.03 MATERIAL STORAGE AND HANDLING

A. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.
B. Consult container labels and material Safety Data Sheets (MSDS) for specific safety instructions.
C. Deliver materials to job site in their original containers as labeled by the manufacturer.

3.04 WOOD NAILER LOCATION AND INSTALLATION

A. Total wood nailer height shall match the total thickness of insulation being used and shall be installed with a 1/8" gap between each length and at each change of direction.
B. Wood nailers shall be firmly fastened to the deck. Mechanically fasten wood nailers to resist a force of 200 lbs. Per linear foot.

3.05 VAPOR RETARDER

None

3.06 ROOF INSULATION APPLICATION: GENERAL

A. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.
B. Seal deck joints, where needed, to prevent bitumen drippage.
C. Lay roof insulation in courses parallel to roof edges.
D. Neatly fit insulation to all penetrations, projections, and nailers. Insulation shall be fit tightly, with gaps not greater than 1/4". All gaps greater than 1/4" shall be filled with acceptable insulation. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 1/4". Tapered insulation shall be installed around roof drains so as to provide proper slope for drainage. Miter roof insulation edges at ridge, valley and other similar non-planar conditions.
E. When installing multiple layers of insulation, all joints between layers shall be staggered at least 6 in.

3.07 INSULATION ATTACHEMENT

A. Base Layer: polyisocyanurate insulation
   1. Base Layer Attachment: Loose-laid
B. Intermediate Layer: None
   1. Intermediate Layer Attachment: None
C. Top Layer: polyisocyanurate insulation
   1. Top Layer Attachment: Mechanically Fastened

3.08 INSULATION APPLICATION

TOP LAYER:

1. Using the Firestone Heavy Duty, or approved equal, fasteners and Firestone, or approved equal, insulation plate engage fastener through insulation into concrete at the depth specified by the manufacturer’s technical manual.

3.09 MEMBRANE PLACEMENT AND ATTACHMENT

A. Beginning at the low point of the roof, place the Firestone RubberGard, or approved equal, membrane without stretching over the acceptable substrate and allow to relax a minimum of 30 minutes before attachment or splicing.
B. After making sure the sheet is placed in its final position, fold it back evenly onto itself so as to expose the underside.
C. Sweep the mating surface of the membrane with a stiff broom to remove excess dusting agent (if any) or other contaminants from the mating surface.

D. Apply Bonding Adhesive at about the same time to both the exposed underside of the sheet and the substrate to which it will be adhered so as to allow approximately the same drying time. Apply Bonding Adhesive so to provide an even and uniform film thickness. Do not apply bonding adhesive to areas that will be subsequently spliced.
E. Allow Bonding Adhesive to flash off until tacky. Touch the Bonding Adhesive surface with a clean, dry finger to be certain that the adhesive does not stick or string. As you are touching the adhesive, pushing straight down to check for stringing, also push forward on the adhesive at an angle to ensure that the adhesive is ready throughout its thickness. If either motion exposes wet or stringy adhesive when the finger is lifted, then it is not ready for mating.
F. Starting at the fold, roll the previously coated portion of the sheet into the coated substrate slowly and evenly so as to minimize wrinkles.
G. Compress the bonded half of the sheet to the substrate with a stiff push broom.
H. Fold the unadhered half of the membrane sheet back onto itself, and repeat the bonding procedure to complete the bonding of the sheet.

3.10 MEMBRANE LAP SPLICING

A. General:
1. Position the sheet at the splice area by overlapping membrane 5 inches. Once the membrane is in place, mark the bottom sheet 1/2" to 3/4" from the edge of the top sheet every 4 to 6 feet. Tack the sheet back with adhesive primer at 5' centers and at factory splices or as necessary to hold back the membrane at the splicing area.
2. Remove excess amounts of dusting agent on the sheet and at factory splices using a stiff push broom. Stir adhesive primer thoroughly before and during use. Dip the scrubber into the bucket of adhesive primer, keeping the scrubber flat. Apply the adhesive primer using long back and forth type strokes with pressure along the length of the splicing area until surfaces become a dark gray in color. Apply adhesive primer to both surfaces at the same time to allow the same flash off time. Change the scrub pad each 200 feet of 3 inch field splice, or when the pad will no longer hold the proper amount of adhesive primer. Additional scrubbing is required at areas that may have become contaminated or have excess amounts of dusting agent, and at all factory splices.
3. Position the lap splice tape on the bottom sheet, aligning the edge of the release paper with the markings. Immediately roll the splice tape with a 3"-4" wide silicone or silicone sleeved steel hand roller or a short nap 3" paint roller.
4. When the lap splice tape has been installed for the entire splice length allow the top sheet to rest on top of the tape's paper backing. Trim the top sheet as necessary to assure that 1/8"-1/2" of the lap splice tape will be exposed on the finished splice.
5. To remove the paper backing from the tape, first roll back the membrane sheet, then peel the paper backing off the lap splice tape by pulling against the weight of the bottom sheet at approximately a 45 degree angle to the tape and parallel with the roof surface. Allow the top sheet to fall freely onto the exposed lap splice tape. Broom the entire length of the splice as the release paper is being removed.
6. Roll the splice using a 1-1/2"-2" wide silicone or silicone sleeved steel hand roller, first across the splice, and then along the entire length of the splice.

3.11 MEMBRANE SECUREMENT

A. Secure membrane at all locations where the membrane terminates or goes through an angle change greater than 2" in 12" except for round pipe penetrations less than 18" in diameter and square penetrations less than 4" square.
B. Mechanically fasten reinforced perimeter fastening strips per manufacturer's recommendations.

3.12 FLASHING - PENETRATIONS

A. General:
   1. If project is a Tear-off or Reroof, remove all existing flashings (i.e. lead, asphalt, mastic, etc.).
   2. Flash all penetrations passing through the membrane.
   3. The flashing seal must be made directly to the penetration.
B. Pipes, Round Supports, etc
   1. Flash with Firestone Pre-Molded EPDM Pipe Flashings, or approved equal, where practical.
   2. Flash using elastomeric uncured flashing when Pre-Molded EPDM Pipe Flashing is not practical.
C. Structural Steel Tubing:
   1. Use a field fabricated pipe flashing detail provided that the minimum corner radius is greater than 1/4" and the longest side of the tube does not exceed 12". When the tube exceeds 12" use a standard curb detail.
D. Roof Drains:
   1. If project is a Tear-off or Reroof remove all existing flashings, drain leads, roofing materials and cement from the existing drain in preparation for membrane and Water Block Seal.
   2. Provide a clean even finish on the mating surfaces between the clamping ring and the drain bowl.
   3. Taper insulation around the drain to provide a smooth transition from the roof surface to the drain. Use pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope. Slope shall not exceed manufacturer's recommendations.
   4. Position the membrane, then cut a hole for the roof drain to allow 1/2" -3/4" of membrane extending inside the clamping ring past the drain bolts.
   5. Make round holes in the membrane to align with clamping bolts. Do not cut the membrane back to the bolt holes.
   6. Place Water Block Seal on top of drain bowl where the clamping ring seats below the membrane
   7. Install the roof drain clamping ring and clamping bolts. Tighten the clamping bolts to achieve constant compression.
E. Pipe Clusters and Unusual Shaped Penetrations:
   1. Fabricate penetration pockets to allow a minimum clearance of 1" between the penetration and all sides.

2.Secure penetration pockets per manufacturer’s details
3.Fill penetration pockets with Pourable Sealer, so as to shed water. Pourable Sealer shall be a minimum of 2" deep.

F. Hot Pipes:
1.Protect the rubber components from direct contact with steam or heat sources when the in-service temperature is in excess of 180° F. In all such cases flash to an intermediate insulated "cool" sleeve per manufacturer’s details.

G. Flexible Penetrations:
1.Provide a weathertight gooseneck set in Water Block Seal and secured to the deck.
2.Flash in accordance with manufacturer’s details.

H. Scuppers:
1.Remove existing scupper and provide a new welded watertight scupper or clean the existing scupper for reuse.
2.Set welded watertight scupper in Water Block Seal and secure to the structure.
3.Flash in accordance with manufacturer’s details.

I. Expansion Joints:
1.Install as shown on roof drawings in accordance with manufacturer’s details.

3.13 FLASHING - WALLS, PARAPETS, MECHANICAL EQUIPMENT CURBS, SKYLIGHTS, ETC.

A. General:
1.Using the longest pieces practical, flash all walls, parapets, curbs, etc., a minimum of 8” high per manufacturer’s details.

B. Evaluate Substrate:
1.Evaluate the substrate and overlay per manufacturer’s specifications as necessary.

C. For Tear-off or Reroof projects:
1.Remove loose or unsecured flashings.
2.Remove mineral surfaced or coated flashings.
3. Remove excessive asphalt to provide a smooth, sound surface for new flashings.

D. Complete the splice between flashing and the main roof sheet with Splice Adhesive before adhering flashing to the vertical surface. Provide lap splices in accordance with manufacturer’s details.

E. Apply Bonding Adhesive at about the same time to both the flashing and the surface to which it is being bonded so as to allow approximately the same flash off time. Apply Bonding Adhesive in a uniform coating.

F. Allow Bonding Adhesive to flash off until tacky. Touch the Bonding Adhesive surface with a clean, dry finger to be certain that the adhesive does not stick or string. While touching the adhesive, pushing straight down to check for stringing, also push forward on the adhesive at an angle to ensure that the adhesive is ready throughout its thickness. If either motion exposes wet or stringy adhesive when the finger is lifted, then it is not ready for mating. Flash off time will vary depending on ambient air conditions.

G. Roll the flashing into the adhesive evenly and carefully so as to minimize wrinkles.

H. Ensure proper contact of flashing by brooming in place.

I. Provide termination directly to the vertical substrate as shown on roof drawings.

J. Install T-Joint covers at field and flashing splice intersections as required by manufacturer.
K. Install intermediate flashing attachment as required by manufacturer’s specifications and details.

3.14 FLASHING - GRAVEL STOPS OR ROOF EDGE METALS

A. Apply adhesive primer to the metal edging and membrane as described in manufacturer’s specifications.
B. Place the roll of roof flashing on the roof a few feet ahead of the application starting point, positioned so that it unrolls from the top of the roll. Remove approximately 2'-3' of release paper and apply to the metal flange and membrane. Lap adjacent rolls of flashing a minimum of one inch.
C. With a 2"-3" wide silicone or silicone sleeved steel hand roller, roll the roof flashing to ensure proper adhesion. Additional attention must be given to factory splice intersections and to any change in plane.
D. Apply 6" length of roof flashing, a joint cover, or 6"x6" elastomeric uncured flashing to the inside edge of the roof flashing at all overlaps.
E. Apply 6" length of roof flashing, a joint cover, or 6"x6" elastomeric uncured flashing at all intersections between the roof flashing and field fabricated splices.
F. Where roof flashing will not completely cover the metal flange, an additional piece of roof flashing must be applied to the metal edge laps. Apply edge treatment at the intersections of the roof flashing sections.
G. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, an additional piece of roof flashing shall be applied over the metal lap to the top of the gravel stop, after the initial application of roof flashing. Edge treatment shall be applied at the intersections of the two flashing sections.
H. When the roof slope is greater than 1 in 12, apply edge treatment along the back edge of the roof flashing.

3.15 TEMPORARY CLOSURE

A. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

3.16 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed as required by the manufacturer
B. Correct identified defects or irregularities.

3.17 CLEAN-UP

A. Clean all contaminants from building and surrounding areas.
B. Remove trash, debris, equipment from project site and surrounding areas.

C. Repair or replace damaged building components or surrounding areas to the satisfaction of the building owner.

END OF SECTION

SECTION 07600

SHEET METAL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals necessary and install all architectural sheet metal as specified herein and shown on the Drawings.

B. Work shall include:

1. Exterior leaders, leader heads and collector boxes.

2. Miscellaneous flashings.

3. Fasteners as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Painting is included in Section 09902.

1.03 SUBMITTALS

A. Submit to the Engineer shop drawings of materials to meet specification and drawing requirements.

PART 2: PRODUCTS

2.01 MATERIALS

A. Sheet Metal: 24 gauge, 5.I., zinc-coated, galvanized steel, ASTII A-525, G90, 1.25 oz. per sq. ft. coating class.

B. Downspouts: 24 gauge, G.I., zinc-coated, to include all elbows, anchors, and hangers.

1. Form downspouts in 8 to 10 ft. sections, telescoping end joint in direction of flow a minimum of 2 in., rivet and solder.

2. Fasten to wall at 6 ft. o.c. max.

3. Provide elbows at bottom where downspout empties onto ground.

4. Where downspouts discharge onto unpaved surfaces, provide pre-cast concrete splash blocks.

C. Leader or Conductor Heads: 24 ga., G.I., zinc-coated.

1. Conductor head width shall be a minimum of 2" wider than downspout elbow and overflow.

2. Conductor head shall be locked to downspout elbow.

D. Leaders and conductor heads shall be products of Republic Steel, Trion Inc., Hickman, or equal.

E. Splash Block: Pre-cast concrete 12" x 24".

F. Fasteners and Anchor: Stainless steel.

G. Solder and Flux: Solder to be 50% tin-50% lead and be in accordance with ASTM B-32. Flux to be phosphoric acid type, manufacturers standard.

PART 3: EXECUTION

3.01 GENERAL

A. Conductor heads and downspouts shall be installed temporarily as soon as roofing is completed to prevent staining of the concrete masonry walls.

B. Depending on construction progress, for work under this Section, contractor shall at a later date remove conductor heads and leaders for application of wall paint on exterior of concrete masonry walls.

Upon completion of wall painting in area of leaders, contractor, for work under this Section, shall permanently install conductor heads and leaders.

C. All items shall be installed in accordance with the manufacturer's standard instructions and good sheet metal practices.

3.02 PAINTING

A. Finish Painting is included in Section 09902.

END OF SECTION

SECTION 07920

SEALANTS AND CAULKING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, tools, equipment, incidentals, and services necessary to install Caulking and sealant work as shown the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Concrete joint accessories including foam backer rod are included in Section 03250.

1.03 DEFINITIONS

A. The term 'sealant' or "sealing" shall refer to exterior joints exposed to the weather or interior joints exposed to moisture. When "sealant" is used in an outside joint in aluminum or steel frames, "sealant" shall be required on the inside joint also.

B. The term "caulk" or "caulking" shall refer to interior joints not normally exposed to weather or moisture conditions.

1.04 SUBMITTAL

A. Submit to Engineer for approval manufacturer's literature, specification data, and color chart for all materials proposed for this project. Identify their use and location. Cured samples of sealant color(s) selected shall be submitted to Engineer for final acceptance.

1.05 ITEMS TO BE SEALED

Items to be sealed and caulked include but are not limited to the following. Numbers and letters which appear in parenthesis refer to materials listed under Part 2 - PRODUCTS

A. Expansion and control joints in exterior and interior surfaces of unit masonry walls. (1B)

B. Perimeters of exterior openings where frames meet exterior facade of building (i.e., precast masonry, brick, block). (1B)

C. Interior control and expansion joints in floor surfaces. (1C)
D. Perimeters of interior frames. (1B or 1D)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver caulking and sealing compounds to the job in unbroken, sealed containers bearing the manufacturer's mixing directions. Store materials in sealed containers in a dry protected area above the ground or floor. Materials shall be stored above 40 Degrees F.

B. Protect caulking materials before, during, and after installation. Protect the installed work of other trades during installation.

C. Do not use caulking materials that have been stored for a period of time exceeding the maximum recommended shelf life of the materials.

1.07 QUALITY ASSURANCE

A. Use only qualified workmen thoroughly skilled and specially trained in the techniques of caulking, who can demonstrate to the satisfaction of the Engineer their ability to fill joints solidly and neatly.

B. Mixing and application of sealing compound shall be in strict accordance with the manufacturer's printed directions. Initial mixing and application shall be under the direct supervision of the manufacturer’s representative.

1.08 GUARANTEE

A. General Contractor, subcontractor, and product manufacturer shall jointly guarantee the work against defects in materials and workmanship for a period of two years from date of Substantial Completion.

1.09 JOB CONDITIONS

A. Do not proceed with the installation of sealants under adverse weather conditions when joint to be sealed is damp, wet, or frozen, or when temperatures are below or above the manufacturer's recommended limitations for installation. Consult the manufacturer for specific instructions before proceeding.

PART 2: PRODUCTS

2.01 MATERIALS

A. The materials listed here show both the United States Federal Specification and the American Society for Testing and Materials (ASTM) Standards.

Type of Sealant	U.S. Federal Specifications Number	ASTM
POLYSULFIDES		
1A Self-Leveling	TT-S-00227E, Type I Class A	C920, Type M, Grade P, Class 25
1B Non-Sag	TT-S-00227E, Type II Class A	C920, Type M, Grade NS, Class 25
1C Self-Leveling	TT-S-00230C, Type I Class A	C920, Type S, Grade P, Class 25
lD Non-Sag	TT-S-002300, Type II Class A	C920,Type S, Grade NS, Class 25

B. MATERIALS - PERFORMANCE REQUIREMENTS

1. Conform to Federal Specifications and ASTM Standards.

2. Colors - As selected by Engineer from manufacturer's standard color chart.

3. Sealant Primer - Suitable to substrate surfaces as recommended by the sealant manufacturer. Knowledge of whether the primer is staining or non-staining should be obtained prior to application.

4. Joint backing is specified in Section 03250.

5. Bond Breaker is specified in Section 03250.

6. Cleaning Agent - As recommended by the sealant manufacturer.

C. MANUFACTURES

Sealants and caulking shall meet the above specifications and standards and be as manufactured by Sonneborn Building Products, Inc., Division of Rexnord Chemical Products, Inc., 7711 Computer Avenue, Minneapolis, MN 55435, (612) 825-3434; Sika Corporation, P.O. 297, Lyndhurst, NJ 07071, (201) 933-8801; or approved equal.

PART 3: EXECUTION

3.01 GENERAL

A. Surface Condition - Joint surfaces to receive a sealant shall be sound, smooth, clean, dry, and free of all contaminants.

B. When perimeter joints around frames that are to be caulked do not have built-in stops or other means to prevent depth of compound from exceeding ½ inch, pack joint with back-up materials of correct type and to depth as necessary to provide minimum 3/8" inch and maximum ½ inch depth of compound.

3.02 PREPARATION OF SURFACES

A. Primer - Thoroughly clean joints and apply primer, if recommended by sealant manufacturer, in accordance with the manufacturer's recommendations. Apply primer prior to application of joint backing, bond breaker, or sealants.

B. Joint Backing - In joints where the depth of the joint exceeds the required depth of the sealant, install joint backing to provide backing and uniform depth of sealant. Joint backing shall be installed with approximately 30% compression. Do not stretch, twist, puncture, or tear joint backing. Butt joint backing at intersections.

C. Bond Breaker Tape - Install bond breaker tape smoothly at back of joint where joint backing is not required or cannot be installed. (Sealant shall adhere only to the sides and not to the back of the joint so as to eliminate three-sided adhesion).

D. Where weather molds, staff beads, etc., do not form an integral part of frames to be caulked, but are removable, remove same prior to caulking, execute caulking, replace molds, etc., and point.

E. Where premolded expansion joint fillers have been installed with temporary wood or other type fillers which remain in joints above expansion joint fillers to allow for final joint caulking, remove such temporary filler and clean joint thoroughly prior to caulking.

3.03 INSTALLATION

A. Joint sealant for all joints indicated on the Drawings shall be placed to the depths shown.

B. Thresholds and Window Sills - Place all exterior door thresholds and window sills in a full bed of sealant during setting procedures.

C. Sealant Application - Apply sealant in accordance with manufacturer's application manual and instructions, using hand guns or pressure equipment, with proper nozzle size, on clean, dry, properly prepared substrates. Force sealant into joint and against sides of joint to make uniform. Avoid pulling of the sealant from the sides. Fill sealant space completely with sealant.

D. Tooling - Tooling is required to ensure firm full contact with the interfaces of the joint. Tool joints to form smooth, uniform beads with slightly concave surfaces. Finish joints shall be straight, uniform, smooth, and neatly finished. Remove any excess sealant from adjacent surfaces of joint, leaving the work in a neat, clean condition. Tooling agents should only be used if recommended by the sealant manufacturer.

E. Where an irregular surface or sensitive border exists, the applicator shall apply masking tape at the edge of the joint to insure neatness and protection. Tape shall be removed after sealant is applied.

3.04 CLEANING

A. Clean off excess compound or smears with cleaning material recommended by the manufacturer of the compound. Clean adjacent surfaces free of caulking and sealant and clean all work of other trades that has in any way been soiled by these operations. Leave work in a condition satisfactory to the Engineer.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1: GENERAL

A. SCOPE

This work includes the furnishing of all labor, materials, equipment, etc., necessary for the proper and complete installation of all hollow metal doors, frames, and view windows, as shown on the Drawings, and/or herein specified. Refer to Door and Frame Schedule and details on Drawings.

B. REFERENCE SECTIONS

The General Conditions, Supplemental General Conditions, Special Conditions, and the applicable portions of Division 1 of the Specifications are a part of this Section.

C. SUBMITTALS

Shop drawings for all work, showing materials, uses, gages, details of construction, connections to other work, fastenings, anchors, etc., shall be submitted in six (6) sets to the Engineer for his approval. Fabrication shall not be started until these drawings are approved.

PART 2: PRODUCTS

A. GENERAL QUALITY

1. Hollow metal doors and frames shall be equal to those manufactured by Steel Craft Manufacturing Co., Republic Steel Corp., Fensetra, Inc., or approved equal.

2. Materials used shall be of the best quality of their respective types.

3. Steel in general shall be cold rolled stretcher level, prime quality steel, of U.S. standard gage as specified under the various headings.

B. HOLLOW METAL DOORS

1. Doors shall be 18 ga. cold rolled stretcher level, prime quality steel.

2. Doors shall have a continuous mechanical interlocking vertical edge seam. Top and bottom closed by a 14 ga. inverted channel, spot welded to face sheets. Furnish minimum 1/8" level in 2" on hinge and lock edges.

3. Doors shall be reinforced, stiffened, sound deadened and insulated with Kraft honeycomb core completely filling the inside of the doors and laminated to both inside faces of the panels.

4. Doors shall be mortised and reinforced for hinges and locks. They shall be reinforced for closers and other surface hardware, as required.

5. Rigid vinyl snap-in cap shall be installed in top and bottom of each exterior door.

6. Doors shall be reinforced internally with a 12 ga. steel reinforcement for surface closers.

7. Doors shall be equal to Type L-18 as made by Steelcraft Manufacturing Company.

C. FRAMES

1. Frames and view windows shall be made of 16 ga. steel as manufactured by Steelcraft Manufacturing Co., Republic Steel Corporation, Fenestra, Inc., or approved equal.

2. Frames for interior drywall construction shall be equal to Steelcraft type DW-16, for K.D. Construction. Frames shall be compatible with drywall system as detailed.

3. All other frames shall have welded and mitered corners, equal to Steelcraft Type F-16.

4. Suitable anchors for jambs shall be provided as required by wall construction. Minimum of 6 jamb anchors and two (2) base anchors per frame shall be supplied.

5. All frames shall be furnished with a minimum of two (2) rubber bumpers installed at the factory.

6. Reinforcing channels, where called for, shall be 11 gage.

D. HARDWARE REINFORCEMENTS

1. All work shall be accurately mortised, reinforced, drilled and tapped at the factory to receive hardware, except that drilling and tapping for door checks and brackets shall be done at the building.

2. Reinforcements shall be of ample size and thickness to stiffen the work against the strain of service required. Reinforcements for locks and escutcheons shall be box type with spring leaf contacts for lock cases.

3. All finish hardware furnished under another Section will be applied on the job by the Carpentry Sub-Contractor.

4. Provide cover boxes in back of all hardware cutouts in combination type frames.

E. FINISH

1. All hollow metal work shall be bonderized and shall be given prime filler and base coats at the factory.

2. Prime coat shall consist of 1 coat of rust resisting paint, filler coats as necessary to insure a smooth even finish and 1 coat of base paint.

3. Each coat shall be baked-on and sanded smooth.

PART 3: INSTALLATION

A. Frames shall be set accurately in their proper location, shall be plumb and true and securely braced in position.

B. Frames shall be checked both before and after the walls are constructed to see that they are properly erected.

END OF SECTION

SECTION 08700

FINISH HARDWARE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish and deliver to the job site all finish hardware as hereinafter specified and scheduled.

B. The schedule included herein designates the type and quality of the hardware desired. The CONTRACTOR will be responsible to supply the correct quantity of all materials, whether or not specifically mentioned in this Section. Any additional items that may be required shall be furnished, and be of the type, quality and function consistent with other hardware specified.

C. It shall be the responsibility of the hardware supplier to provide the proper hardware for door function and to meet the proper codes.

D. The Drawings show the direction of swing, or hand, of each door leaf. Furnish each item of hardware for proper installation and operation of the door movement as shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Hollow metal doors are included in Section 08110.

1.03 SUBMITTALS

A. Submit to the Engineer a hardware schedule as provided in the General Conditions for shop drawings.

1.04 PRODUCT HANDLING

A. Packing and Marking

1. All hardware shall have the required screws, bolts and fastenings necessary for proper installation, wrapped in paper and packed in the same package as the hardware. Each package shall be legibly labeled, indicating that portion of the work for which it is intended.

B. Delivery and Storage

1. All hardware shall be delivered to the site in the manufacturer's original unopened containers with all labels legible and intact.

2. All hardware shall be delivered to the job in **ONE** shipment.

3. Hardware shall be stored in a safe dry area, protected from the environment and damage from the work.

PART 2: PRODUCTS

2.01 MATERIALS

A. All hardware shall meet the approval of the State Building Code Requirements, the National Board of Fire Underwriters and other authorities having jurisdiction. All hardware shall be best grade, entirely free from imperfections in manufacture and finish. Qualities, weights, and sizes specified herein are the minimum that will be accepted.

B. Hardware Items

1. Hinges – Hinges shall be five-knuckle construction. Hinges shall be solid bronze with non-removable pins for exterior doors. All hinges shall be 4-1/2 x 4-1/2 inches x 0.134 inches unless otherwise specified.
2. Locksets – All locksets shall be mortise type. Lock bodies and trim shall be by same manufacturer.
3. Exit Devices – Devices for label doors shall be listed with Underwriter’s Laboratories as Fire Exit hardware and shall have their label attached to the device.
4. Closers -- Surface mounted, LCN 4110 Series "Smoothee" with hold open arm and aluminized finish or equal by Norton, Yale or Sargent.
5. Silencers - Glynn-Johnson GJ 64 or equal by Baldwin.
6. Flush Bolts - manual recessed flush bolts, Glynn-Johnson FB6 with US10 (satin bronze finish) or equal by Stanley.
7. Thresholds - Extruded aluminum, Zero International #654, or equal by Pemko or Reese.
8. Astragals - Where required.
9. Nameplates - 1/8" thick plastic: with standard 1" high letters, with Scotchmount adhesive fastening. Color and engraving as selected by Engineer.
10. Floor Stop - The floor stop shall have two anchoring points, made of stainless steel, 3" high with replaceable bumpers. Provide door stops wherever necessary to prevent door or hardware from striking an adjacent partition or obstruction.

D. Provide 3 silencers in lock side jamb of single doors and 4 silencers in head of double doors.

E. Templates

1. All hardware applied to metal doors or jambs shall be made to template and secured by machine screws. Furnish templates to the metal door and frame manufacturer for application at the factory, unless otherwise requested.

2.02 FINISH

A. As noted above.

2.03 FASTENINGS

A. Furnish necessary screws, bolts, nuts and others of suitable types and sizes to install hardware securely in position to withstand hard usage. Supply fastenings that harmonize with hardware material and finish. Furnish required expansion shields, bolts, and other anchors as recommended by manufacturer and approved by Engineer. Furnish hardware to be fastened to concrete with machine screws and tamping.

2.04 KEYING

A. Cylinder locks of all buildings shall be "grand master keyed."

B. All cylinder locks within the same building shall be master keyed.

C. All locks shall be keyed different, except locks within the same room shall be keyed alike.

D. All cylinders shall be ‘Construction Keyed’ for Contractor's use during installation of hardware.

E. Furnish:

1. Three keys with each type of keying.

2. Three construction day keys

F. Key Control System – Provide a key control system with a 60 key capacity. Key control system shall be complete with a 16 gauge, black enamel, wall mounted locking cabinet. Provide with collection envelopes, permanent key tags, loan key tags, three-way cross-index with binder, and permanent loan record with binder.

PART 3: EXECUTION

3.01 SCHEDULE OF HARDWARE SETS

A. The following general hardware sets represent hardware for one opening (single or pair of doors). Refer to Materials paragraphs above for additional items required under specified conditions. The quantities of each set are the responsibility of the Contractor. Refer to Drawings for locations. The actual content of each set shall be determined by approved hardware sets.

HW-10 For Single Exterior Doors (Each)

3 EA	Hinges
1	Cylinder Set
1	Door Closer
1	Silencer
1	Threshold
1	Weather stripping

HW-20 For Single Interior Doors (Each)

3 EA	Hinges
1	Door Closer
1	Hold Open
1	Silencer
1	Sweep
1	Nameplate

HW-25 For Single Interior Doors (Each)

3 EA	Hinges
1	Lockset
1	Sweep
1	Nameplate

HW-30 For Exterior Double Doors (Each Pair)

See Section 8410 – Aluminum Storefront

HW-35 For Exterior Double Doors (Each Pair)

6 EA	Hinges
1	Cylinder set at active door

2 Ea	Exit device / panic hardware
2	Door closer
2	Silencer
1	Threshold
1	Flush bolts at top and bottom of inactive door
1	Astragal
2	Hold opens
2	Sweeps
1	Nameplate
1 Set	Weatherstrip

HW-40 For Interior Double Doors (Each pair)

6 EA	Hinges
1	Cylinder set at active door
2	Door closer
2	Silencer
1	Flush bolts at top and bottom of inactive door
1	Astragal
1	Nameplate
1 Set	Weatherstrip

HW-45 For Interior Double Doors (Each pair)

6 EA	Hinges
2	Door closer
2	Silencer
1	Flush bolts at top and bottom of inactive door
1	Nameplate

HW-50 For Exterior Double Doors (Each Pair)

4 EA	Hinges
2	Cylinder set at active door
2	Door closer
1	Threshold
1	Flush bolts at top and bottom of inactive door
1	Astragal
2	Hold opens
2	Sweeps
1	Nameplate
1 Set	Weatherstrip
1	Monorail weather strip

3.02 CHECKING AND CORRECTING OF HARDWARE

A. After the hardware has been installed by the Contractor, the Contractor and Engineer shall inspect the installation and ascertain that locks are properly secured, keyway correctly positioned and knobs and latches functioning freely.

B. The Contractor shall make all required installation corrections and adjustments to put the hardware in proper working order.

C. Faulty operating hardware shall be replaced by the Contractor at no cost to the Owner.

END OF SECTION

SECTION 09901

SURFACE PREPARATION AND SHOP PRIME PAINTING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless steels, as specified herein.

1.02 RELATED WORK SPECIFIED

A. Field and finish painting is included in Section 09902.

1.03 SUBMITTALS

A. Submit to the Engineer for approval, as provided in Section 01300, shop drawings, manufacturer's specifications and data on the proposed primers, detailed surface preparation and application procedures, dry mil thicknesses and MSDS forms.

B. Submit representative physical samples of the proposed primers, if required by the Engineer.

PART 2: PRODUCTS

2.01 MATERIALS

A. Submerged Surfaces - Surfaces which will be submerged or which are subject to splash action or which are specified to be considered submerged service shall be sprayed with one shop coat of Tnemec Series 66 Boston Gray Primer, dry film thickness 3.5 to 4.B mils, Koppers 654 Epoxy Primer, or equal.

B. Non-Submerged Surfaces - Spray apply one shop coat of Tnemec Series 66 Boston Gray Primer, dry film thickness 3.0 to 4.0 mils Koppers 654 Epoxy Primer, or equal.

C. Surfaces in Non-process Buildings - Apply one shop coat of Tnemec Series 4, Gray, dry film thickness 2.0 to 3.0 mils, Koppers 662 shop primer, or equal.

D. Non-Primed Surfaces - Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods cf storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

E. Ferrous Metal Surfaces - Spray apply one shop coat of Tnemec Series 66 Boston Gray Primer, dry film thickness 3.0 to 4.0 mils Koppers 654 Epoxy Primer, or equal.

F. Compatibility of Coating Systems - Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09902 for use in the field and which are recommended for use together.

PART 3: EXECUTION

3.01 APPLICATION

A. Surface Preparation and Priming

1. Ferrous metal components scheduled to receive shop coating, as defined above, shall be sand blasted clean in accordance with SSPC-SP-6, Commercial Grade, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be sandblasted clean in accordance with SSPC-SP-l0, Near White, immediately prior to priming. Surface profile after abrasive blasting shall be 1.0 to 1.5 mils for exterior surfaces, 2.0 to 2.5 mils for immersion service, or approximately 25% of the total dry film thickness of the paint being applied.

2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming, by detergent and/or steam cleaning per SSPC-SP-l.

3. Shop coat in accordance with approved manufacturer's recommendations.

4. Cold water pipes used for grounding shall not be painted where grounding wire is connected.

5. The interior surfaces of walls, ceiling, etc. Also See 09902.

6. All equipment and electrical components shall be protected prior to any surface preparation activities taking place.

The components shall be protected by plastic wrapping or other measures with the Engineer's approval.

7. The surfaces shall be free of dust, flaking paint, grease or other foreign matter prior to priming. The surfaces shall be primed with material compatible with the finish paint as specified in Section 09902.

END OF SECTION

SECTION 09902

FINISH PAINTING

GENERAL

1.01 SCOPE OF WORK

A. Furnish all materials, labor, equipment and incidentals required to perform all the painting necessary to complete this contract in its entirety.

B. It is the intent of these Specifications to paint all exposed structural and miscellaneous steel, doors, frames, hatch covers, mechanical equipment, operators, posts, pipe, fittings, valves, CMU and Concrete walls, as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of the specifications as stated herein.

C. The following items will not be painted, except as is the normal procedure of a manufacturer furnishing a finished product:

1. Concrete not exposed to sight and concrete floors (unless otherwise specified in the painting schedules).

2. Finish hardware unless specifically noted otherwise.

3. Non-ferrous metals, or galvanized metals unless specifically noted otherwise.

4. Grating.

5. Packing glands and other adjustable parts and name plates of mechanical equipment.

6. Factory pre-finished architectural components.

7. Parts of buildings not exposed to sight, unless specifically noted otherwise.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Valve identification is included in Section 01010.

B. Shop priming and surface preparation of equipment and piping are Specified in Section 09901. Additional instructions are included in the respective Sections.

PART 2: PRODUCTS

2.01 MATERIALS

A. All painting materials shall be equal to those manufactured by the Tnemec Company, Inc., Mobil Co., Koppers Co., or equal. The painting schedule has been prepared on the basis of Tnemec products (unless otherwise noted) and Tnemec recommendations for application. No brand other than those named will be considered for approval unless the brand and type of paint proposed for each item in the following schedule together with sufficient data substantiated by certified tests conducted at no expense to the Owner to demonstrate its equality to the paint(s) named, is submitted to the Engineer in writing for approval within 30 days after the signing of the Contract Agreement. The type and number of tests performed shall be subject to the Engineer's approval.

B. All painting materials shall be delivered to the mixing room in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration and mixed, thinned, and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.

C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for primers.

D. No paint containing lead will be allowed. Oil shall be pure boiled linseed oil.

E. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes, and no plumbing fixture shall be used for this purpose.

2.02 COLOR CODING FOR PIPES AND EQUIPMENT

A. To facilitate identification of piping in plants and pumping stations, the following color scheme shall be utilized.

Water Lines

Raw	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue

Chemical Lines

Alum or Primary Coagulant	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow w/Green Band
Chlorine (Gas and Solution)	Yellow
Fluoride	Light Blue w/Red band
Lime Slurry	Light Green
Ozone	Yellow w/Orange Band
Phosphate Compounds	Light Green w/Red Band
Polymers or Coagulant Aids	Orange w/Green Band
Potassium Permanganate	Violet
Soda Ash	Light Green w/Orange Band
Sulfuric Acid	Yellow w/red Band
Sulfur Dioxide	Light Green w/Yellow Band

Waste Lines

Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray
Raw Sludge Line	Brown w/Black Bands
Sludge Recirculation Suction Line	Brown w/Yellow Bands
Sludge Draw Off Line	Brown w/Orange Bands
Sludge Recirculation Discharge Line	Brown
Sludge Gas Line	Orange (or red)
Natural Gas Line	Orange (or red) w/Black Bands
Nonpotable Water Line	Blue w/Black Bands
Water Lines for Heating digesters or buildings	Blue w/6-inch(152mm) Red Band Spaced 30 inches (762mm) apart

Other

Compressed Air	Dark Green
Other Lines	Light Gray

In situations where two colors do not have sufficient contract to easily differentiate between them, a six-inch band of contrasting color shall be on one of the pipes at approximately 30 inch intervals. The name of the liquid or gas shall also be on the pipe. Provide arrows indicating the direction of flow.

B. All hangers and pipe support floor stands shall be painted the same color with the same paint as used to paint the pipe it supports. The system shall be painted up to but not including the flanges attached to the mechanical equipment nor the flexible conduit connected to electrical motors.

C. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to but not including the fixed flanges or connections on the equipment.

D. The color code shall establish, define and assign a definite color for each category of pipe.

E. All pipes and equipment shall be painted unless otherwise approved by the Engineer.

2.03 LETTERING OF TITLES

A. The name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of liquids, shall be indicated on each pipe system. Titles shall be as designated on the Contract Drawings. Titles shall not be located more than twenty six (26) linear feet apart and shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent cleanout, and all pieces of equipment.

B. Titles shall identify the contents by complete name. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.

C. Numbers and letter shall be die-cut from 3.5 mil vinyl film and prespaced on carrier tape. Adhesive and finish surface shall be protected with one piece removable liners. Color shall be white.

D. Letter size shall be as indicated in the following table.

OUTSIDE DIAMETER OF PIPE SIZE	SIZE OF LEGEND LETTERS OR COVERING
3/4-in to 1-1/4-in	½-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

E. The system for preparation and application of letters shall be ASI/LTV Series by Architectural Signing Inc., Marina Del Rey, CA, Architectural Graphics Inc., Norfolk VA or equal. Letter type shall be Helvetica Medium, upper case. Grid 2 spacing shall be employed. Arrows shall be standard Helvetica Medium. Arrow shall match type size. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and applications of letters.

2.04 TITLES FOR EQUIPMENT

A. Titles shall be provided on all equipment, including pumps, using 1-in high Helvetica Medium upper case, Grid 2 spacing, white in color except as otherwise noted on the drawings in these specifications. Titles shall include both the equipment tag number and name, as shown in the Drawings or as otherwise indicated by the Engineer. Titles shall be mounted at eye level on machines where possible or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example Pump No. 1, Pump No. 2, etc.

B. Titles shall be sized, proportioned, arranged and located to be easily readable. It may be required by the Engineer that some equipment be labeled in two or more places, in which cases, the Contractor shall comply with no additional cost to the Owner.

C. The Contractor shall submit for Engineer's approval in accordance with Section 01600 a listing of all equipment titles he proposes to provide, including for each equipment's labeling.

1. Size and color of letters to be used.
2. Location(s) of labels.
3. Formation of label, e.g.: Raw Water Pump No. 1

D. It is the intent of these specifications that all equipment items be labeled and that such labeling allow easy identification of the item of equipment from the direction(s) it will most normally be viewed. To satisfy this intent, all equipment shall be labeled, whether included in the Contractor's listing, or not.

2.05 METAL TAGS

A. For pipelines smaller than 3/4-in in diameter, securely fasten metal tags, 2-1/2-in x ½-in, of 316 ss construction with lettering etched and filled with enamel. Tags shall be approved by the Engineer.

2.06 EXTRA PAINT

A. Furnish to the Owner one unopened gallon can of each type and each color of paint used.

B. A listing shall be provided, indicating for each surface painted, the paint used, keyed to the extra paint provided.

PART 3: EXECUTION

30.1 PREPARATION OF SURFACES

A. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting. Special care shall he given to thoroughly clean interior concrete and concrete block surfaces to receive polyamide cured epoxy paint of all marks before application of finish.

B. All metal welds, blisters, etc., shall be ground and sanded smooth. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All loose scale, oil, grease and dirt shall be removed by steam and/or detergent cleaning per SSPC-SP-1.

C. Concrete surfaces shall have been finished as specified in Section 03345. Report unsatisfactory surfaces to the Engineer. Concrete shall be left for one month minimum before painting and shall be free of dust, oil, curing compounds, and other foreign matter.

D. Concrete masonry unit surfaces shall be smooth and cleaned of all dust, loose mortar and other foreign matter.

E. Galvanized surfaces and aluminum surfaces to be painted shall have all oxidation and foreign material removed by steam and/or detergent cleaning per SSPC-SP-l, before painting.

F. All surfaces that received a shop coat as specified in Section 09901 in which the shop coat has been removed before and during erection shall be touched up at the damaged area. The touch-up coat shall be the same material as the shop coat and should be placed in such a manner to maintain uniform thicknesses and continuity of appearance.

G. Submerged concrete surfaces, and those subject to splashing, scheduled to be painted, shall be whip sandblasted with resultant finish equal to medium grain sandpaper.

H. All PVC pipe and other plastic matrix surfaces to be painted shall be lightly sanded and cleaned of residue before painting.

3.02 PAINTING OR COATING SYSTEMS

A. Contractor shall submit proposed colors for approval.

B. The following types of paints by Tnemec, unless otherwise indicated, have been used as a basis for the paint schedule. See 2.01.A for procedure to secure approval of equal types of paints.

1. Hi-build Epoxoline (Series 66) - polyamide cured epoxy

2. Endura-Shield - Semi-gloss (Series 71) - aliphatic polyurethane

3. Epoxy-Polyamide Masonry Filler (Series 54-660) - Block Filler and Concrete Sealer

4. Tneme-Creto (Series 52) modified epoxy masonry texture coating

5. Tneme-Cryl (Series 6) - acrylic latex coating.

C. Cast-In-Place Concrete (except floors and walks) with “Smooth Form and Grout Cleaned Finish and Precast Concrete”; Interior Non-submerged.

1. Surface Preparation: Prepare surfaces as specified in 3.01.

2. Product and Manufacturer: Provide the following:

a. Tnemec (System Series 135 Epoxy-polyamidamine)

(1) Primer: Series – Color Chembuild – 1 coat, thinned per manufacturer.
(2) Finish: No. 135 – Color Chembuild – 2 coats, 4.0 to 6.0 dry mils per coat.

D. Cast-In-Place Concrete in Chemical Containment Areas with "Smooth Form and Grout Cleaned Finish"

1. Surface Preparation
   a. Abrade concrete in accordance with ASTM D-4259. Finish to resemble medium-grit sandpaper.

2. Product and Manufacturer
   a. Tnemec
      (1) primer: 201 Epoxoprime at 180 to 200 s.f./gallon
      (2) Intermediate Coat: 275 Stranlok at 25.0 dry mils.
      (3)* Finish: 282 Tnemeglaze at 8.0 to 10.0 dry mils.

      * For containment of hydrofluosilic acid, the finish (topcoat) coat shall be Tnemec 120-5002 at 15.0 to 18.0 dry mils.

E. Concrete Block Walls and Cast-In-Place Concrete not conforming to "Smooth Form and Grout Cleaned Finish"; Interior Non-submerged:

1. Surface Preparation: Prepare surfaces as specified in Section 3.01. Fill pores of concrete block with block filler at a rate of 50 to 100 square feet per gallon.

2. Product and Manufacturer: Provide the following:
   a. Tnemec (System No. 66-15 Epoxy-Polyamide)
      (1) Primer: No. 130 Modified Acrylic masonry filler – l coat at a rate of 75 to 100 square feet per gallon.
      (2) Intermediate: No. 135 – Series Chembuild – 1 coat 2.0 to 3.0 dry mils.
      (3) Finish: No. 135 – Series chembuild – 1 coat 4.0 to 6.0 dry mils.

F. Concrete Block Walls and Cast-In-Place Concrete; Exterior Non-submerged Opaque:

1. Surface Preparation: prepare surfaces as specified in Section 3.01. Fill pores of concrete block with Block Filler, or equal at a rate of 50 to 100 square feet per gallon, or Tnemec Series 54-562 at a rate of 50 to 100 square feet per gallon.

2. Product and manufacturer, provide the following:

a. Tnemec
(1) Blockfiller: Series 130, if required.
(2) Primer: Series 6/7 Color Tnemecryl – l coat, 2.0 to 3.0 dry mils.
(3) Finish: Series 6/7 Color Tnemecryl – l coat, 2.0 to 3.0 dry mils.

G. Architectural, Precast, Poured-in-Place Concrete; Brick Walls, Natural Stone Exterior Sealer, Clear; Non-submerged:

1. Surface Preparation: Prepare surfaces as specified in Section 3.01.

2. Product and Manufacturer:
a. ProSoCo, Inc.
(1) Primer/Finish: Weather-Seal Siloxane, coverage rate may vary
Brick: 100 to 150 s.f./gallon
Architectural Concrete: 125 to 175 s.f./gallon
Natural Stone: 125 to 175 s.f./gallon
Concrete Masonry Units: 75 to 175 s.f./gallon

H. Concrete Floors and Walks; Interior (if designated to be painted)

1. Surface Preparation: Prepare surfaces and acid etch as specified in 3.02.B.

2. Product and Manufacturer: Provide the following:
a. Tnemec (Epoxy-Polyamide)
(1) Primer: No. 135 – Chembuild – 1 coat, 2.0 to 3.0 dry mils.
(2) Finish: No. 104 – H.S. Epoxy – 1 coat, 4.0 to 6.0 dry mils.
Add silica sand to finish coat.

I. Submerged Concrete; Interior and Exterior, Potable Water

1. Surface Preparation
a. Abrade surface in accordance with ASTM D4259. Surface to resemble medium grit sandpaper when completed.

2. Product and Manufacturer
a. Tnemec
(1) Primer: Series 20-1255 at 3.0 to 5.0 dry mils.
(2) Finish: Series 20-WH02 at 4.0 to 6.0 dry mils.

J. Ferrous Metals and all Ferrous Piping; Interior Non-submerged

1. Product and Manufacturer
a. Tnemec
(1) Surface Preparation: SSPC-SP6 Commercial Blasting Cleaning

(2) Primer: No. 135 Epoxy – l coat, 4.0 to 6.0 dry mils
(3) Finish: No. 104 Epoxy – 2 coats, 4.0 to 6.0 dry mils per coat

K. Submerged or Intermittently Submerged, Ferrous and Non-Ferrous Metals; Interior and Exterior, Potable Water Exposure

1. Surface Preparation:
   a. SSPC-SP-10 with 2.0 mil profile.

2. Product and Manufacturer: Provide the following:
   a. Tnemec
      (1) Primer: Potapox II at 3.0 to 5.0 dry mils.
      (2) Finish: Potapox II at 4.0 to 6.0 dry mils.

L. Ferrous, Non-ferrous Metals and Galvanized Metals; Exterior Non-submerged

1. Surface Preparation
   a. Ferrous Metals: SSPC-SP6 Commercial Blast Cleaning
   b. Galvanized and Non-ferrous Metal: Solvent wipe and pretreatment with paint manufacturers recommended system.

2. Product and Manufacturer: Provide the following:
   a. Tnemec (System No. 74-1 Aliphatic Polyurethant)
      (1) Primer: No. 66-Color(b) Hi-Build Epoxoline – 2 coats, 4.0 to 6.0 dry mils per coat.
      (2) Finish: No. 74/75 – Color Endura – Shield – 1 coat, 2.0 to 5.0 dry mils per coat.

M. Galvanized Metal and Non-Ferrous Metal; Interior, Non-submerged

1. Surface Preparation: Pretreatment with Carboline Multi-Bond 120 or Clean-N-Etch by Great Lakes Laboratories.

2. Product and Manufacturer: Provide the following:
   a. Tnemec
      (1) Primer: No. 135 Epoxy Chembuild – l coat, 3.0 to 5.0 dry mils.
      (2) Finish: No. 135 Epoxy Chembuild – l coat, 4.0 to 6.0 dry mils.

N. Pipe and Duct Installation, Cloth; Interior

1. Surface Preparation: Remove all foreign matter as specified in 3.02 G.

2. Products and Manufacturer: Provide the following:

a. Tnemec
   (1) Primer: Series 6/7 Color Tnemecryl – l coat, 2.0 to 3.0 dry mils.
   (2) Finish: Series 6/7 Color Tnemecryl, 2.0 to 3.0 dry mils.

O. PVC Piping, Fiberglass, Fiberglass Insulation Covering; Interior

1. Surface Preparation: Sand as specified in 3.01.
2. Product and Manufacturer: Provide the following:
   a. Tnemec
      (1) Primer: No. 135 Chembuild – l coat, 4.0 to 6.0 dry mils.
      (2) Finish: No. 135 Chembuild – l coat, 4.0 to 6.0 dry mils.

P. Gypsum Wallboard, Interior

1. Surface Preparation: Sand and seal as specified in 3.2.H.
2. Product and Manufacturer: Provide the following:
   a. Tnemec
      (1) Primer: No. 51-792 PVA sealer – l coat, 1.0 to 2.0 dry mils.
      (2) Intermediate: No. 113/114, Color Tnemec, Tufcoat – l coat, 2.0 to 2.5 dry mils.
      (3) Finish: No. 113/114, Color Tnemec, Tufcoat – l coat, 2.0 to 2.5 dry mils.

Q. Ferrous Metals, Buried Exterior or Concrete Waterproofing, Buried Exterior

1. Surface Preparation: SSPC-SP10 Near-White Metal Blast Cleaning (ferrous metals). Clean concrete of all dirt, residues.

2. Product and Manufacturer: Provide the following:
   a. Tnemec (System No. 46-30 Coal Tar Epoxy)
      (1) Finish: No. 46H – 413 Hi-Build Tneme – Tar, 1 coat, 14.0 to 20.0 dry mils.

3.03 WORKMANSHIP

A. General

1. At the request of the Engineer, samples of the finished work prepared in strict accordance with these Specifications shall be furnished and all painting shall be equal in quality to the approved samples. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with color tints shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.

2. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operation. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc., before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.

3. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

B. Field Priming

1. Steel members, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted in the field shall have surfaces prepared in accordance with Section 09901 and shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule.

2. Equipment which is customarily shipped with a baked-on enamel finish or with a standard factory finish shall not be field painted unless the finish has been damaged in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coat or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish, or a full-surface repainting shall be applied, to produce an attractive finish.

3. Equipment shipped with a protective shop painting coat or coats shall be touched up to the satisfaction of the Engineer with primers as recommended by the manufacturer of the finish paint.

C. Field Painting

1. All painting at the site shall be designated as Field Painting and shall be under the direct and complete control of the Engineer, and only skilled painters and specialists, where required, shall be used on the work.

   Adequate notice (minimum of two working days) shall be given to the Owner to move cars and protect necessary items from over spray.

2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature of the surface being painted is below 60 deg. F., in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.

3. Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to the approximate shade of the finished coat.

4. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with No. 00 sandpaper or equal to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted and all exterior trim shall be back-primed before installation. Finishes in clarifier launders shall be as required to produce a smooth, easily cleaned surface.

5. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weather shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.

6. All materials shall be brush painted unless spray painting is specifically approved by the Engineer.

7. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept fresh, warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off, or otherwise removed, and repainted in accordance with the Engineer's directions.

8. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.

9. Only the aluminum work noted on the Drawings or in the Painting Schedule shall be field painted.

3.04 CLEANUP

A. At all times keep the premises free from accumulation of waste material and rubbish caused by employees or work. At the completion of the painting, remove all tools, scaffolding, surplus materials, and all rubbish from and about the buildings and leave the work 'broom clean" unless more exactly specified.

B. Upon completion, remove all paint where it has been spilled, splashed, or spattered on all surfaces, including floors, fixtures, equipment, furniture, etc., leaving the work ready for inspection.

3.05 COLOR SELECTION FOR BUILDINGS

A. Colors for interior and exterior items including doors, walls, and structural members, etc. shall be selected by the Engineer from color charts provided by the Contractor.

END OF SECTION

SECTION 11210

INFLUENT LIFT STATION

PART 1: GENERAL

1.01 Scope of Work

A. Provide all labor, materials, equipment and services required to install submersible centrifugal pumps as shown on the Contract Drawings and as specified herein. Equipment supplier shall supply all OSHA required guards and all OSHA recommended/required warning signs for their equipment. The work includes (but is not limited to):

1. Modification of pedestal mounted duplex control panel;

2. Installation of two (2) new submersible pumping units;

3. Installation of new level sensor;

4. Installation of miscellaneous pipe, valving, hatches, appuretnances, etc.;

5. Associated electrical work, including all power service conduits and disconnects;

6. All related site work including clearing, grading, trenching, backfilling, surface restoration, clean-up, etc.

7. Station startup with pumps and controls vendor, Engineer, Owner, Contractor and Inspector.

1.02 Related Work

A. Pressure pipe is specified in Division 15.

B. Painting is specified in Division 9.

C. Valves are specified in Division 15.

D. Electrical Work is specified in Division 16.

1.03 Systems Description

A. It is the intent of these Specifications to provide a completely functional and operational pumping system as planned and specified with all necessary equipment, materials, parts, controls and other components and proper installation of these items of equipment, materials, etc., to perform the functions specified.

1.04 Qualifications

A. The pumps and equipment shall be furnished by a single manufacturer who is experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with best practices and methods. The equipment shall be manufactured by KSB, Myers, Flygt, Yeomans, or approved equal.

1.05 Submittals

A. Shop drawings and other items needed to establish compliance with the Drawings and Specifications for all products in this Section shall be submitted to the ENGINEER in accordance with Section 01300 – Submittals.

In addition to the standard dimensions, materials, and weights, the following additional submittal documentation shall be required:

(1.) The manufacturer shall certify ISO 9000 compliance.
(2.) One year warranty on all components.

B. O&M instructions shall be submitted to the ENGINEER in accordance with Section 01600.

1.06 Equipment or System Warranty

A. The manufacturer of the submersible pumping station shall guarantee all equipment supplied against defects in workmanship and material for a period of five (5) years or 10,000 hours.

In the event a component fails to perform as specified or is proven defective in service during the guaranteed period, the Manufacturer shall repair or replace, at his discretion, such defective part. He shall further provide, without cost, such labor as may be required to replace, repair, or modify major equipment components.

B. Refer to Section 01600 for additional warranty requirements.

PART 2: PRODUCTS

2.01 General

A. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, control panel and appurtenances as required to provide a complete installation as shown on the Plans.

2.02 Requirements

A. Conditions of Operation

Service:	On Site Pump Station Submersible Wastewater Pumps
Number of Pumps:	2 installed
Liquid:	Site sewage & filtrate from sludge dewatering box
Maximum temperature:	Per Manufacturer
Comparison model:	As Noted on Plans
Impeller:	Recessed impeller, bronze
Design capacity one unit on:	As Noted on Plans
Min. efficiency at design op:	20 Percent
Shut off head:	As Noted on Plans
Run out:	As Noted on Plans
NPSH required at design op:	Per Manufacturer
Maximum speed :	As Noted on Plans
Non-overloaded motor HP:	As Noted on Plans
Service:	As Noted on Plans

Each pump shall be fitted with 25 feet of stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

2.03 Explosion-Proof Lift-Out Rail System

A. General – Furnish and install a complete lift-out rail system. The lift-out rail system shall be of non-sparking design and shall be UL listed for class 1, Group D explosion-proof service.

B. Components – Each lift-out rail system shall consist of: a ductile iron discharge base, brass faced pump attaching and sealing plate, brass pump guide plate, and cast iron elbow. All exposed nuts, bolts, and fasteners shall be of 300 series stainless steel. No fabricated steel parts shall be used.

C. Elbow – Discharge elbow shall be 4” x 4”. Elbow shall bolt onto base and have standard 125 lb. flanges.

D. Sealing – A sealing plate shall be attached to the pump. A simple downward sliding motion of the pump and guide plate on the guide rails shall cause the unit to be automatically connected and sealed to the base. The open face of the sealing plate shall have dove-tailed groove machined into the face to hold a sealing "o"-ring. The "o"-ring shall provide a leak-proof seal at all operating pressures.

E. Guide Rails – Two rail pipes shall be used to guide the pump from the surface to the discharge base connection. The guide rails shall be 1-1/2" schedule 40 stainless steel pipe. The weight of the pump shall bear solely on the discharge base and not on the guide rails. Rail systems which require the pump to be supported by legs which might interfere with the flow of solids into the pump suction will not be considered equal.

F. Lifting Chain – An adequate length of stainless steel lifting chain shall be supplied for removing the pump. The chain shall be of sufficient length and shall include an adequate number of lifting rings for easy removal.

2.04 Pump Construction

A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

B. Sealing design shall incorporate **metal-to-metal contact** between machined surfaces. Critical mating surfaces where watertight sealing is required, shall be machined and fitted with Nitrile or viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

2.05 Cooling System

A. Each unit shall be provided with an adequately designed cooling system. The water jacket shall encircle the stator housing; thus, providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket.

The cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling and seal flushing shall also be provided. The cooling system shall provide for continuous pump operation in liquid temperate of up to **104 Degrees F**. Restrictions below this temperature are not acceptable.

2.06 Power Cable

A. Power cord and control cord shall be double seated. The power and control conductor shall be single strand sealed with epoxy potting compound and then clamped in place with rubber seal bushing to seal outer jacket against leakage and to provide for strain pull. Cords shall withstand a pull of 300 pounds to meet U.L. requirements.

B. Insulation of power and control cords shall be type SOW/SOW-A. Both control and power cords shall have a green carrier ground conductor that attaches to motor frame.

2.07 Cable Entry Seal

A. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. **The cable entry junction chamber and motor shall be separated by terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable**.

2.08 Motor

A. Pump motor shall be of the totally enclosed, submersible, squirrel cage induction type rated and be of the horsepower/voltage/phase/ etc, as noted on the plans.

B. Stator winding shall be of the open type with Class F insulation good for 155°C (311°F) maximum operating temperature. Winding housing shall be filled with a clean high dielectric oil that lubricates bearings and seals and transfers heat from windings and rotor to outer shell.

C. Motor shall have two heavy duty ball bearings to support pump shaft and take radial and thrust loads and a sleeve guide busing directly above the lower seal to

take radial load and act as flame path for seal chamber. Ball bearings shall be designed for 50,000 hours B-10 life. Stator shall be heat shrunk into motor housing.

D. A heat sensor thermostat shall be attached to and imbedded in the winding and be connected in series with the motor starter contractor coil to stop motor if temperature of winding is more than 221°F. Thermostat to reset automatically when motor cools to safe operating temperature. Three heat sensors to be used on 3 phase motors. The common pump motor and grinder shaft shall be of 416 stainless steel threaded to pump impeller and grinder impeller.

2.09 Mechanical Seal

A. Motor shall be protected by two mechanical seals mounted in tandem with a seal chamber between the seals. Seal chamber shall be oil filled to lubricate seal face and to transmit heat from shaft to outer shell.

B. Seal face shall be carbon and ceramic and lapped to a flatness of one light band. Lower seal faces shall be tungsten carbide.

C. A double electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control box. This signal shall not stop motor, but shall act as a warning only, indicating service is required.

2.10 Pump Shaft

A. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings will not be acceptable.

2.11 Impeller

A. The impeller shall be of the recessed type to provide an open unobstructed passage through the volute for the ground solids. Impeller shall be of 85-5-5-5 bronze and shall be threaded onto stainless steel shaft. Enclosed or semi-open pump impellers which might become obstructed during use or add excessive radial loads shall not be considered as equal.

2.12 Controls

A. A NEMA 4x full dead front panel shall be furnished and installed appropriate for the electrical characteristics of the pump station. All pump control panels shall be a minimum size of 30″ wide x 30″ high x 8″ deep.

B. Each panel shall contain a main circuit breaker for each pump, a magnetic starter with quick trip ambient compensated overload relays in each phase, 115 volt control circuit breaker, green run light for each pump, red seal failure light for each pump, H-O-A switch for each pump, alternator relay to alternate pumps on each successive cycle, an alternator override switch, an override circuit to start all pumps if level rises in basin or to start second pump if first pump fails.

C. In addition to the above items, each panel shall be supplied with two (2) 110 volt power receptacles accessible from the outside of the panel for operation of maintenace power tools, etc., and one (1) 110 volt power receptacle accessible from the inside of the panel for additional receptacle usage. All receptacles shall be ground fault interruption protected. Controls shall have elapsed time meters calibrated in hours, strip heater with thermostat on a separate circuit, power supply for remote control system graphic panel, starters, phase/volt monitor, lightning arrestor, push to test switches for each seal leak light, motor heat sensor circuits, terminal strips and wire ways.

D. All switches, lights and resets shall be oil tight. Alternator and starters shall be FURNAS or equal. Breakers shall be SQUARE D or equal.

E. Full dead front shall be aluminum equal to HOFFMAN A-30-30AL with HOFFMAN A-NADFK dead front kit installed so as to be water tight. Starter reset buttons shall be installed on the dead front as well as all switches and lights.

F. The control panel shall include the following dry contacts for a SCADA unit:

1. Submersible Pump Fail
2. Over Temp
3. Seal Leak

2.13 Panel Mounting Pedestal

A. One (1) fabricated aluminum panel mounting pedestals shall be supplied for installation over 4" diameter holes in the wetwell top slab. Pedestal bottom flange shall be fabricated to accept four (4) 1/2" diameter stainless steel concrete anchor bolts and provide for a sturdy panel installation. Top flange on pedestal shall be flanged and drilled in eight (8) places for 1/4" bolts to allow for panel/mounting plate installation. One side of the pedestal shall have a removable gasketed door to allow for cable installation and removal. All fasteners shall be stainless steel.

2.14 Level Controls

A. The probe shall be constructed from uPVC 32mm tubing with moulded sensor units at regular intervals along the probe. Each sensor unit will be PVC injected

to prohibit ingress of moisture, and the sensor material will be Avesta SMO254 stainless steel.

B. The probe will be mounted in a turbulent area of the wet well, suspended on its own cable and connected to a 6mm stainless steel hook which would hang from a 30mm stainless steel angle containing a polyurethane squeegee pad positioned in the opening into the wet well, so that the probe can be removed without entering the wet well.

The squeegee will have a 30mm hole and slot, enabling the probe to be pulled through and cleaned.

Probe cable shall be run in a separate conduit away from any high voltage cables.

C. 10 sensors will be spaced along the length of the probe assembly, and each will be individually connected to a correspondingly numbered PVC/PVC .75mm flexible cable.

The moulded sensor unit will contain two Avesta sensors mounted on opposite sides of sensor unit. Each Avesta sensor will be 24mm high and no wider than 2mm, and will protrude from the surface of the PVC.

The probe shall be pressure injected with an epoxy resin to encapsulate all internal components and connections to form a rigid, homogenous unit.

Each sensor unit containing the two Avesta sensors will be rotated 90 degrees to the previous sensor unit to eliminate tracking between sensors.

D. The cable will be encoded with number and text along the entirety of the cable and at intervals not greater than 200mm, for identification. This cable will be dark blue in colour, with the cores light blue.

The flexible cables shall be capable of supporting the weight of the probe and cable, without the need for additional support.

The cable shall be secured to the top of the probe by a synthetic rubber compression fitting.

2.15 Alarms

A. There shall be furnished and installed in the panel, an alarm system with a red flashing light that shall be activated in cases of pump failure or pump sensor alarm, or high water situation. Audible alarm shall be set to activate in the high water alarm condition only.

2.16 Protection

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm.

B. A leakage sensor shall be available as an option to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.

C. The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS shall be designed to be mounted in any control panel.

PART 3: EXECUTION

3.01 Delivery, Storage and Handling

A. Delivery, storage, and handling shall be in accordance with Section 01600.

1. General -

Consider a unit in storage when:

(1) It has been delivered to the job site and is awaiting installation.

(2) It has been installed, but operation is delayed pending completion of plant construction.

(3) There are long periods (30 days) between operation cycles.

(4) The plant is shut down.

2. Pumps and Motors

a. If the pump and motor are in storage as described in 3.01.1 (1), or are taken out of service and put into storage, the following precautions shall be taken:

(1) Store indoors.

(2) Pumps and motors should not be stored on vibrating bases or floors. Any motor so stored should be disassembled and inspected for bearing damage, prior to service. If bearing damage is evident, replace bearing.

(3) Check the rust preventative coating on external machined surfaces (including shaft extension) for damage. If necessary, recoat the surfaces with Rest Veto No. 342 (Manufactured by E.F. Houghton Co.) or equivalent. The condition of the rust preventative coating should be checked periodically and surfaces should be recoated as recommended by the coating manufacturer.

(4) Oil lubricated bearings - drain oil from bearing housing and refill, to maximum level, with a circulating type oil. Oil should be changed every 12 months while motor is in storage.

(5) Grease lubricated bearings - once a month, inject a small quantity of grease into the grease fill such that grease is purged from the drain. Inspect purged greases for water condensation or oxidation. If water condensation or oxidation is evident, the motor should be disassembled and contaminated grease removed, and replaced with new grease.

(6) Rotate pump and motor shaft several revolutions by hand once every two weeks while in storage to insure a protective oil film on bearing surfaces.

3.02 Pump and Motor Installation

A. General

1. All pumps shall be installed by the supplier, or, if by the general CONTRACTOR then under the supervision of a factory trained and qualified representative of the supplier, at no extra cost to the OWNER over and above that bid by the General Contractor.

3.03 Field Painting

A. Field painting is specified in Section 09902.

B. The CONTRACTOR and the equipment manufacturer shall coordinate shop paint and field paint to assure compatibility in accordance with Section 09901.

3.04 Pump and Motor Testing

A. Factory Testing

1. The pumps shall be given a standard running test. The OWNER shall be notified not less than 10 days prior to the date the pumps will be ready for inspection or witness test. The pumping unit shall be tested at the factory for capacity, power requirements, and efficiency at minimum head for continuous operation, rated head, shutoff head, and at as many other points as necessary for accurate performance curve plotting. All tests shall be made in conformity with the requirements and recommendations of the Hydraulic Institute.

C. Field Testing

1. Pump and Motor Performance

a. Each pump and motor will be field tested for conformance with approved characteristic curves and motor efficiencies. The tests shall be made by the CONTRACTOR and shall be witnessed by the ENGINEER. The CONTRACTOR shall furnish all test equipment. If the efficiency of the units proves to be lower than approved data shows, it will be cause for rejection of the unit.

3.05 Start-Up and Training

A. Start- up and training shall be in accordance with Section 01600.

3.06 Tools and Spare Parts

A. All special tools required for normal operation and maintenance shall be furnished by the equipment manufacturer.

B. Spare Parts for pumps shall be those as recommended by the pump manufacturer and shall include as a minimum those parts which require periodic replacement under normal operating conditions.

END OF SECTION

SECTION 11215

ODOR AND CORROSION CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

For the purpose of controlling odor and corrosion in wastewater collection systems, an automated and integrated system using sustainable, onsite generation of oxygen and ozone, applied through a process of liquid phase treatment, termed hydrodynamic infusion, with the capability of treating a lift station, shall be used, where the lift station treatment shall also be capable of remediating fat, oil and grease (FOG) build-up.

1.02 EQUIPMENT & PROCESS DESCRIPTION

A. *System Components*

The system shall be capable of treatment of a lift station, to control and remediate odor, corrosion and FOG. The system shall be composed of a PLC- based system control in a dedicated enclosure, an oxygen concentrator system in a dedicated enclosure, an ozone generator system in a dedicated enclosure and with a dedicated air conditioning system attached, and a recirculation system to be located in the wet well for the purposes of creating a side-stream flow whereby an onsite mixture of oxygen and ozone shall be infused into the side stream and returned to the wet well delivering treatment via a rotating head.

1. Oxygen Concentrator: The system shall include an oxygen concentrator system that produces a dried and purified stream of oxygen with purity levels of greater than 93% by weight and whose source of oxygen is ambient air.
    a. The oxygen concentrator system shall use one or more compressors for the intake of ambient air. The air intake shall have particulate filters that are replaceable.
    b. The compressors shall be of sufficient capacity to supply pressures and flows to the oxygen concentrator(s) module(s), rated at 15 liters per minute.
    c. The compressors shall be oil-less, non-lube piston and cylinder design with permanently lubricated bearings and stainless steel valves. It shall have die-cast aluminum housing and contain a hard-coated, aluminum cylinder for maximum heat transfer. The compressor shall have a dual intake/exhaust manifold system.
    d. The compressors shall have individual water traps, where each trap has a minimum 5 micron particulate filter and a float-type auto drain. The water traps shall be plumbed in such a fashion that all excess water is automatically drained outside of the enclosure, with an external fitting on the outside of the unit for connecting tubing to direct flow away from the enclosure.
    e. The oxygen concentrator shall be a pressure swing adsorption design which uses a single rotary distribution valve that is self-cleaning. Intake compressed air shall be directed to a series of four sieve beds for

adsorption while concurrently four additional sieve beds are purged in a desorption process. The concentrator shall have a total of twelve sieve beds that engage in a continuously adsorption-desorption process to produce oxygen with purities of >93%.

f. The oxygen concentrator cylinders shall have a rating of up to 15 liters per minute capacity. They shall be mounted vertically within the enclosure and secured with two (2) powder coated steel support brackets which secure both the top and bottom of the module(s).
g. The oxygen concentrator system shall be a dedicated circuit breaker (see electrical requirements for additional details).
h. The system shall not exceed 63 dB at 1 meter, with the enclosure door closed.
i. The enclosure shall be NEMA 4 rated with a single rod, dual latch system.
j. This enclosure shall be capable of being mounted onto a rail, or be free-standing.

2. Ozone Generator: The system shall include an ozone generator that produces ozone at an average concentration of 5% by weight at the specified ozone mass output and oxygen volumetric flow rate of the application. The ozone generator system shall utilize the intake of dried, purified oxygen from the oxygen concentrator, which, in turn, utilizes ambient air as the original source material for the production of oxygen.
    a. The ozone shall be produced via single cell corona discharge using pulse density modulation control.
    b. The corona discharge cell shall be air cooled.
    c. All electronics shall have conformal coating for protection against corrosion and moisture damage.
    d. The high voltage surfaces within the cell shall be completely insulated and isolated from exterior surfaces.
    e. The ozone cell shall include a transformer, inverter, the cell (block and fan.
    f. The ozone generator shall be housed in its own, distinct enclosure, for thermal regulation purposes where it shall have a, dedicated air conditioning system with a minimum rating of 6000 BTUH to maintain optimized operating temperatures only within the ozone enclosure.
    g. The ozone generator will have its own circuit breaker system, distinct and physically separate from the oxygen generator (see electrical for more details).
    h. All wires shall be individually labeled.
    i. The air conditioner shall be contained in its own NEMA 4 housing and mounted directly adjacent to the ozone enclosure with its air intake drawing from the ambient environment.
    j. The ozone generator enclosure shall include an ambient air ozone monitor utilizing a heated metal oxide semiconductor sensor. The monitor shall provide feedback to the system control (see system control for details) indicating ozone levels. Should the sensor detect the presence of ozone at

a predefined level, the generator shall immediately enter a rapid shut down sequence.

k. Pressure drop detection via pressure sensor feedback within the gas (oxygen-ozone) generator system loop. Should the sensor detect a pressure drop based on a predefined level, the generator shall immediately enter a rapid shut down sequence.
l. The system shall not exceed 63 dB at 1 meter, with the door closed.
m. The enclosure shall be NEMA 4 rated with a dual latch system.
n. This enclosure shall be mounted onto an aluminum frame, powder coated skid.

3. System Control: the system shall include a fully integrated PLC control, touch screen interface, external sensor inputs and communication capability for interfacing with SCADA, internet and cellular communications protocols.
    a. System shall monitor generator status for assessing operating parameters and safety parameters including the following:
        SYSTEM IS READY, NOT ON
        SYSTEM IS ON
        2 MINUTE DELAY AFTER POWER IS TURNED ON
        SYSTEM IS WAITING FOR 2 MINUTES AFTER COMPRESSOR SHUTDOWN FOR RESTART
        SYSTEM IS PURGING
        SYSTEM IS HOT AND COMPRESSORS ARE OFF UNTIL IT COOLS DOWN
        SYSTEM HAS BEEN SENT THE COMMAND TO OPEN THE VALVE BUT IS WAITING FOR PRESSURE OR O2 PURITY
        ENCLOSURE INTERNAL TEMPERATURE
        THE ENCLOSURE DOOR IS OPEN/CLOSED
        OZONE MONITOR HAS DETECTED A HIGH OZONE LEVEL
        OZONE GENERATOR FAULT
        WARNING OXYGEN CONCENTRATOR AIR PRESSURE IS HIGH
        SYSTEM SHUTDOWN DUE TO LOW OXYGEN PURITY
        WARNING OXYGEN CONCENTRATOR AIR PRESSURE IS LOW
        SYSTEM SHUTDOWN DUE TO HIGH OXYGEN FLOW
    b. The system control shall be housed in its own enclosure using double-door construction whereby the external door is lockable. The inner door, or dead panel, shall have an LCD display.
    c. Access to the display shall be by password.
    d. The system control shall house hardware including pump controls and input/output interfaces for supporting optional external gas monitors including but not limited to hydrogen sulfide, oxygen and ozone, float sensor inputs and flow control sensors.
    e. The enclosure shall be NEMA 4 rated with a single rod, dual latch system with locking handle.
    f. This enclosure shall be mounted onto an aluminum frame, powder coated skid.
4. Electrical: the system shall include a master circuit breaker in its own enclosure and shall meet all electrical safety requirements.
    a. The breaker will have an externally accessible and lockable “master throw switch”.

b. The main circuit breaker shall be wired to three separate sub breakers; one dedicated to the oxygen generator and the supporting compressors and boosters, one dedicated to the ozone generator and its air conditioner and the other dedicated to the system control.
c. All wires in the master breaker shall be labeled.
d. The enclosure shall be NEMA 4 rated, stainless steel with a latching mechanism that does not allow the enclosure door to be opened while the master throw switch is in the "on" position
e. The enclosure shall be mounted onto an aluminum frame, powder coated skid.

B. *System Safety*

Should any of the safety levels be exceeded, the system shall immediately enter a rapid shut down sequence and provide an output alarm signal to a programmable microprocessor. Based on user-defined set points, the alarm protocol shall be capable of communicating the condition via any and all of the following: warning lights on-site, wireless web communication, SCADA, cellular network, beeper and email.

C. *Lift Station Treatment System*

The lift station treatment system shall include a hydrodynamic infuser system (HIS), also referred to as an effluent distributor or a well washer, which re-circulates resident wastewater in the wet well through either the return of effluent from a tap of the discharge main or through a dedicated pump.

1. The HIS shall be composed of a dedicated, submersible grinder pump with feed pipe or hose connected to an inlet pipe mounted under the hatch of the wet well. The pipe shall be connected to a venturi where the ozone and oxygen gas shall be introduced to the liquid flow on the vacuum side of the venturi affecting treatment. The treated flow shall be directed via pipe that holds and suspends a rotating head whereby the head suspended at four to six feet above the high water level distributes the treated flow into the wet well.
2. The lift station treatment system shall be capable of providing BOTH liquid and vapor phase odor control.
3. The HIS system shall allow a combined oxygen and ozone gaseous mix to be directly infused into the re-circulating and returning wastewater flow.
    a. The gas stream shall be introduced to the wastewater with a venturi based infuser.
    b. The oxygen-ozone infused wastewater stream shall travel from the introduction point to the rotating head, which shall also contain a dynamic mixing chamber.
    c. The rotating head dynamic mixing chamber shall promote turbulence and mixing to improve effectiveness of the oxygen-ozone mix and shall be a solids handling design so as to prevent or limit the potential for clogging.

d. The same head shall allow for dispersion of the oxygen-ozone infused wastewater back into the wet well in a rotary pattern.
e. The head shall be positioned approximately 4 feet above the high water level in the wet well and rotate from 15 to 40 rpm, using the hydraulic force of the exiting effluent to induce rotation and shall have adjustable deflectors to control the rotational speed and direction of exiting wastewater.
f. The device shall be attached to an anti-rotational locking bracket system.

4. Liquid Phase and Vapor Phase Treatment
    a. Liquid phase treatment shall be initiated via infusion of oxygen-ozone mix directly into a recycling wastewater stream passing through the venturi to the rotating head which shall deliver the treated liquid into the wet well.
    b. Vapor phase treatment shall be initiated via the return of the wastewater stream as it exits the rotating head infusion a fractional portion of the treatment flashes off in the vapor phase.
    c. The system shall produce discernable and measurable odor reduction, with H_2S as the indicator, within 30 minutes of start-up.
5. The HIS shall be constructed of 316 or higher grade stainless steel and ABS/Glass composite materials.
6. The HIS "On/Off" cycles shall be controlled either by closed-loop feedback, whereby actuation takes place when a user-defined level of H_2S is exceeded, providing virtual real-time response to H_2S levels, or through actuation via timer. The processing of either the closed-loop or timer functions shall be part of the computerized system control.
7. The HIS shall provide surface agitation, oxygenation, homogenization and cleaning action by virtue of the action of the returning treated fluent.
    a. The returning wastewater shall provide an action that reduces and prevents build-up of accumulated FOG.
    b. The device shall improve the overall cleanliness of the lift station.
    c. The device shall not require reclaimed or potable water.
    d. The materials of construction of the HIS shall be corrosion resistant. The rotating head shall be composed of composite materials on all exposed surfaces.
    e. The feed pipe and mounting bracket suspending the HIS rotating head shall be 316 stainless steel.
    f. The venturi shall be composed of a composite or stainless steel material.

1.03 MANUFACTURER

A. All systems integration shall be manufactured in the United States.
B. The high performance washing apparatus and feed system shall be provided by a single manufacturer who shall have sole-source responsibility for the system.

1.04 SUBMITTAL

A. The manufacturer shall submit complete shop drawings and engineering data to the Owner or Design Engineer, upon request. These submittals shall include, at a minimum:
    1. Drawings showing plan and elevation views of the Odor and Corrosion control system.
    2. Installation guide and descriptions for proper function of the system.
    3. Performance specification.

1.05 PROOF OF CONCEPT

A. The complete system shall demonstrate effective control of odor through an on-site, full scale pilot test and demonstration, located in at least one site under the jurisdiction of the end user.
B. The on-site demonstration shall entail a complete system set-up and full operation for a period not to exceed ten (10) days for proof of results.
C. All data collected shall be presented to the Design Engineer for review and consideration as an equal to the requirements of this project fourteen (14) days prior to the bid date.
    1. The system shall be demonstrated and show a measurable reduction of odor.
    2. The system will maintain the required levels of performance throughout the entire demonstration.
    3. The proposed alternate manufacturer shall provide a written guarantee of odor reduction performance in accordance with these specifications.

1.06 SUBSTITUTIONS

Any substitutions or deviations in equipment or arrangement from those noted and as specified herein shall require prior approval by the Design Engineer fourteen (14) days prior to the bid date. Any deviations must be accompanied by detailed structural and/or mechanical drawings and data for review by the Owner, Design Engineer or Contractor. All substitutions shall provide a "Proof of Concept" as per 1.05 above. Any and all costs associated with review of the substitutions and/or deviations and costs associated with project drawing changes as a result of approval shall be borne by the submitting manufacturer or bidder.

PART 2 - EXECUTION

2.01 SITE AND UTILITIES

Site preparation and utility service is not provided by the Manufacturer under these specifications. The following utilities shall be provided:

A. Electrical: adequate power for operation of the specific model to be installed, per manufacturer specification, up to three phase, 230V.
B. Access to wastewater to be treated. Lift station systems require access to the wet well to place and remove the HIS including the head assembly.

C. Adequate space to securely place the system while accommodating the footprint and allowing for operation and ease of access to the cabinet for system programming, systems check, maintenance, etc.

2.02 INSTALLATION

A. The system shall be installed in accordance with the manufacturer's specifications. All installation personnel shall be qualified and certified, as required by applicable state and local law. The systems are of an electro-mechanical nature and require knowledge in the following skills areas: electrical, plumbing and software programming.

B. All federal, state and local laws shall be observed for worker health and safety during the time of installation and pursuant operation.
   1. Manufacturer shall supply all appropriate safety data sheets
   2. Installation contractor shall ensure that all practices are in compliance.

PART 3 - WARRANTY

The Manufacturer shall provide a one year warranty for the system and a three year warranty on the corona discharge cell (ozone generator).

SECTION 11260

ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1—GENERAL

1.01 DESCRIPTION

A. Scope:

Furnish all labor, materials, equipment and appurtenances required to provide an open channel gravity flow ultraviolet (UV) disinfection system. To be complete and operational with all control equipment and accessories as shown and specified.

B. Related Work (Specified Elsewhere):

1. Cast-in-Place Concrete Sections
2. Electrical Sections
3. Anchor Bolts, Expansion Anchors and Concrete Inserts Sections

1.02 QUALITY ASSURANCE

A. Design Criteria

1. Provide equipment which will disinfect an effluent with the following characteristics:

a.	Peak Flow:	840,000 GPD
b.	Total Suspended Solids:	30 mg/L on a 30 day average
c.	Ultraviolet Transmittance @ 253.7 nm:	65%
d.	Annual Effluent Temperature Range:	33 to 85 ºF or 0 to 29 ºC
e.	Effluent standard to be guaranteed:	200/100 ml Fecal Coliform based 30 day Geometric Mean of consecutive daily grab samples

2. The UV equipment will be installed in a stainless steel channel furnished as part of this system, and having dimensions as shown on the drawings.
3. The system supplied will be arranged in the following manner.

a.	Number of Lamps in each UV Lamp Module:	2
b.	Number of UV Lamp Modules:	12
c.	Number of UV Banks:	2

4. The lamp array configuration will be evenly spaced in both horizontal and vertical rows with all lamps parallel to each other and to the effluent flow.

5. The supplied UV disinfection system shall accommodate the existing 2 lamp disinfection modules provided with the existing Trojan UV disinfection system.

B. Performance Requirements:

1. The UV system will be designed to deliver a minimum UV dose of 30,000 µWs/cm2 in effluent with a UV Transmission of 65% after reductions for quartz sleeve absorption, sleeve fouling, and lamp aging. The basis for evaluating the UV dose delivered by the UV system will be the manufacturer's bioassay as carried out by an independent third party. Bioassay validation methodology to follow protocols described in US EPA Design Manual - Municipal Wastewater Disinfection (EPA/625/1-86/021), without exception.

2. The UV system will produce an effluent conforming to the following discharge permit: 200 Fecal Coliform/100 ml, based on a 30 day Geometric Mean. Grab samples will be taken in accordance with the Microbiology Sampling Techniques found in Standard Methods for the Examination of Water and Wastewater, 19th Ed.

C. Qualification Requirements: UV manufacturers must strictly meet the requirements of this specification and including the following:

1. To be considered, the manufacturer will be regularly engaged in the manufacture of UV systems with a proven track record of at least one thousand (1,000) municipal installations in North America.

2. The manufacturer will provide documentation of previous experience with municipal UV disinfection systems in wastewater applications with electronic ballasts.

3. To be considered, the manufacturer will submit a bioassay evaluation for the proposed reactor. This bioassay will have been validated by an independent third party and have followed protocols described in the US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021), without exception. The manufacturer's bioassay report must demonstrate that the proposed UV system design and number of lamps will deliver the specified dose.

4. Documentation of UV manufacturer's service capabilities including location and experience.

5. Sample disinfection performance guarantee including scope and duration of guarantee-minimum of 5 years required.

1.03 SUBMITTALS

A. Shop Drawings:

Submit for review shop drawings showing the following:

1. Complete description in sufficient detail to permit an item comparison with the specification.
2. Dimensions and installation requirements.
3. Descriptive information including catalog cuts and manufacturers specifications for components.
4. Electrical schematics and layouts.
5. Independent bioassay report demonstrating dose delivered under design conditions.
6. Experience documentation.

1.04 GUARANTEE

A. Equipment:
The equipment furnished under this section will be free of defects in material and workmanship, including damages that may be incurred during shipping for a period of 12 months from date of substantial completion or 18 months after shipment, which ever comes first.

B. UV Lamps:
The UV lamps to be warranted for a minimum of 12,000 hours (non-prorated) or thirty-six (36) calendar months from shipment, whichever comes first. Pro-rated lamp warranties will not be accepted. On / off cycles are limited to an average of four (4) per day without exception.

Part 2—PRODUCTS

2.01 MANUFACTURER

A. Trojan Technologies, or approved equal. If other equipment is proposed, the Contractor must demonstrate to the Engineer and the Owner that all requirements of materials, validation, experience, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation.

2.02 GENERAL REQUIREMENTS

A. Provide a UV disinfection system complete with UV lamp modules, effluent channel, level control, and UV monitoring system as shown on the Contract Drawings and as herein specified.

B. UV system will be designed for complete outdoor installation, without shelter or supplemental cooling or heating required.

2.03 DESIGN, CONSTRUCTION AND MATERIALS

A. General:

1. All material in contact with effluent will be stainless steel or quartz.
2. All material exposed to UV light will be stainless steel, anodized aluminum, quartz 214, or Teflon™.

B. UV Module (UVM):

1. Each UV lamp module will consist of 2 lamps and their corresponding electronic ballast. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed and the other end sealed by a lamp end seal and holder.
2. The electrical wires connecting the lamps to the electronic ballasts will be enclosed in the stainless steel frame. Systems where lamp wiring is submerged in the effluent and exposed to UV light will not be allowed.
3. Each UV module will be provided with a standard 120 Volt plug and weatherproof cable for connection to a receptacle. The cable will be 10 feet long. A total of 12 UV modules will be supplied. Lamp status will be displayed on top of each UV module using watertight LED indicator lights.
4. Modules will be approximately 68.2 inches long, 14.16 inches high and 2.26 inches wide, weighing approximately 30 lbs. Materials of construction will be stainless steel type 316, anodized aluminum, quartz 214, and Teflon™, with UL rating of Type 6P.
5. The modules shall be interchangeable with the existing 2 lamp modules provided with the existing Trojan UV disinfection system.

C. UV Lamps:

1. UV system will use low pressure mercury slimline lamps of the hot cathode, instant start design.
2. 90% of UV output will be within the wavelengths of 233.7 to 273.7 nm.
3. The operating life of the lamp will be guaranteed for 12,000 hours, non pro-rated.
4. Independent validation of lamps aging factor is required.

D. Lamp End Seal and Lamp Holder:

1. The open end of the lamp sleeve will be sealed by means of a sleeve nut which threads onto a sleeve cup and compresses the sleeve ‘O' ring.
2. The sleeve nut will have a knurled surface to allow a positive handgrip for tightening. The sleeve nut will not require any tools for removal.

E. UV Lamp Sleeves:

1. Quartz sleeves to be Type 214 clear fused quartz circular tubing as manufactured by General Electric or equal.

2. Quartz to be rated for UV transmission of 89% and not subject to solarization.
3. The nominal wall thickness will be 1.0 to 2.0 mm to maximize UV transmission.

F. Effluent Channel:
1. Each UV unit will be provided with one (1) effluent channel complete with drain, UV module support rack and downstream level control weir.
2. The effluent channel will have the following dimensions: Length 235.75 inches, width 18 inches, and height 17.08 inches.

G. Level Control Weir:
1. Weir will be located downstream of the UV modules to maintain an average water depth of 6 inches/cm and ensure lamp submergence at all times.
2. Maximum effluent level variance from zero to peak flow will not exceed 1.5 inches.
3. Weir will be welded water tight and include a drain.

H. Electrical:
1. The UV disinfection system will be divided into 12 UV modules.
2. Interconnecting Cables to be standard 120 Volt, weatherproof, 10 feet long and will be suitable for outdoor installation.
3. Power Distribution Receptacles:
   a. 120 Volt receptacles rated for continuous outdoor use will be provided. Receptacles will be of the duplex type complete with ground fault interrupter circuitry.
   b. Receptacles to be provided by the UV Manufacturer.
4. Power Consumption:
   a. Maximum power draw to UV System will be 2,100 watts.
   b. All electrical supplies will be 120 Volt, 60 Hz.
   c. A separate 120 volt, 5 amp supply to be provided for the Monitoring System.

I. Cleaning Procedure:
The UV lamp modules will be cleaned by removing from the effluent channel and hand wiping the sleeves with an acid solution, using a non-abrasive cloth.

J. Monitoring System:
1. Two (2) submersible UV sensors will continuously monitor the UV intensity produced in the bank of UV lamp modules. The sensor will measure the germicidal portion of the light emitted by the UV lamps.
2. UV intensity will be indicated on a 3 character display in mW/cm^2.
3. Elapsed time in hours (lamp age) will be indicated on a 5 character display.
4. Both displays will utilize LEDs and will be visible through the panel door.
5. A dry contact will be provided for remote indication of Low UV intensity alarm.

6. Monitoring System will be enclosed in a fiberglass Type 4X wall mounted panel and is to be located less than twelve (12) feet (3.66 m) from the LED end of the UV Module.

Installation Contractor's Responsibility: The Installation Contractor to be responsible for wall mounting the Monitoring Panel as shown on the layout drawings. The Installation Contractor to be responsible for the supply, installation and connection of the following at each Monitoring Panel:

One (1) 120 Volt (230 Volt), 1 phase, 2 wire (plus ground), 50 / 60 Hz, 5 Amps power supply

One (1) 4-20 mA for remote indication for UV intensity (required if UV intensity will be monitored remotely)

One (1) dry contact for low UV intensity alarm (required if remote low UV intensity alarm is required).

K. Power Distribution Receptacle (PDR):

1. Duplex ground fault interrupter receptacle(s) will be provided by the UV Manufacturer.
2. Receptacles will be mounted in an individual, impact resistant thermoplastic junction box complete with a Type 3R rain shield for outdoor installation.

Contractor to supply appropriate 120 Volt, single phase, 60 Hz circuit to power the PDRs which have a total current draw of approximately 19.2 amps. Contractor to be responsible for distributing the power from the main 120 Volt feed to the individual PDRs. Responsibility to be all encompassing and in accordance with the local electrical codes.

L. Transition Connections:

1. One (1) inlet and one (1) outlet transition box will be supplied.
2. The material of construction for the transition boxes will be stainless steel type 304, 14 gauge.
3. Openings on the transition boxes (for flange connections) shall conform to ANSI standards and have dimensions as shown on the Contract Drawings.

M. Maintenance Rack:

One (1) Type 304 stainless steel maintenance rack will be supplied. The rack is designed to hold UV modules during service or maintenance.

N. Spare Parts:

The following additional parts will be furnished:

Eight (8) UV Lamps
Eight (8) Lamp Sleeves
Eight (8) Lamp Holders
Two (2) Operators Kits (including 1 face shield, gloves)

PART 3—EXECUTION

3.01 INSTALLATION

In accordance with Shop Drawings/Manufacturer's instructions.

3.02 MANUFACTURER'S REPRESENTATIVE'S SERVICES

Manufacturer’s equipment start up and plant operator training shall be for not less than one (1) full day.

SECTION 11285

STAINLESS STEEL SLUICE GATES, SLIDE GATES & WEIR GATES

GENERAL

1. The gates shall be provided as specified and as shown in the Contract Documents.
2. The gates shall be in compliance with the latest version of AWWA C561 as modified herein.

DEFINITIONS

1. A stainless steel sluice gate is defined herein as a heavy-duty gate with a four-sided seal system that is used to close off an orifice that experiences a maximum water level that can exceed the top of the orifice.
2. A stainless steel slide gate is defined herein as a gate that has a three-sided seal system. The seals are positioned along the sides and across the invert of the opening.
3. A stainless steel weir gate is a downward-opening slide gate.

PERFORMANCE REQUIREMENTS

1. Leakage for sluice gates and slide gates shall be restricted to 0.05 gpm/ft or less of the seal perimeter at the design seating head and the design unseating head.
2. The gate assemblies on sluice gates that are used to cover openings 60-inches wide or less shall be designed for a minimum of 20-feet of seating head and unseating head regardless of the design head. The operating mechanism shall be designed for the design head.

SUBMITTALS

1. Submittals shall include, at a minimum, detailed custom drawings of the gate assembly with dimensional and mounting information and a listing of the materials of construction. General arrangement drawings and cut sheets are not considered acceptable drawings.
2. Calculations shall be provided to confirm compliance with the safety factors listed in AWWA C561 for all parts of the frame, anchorage and slide including the portion of the slide that engage the frame.
3. A copy of the test results from the 25,000 cycle test confirming the durability of the seal system.

QUALITY ASSURANCE

1. Gates shall be equal to Model RW1000-S as manufactured by RW Gate Company, Troy, NY.
2. All gates shall be shop inspected for proper operation prior to shipment.
3. Welds shall be performed by welders with ASME Section IX certification.

4. The gate manufacturer shall be ISO 9001:2008 certified.

MATERIALS OF CONSTRUCTION

1. All stainless steel referenced in this specification shall be Type 304 or Type 304L, ASTM A240 or ASTM A276 unless otherwise indicated herein.
    a. All welded stainless steel components shall be constructed of Type 304L stainless steel.
    b. All structural stainless steel used in the construction of slides, frames and wall thimbles shall have a minimum material thickness of 1/4-inch.
    c. All non-welded stainless steel components, excluding anchor bolts and assembly bolts, shall be Type 304 or Type 304L stainless steel.
    d. Anchor bolts and assembly bolts shall be Type 316 stainless steel.

SLIDE

1. The slide shall consist of a stainless steel plate that is reinforced with stiffeners to withstand the specified head conditions. The slide shall engage the frame a minimum of 1-inch on each side.
    a. The slide shall be reinforced with plates or channel shaped members to restrict deflection to 1/16-inch or less at the design head.
    b. The stiffeners shall be welded to the slide plate in the horizontal and vertical positions.
    c. The portion of the slide that engages the frame shall have a minimum thickness of 1/2-inch.
    d. On rising stem gates, a stem connector shall be welded to the slide as a means of connecting the operating stem. The bottom portion of the stem shall be affixed to the stem connector with a minimum of two bolts.

FRAME

1. The frame shall be constructed of stainless steel plate, with the guide section formed into “C” shaped channel to house the seal, and shall be reinforced to withstand the specified operating conditions.
    a. The frame shall be a rigid, one-piece assembly with a flanged frame arrangement incorporating a tubular cross section along the guides for additional rigidity.
    b. The configuration of the frame shall be as shown on the Contract Drawings. Round back frames shall be provided when the gate assembly is to mount inside a circular structure.
    c. Flat frames shall only be provided on gates with frames that will be embedded in the concrete wall or mounted inside existing channels.
    d. Flanged frame sections shall extend the length of the frame. The use of angles as extensions from the guides to the yoke is not acceptable.

e. The guide portion of flanged frame gates shall have a minimum weight of 13 lbs/ft.
f. The guide extension portion of the frame shall have a minimum weight of 6 lbs/ft.
g. Lifting lugs shall be provided on all frame styles.
h. The frame shall be of the configuration as shown in the Contract Drawings.
i. On self-contained gates, the side frame shall extend above the operating floor and the operating mechanism shall be mounted to the yoke. When shown, the frame may extend to or below the operating floor and a floorstand may be mounted on the yoke.

SEALS

1. The seal system shall consist of self-adjusting UHMWPE seals with a nitrile compression cord.
    a. The UHMWPE seals shall be arranged to ensure that there is no metal-to-metal contact between the slide and frame.
    b. The compression cord shall be contained by the UHMWPE seal so that it shall not be in contact with the slide.
    c. Seal system shall be self-adjusting for the life of the gate. Adjustable wedging devices such as wedges, wedge bars and pressure pads are not acceptable.
    d. On upward-opening gates, rubber side seals and/or top seals such as J-bulb seals, P-seals and D-seals are not acceptable in lieu of UHMWPE seals.
    e. On downward opening gates, rubber side seals and/or invert seals such as J-bulb seals, P-seals and D-seals are not acceptable in lieu of UHMWPE seals.
    f. The invert seal on upward opening gates shall use a compressible rubber seal located on the bottom of the slide or in the invert of the frame.
        i. The invert seal shall be of a flush bottom arrangement.
        ii. The invert seal shall be mechanically fastened with stainless steel bolts.
        iii. Invert seals attached solely by the use of adhesives are not acceptable.
    g. All seals shall be secured with assembly bolts. All seals shall be field removable and field replaceable without the need to remove the gate frame from the wall.
    h. The seal system shall have been shop tested with a 25,000 cycle operating test in an abrasive environment to confirm the ability of the seals to withstand the abrasive condition with negligible deterioration and to confirm that the leakage restriction requirement is still possible.
        i. The shop test shall have been performed on a stainless steel sluice gate and the test results shall have been certified by the manufacturer in writing.
        ii. A copy of the test shall be provided to the Engineer.

OPERATING STEM

1. The operating stem shall be of stainless steel and shall be designed to transmit in compression at least 2 times the rated output of the manual operating mechanism with an 80 lbs effort.
2. The stem shall have a slenderness ratio (L/r) less than 200.
3. The threaded portion of the stem shall have a minimum diameter of 1-1/2 inches.
    a. The threads shall have machine rolled, full depth ACME threads.
    b. Stub threads are not acceptable.
4. Stems provided in multiple pieces shall be provided with couplings.
    a. Couplings shall be bronze or stainless steel and shall be internally threaded and keyed or bolted.
5. Stem guides shall be constructed of stainless steel with UHMWPE bushings.
6. Gates with rising stems shall be provided with a clear plastic stem cover.
    a. The stem cover shall be butyrate and shall have a cap and condensation vents.
7. Stop collars shall be provided to limit the downward travel on gates with manual operating mechanisms.
    a. Stop collars shall be bronze and shall be internally threaded and provided with set screws.

OPERATING MECHANISM

1. Operating mechanisms shall be provided by the gate manufacturer.
2. Manual operators shall be yoke mounted on self-contained gates or floorstand mounted when shown in the Contract Documents.
    a. Manual operators shall be of the bevel gear type suitable for operation with a portable operator.
    b. Gear ratios shall be selected by the gate manufacturer to ensure that the maximum operating effort is 40 lbs at the design head.
    c. Minimum gear ratio shall be 2:1.
    d. Gearboxes shall have ductile iron housings, a bronze lift nut, steel gears and a stainless steel input shaft.
    e. Ball or roller bearings shall support the lift nut and input shaft.
    f. The housing shall be grease lubricated and permanently sealed.
    g. Handwheels shall be provided.
    h. Adaptor plates shall be utilized to attach the operating mechanism to the yoke. Adaptor plates shall be stainless steel and shall have a minimum thickness of ¾-inch.

FLOORSTANDS AND WALL BRACKETS

1. Floorstands shall be mounted to the concrete, mounted to a wall bracket or mounted on the yoke of a self-contained gate as shown on the Contract Drawings.
2. All floorstands and wall brackets shall be fabricated from stainless steel.

a. The base plate, adaptor plate and gussets shall be minimum 1/2-inch thick.

ANCHORAGE

1. Anchor bolts and wall thimble studs shall be 316 stainless steel, fully threaded and shall have a minimum diameter of 1/2-inch.
    a. Anchor bolts shall be of the epoxy type.

FINISH

1. All heat tint and slag from the welding process shall be acid passivated or mechanically passivated through bead blasting in accordance with ASTM A380. Grinding or buffing is not acceptable in lieu of passivation.
2. All ferrous components shall be suitably prepared and then shop coated with primer. Finish coating shall be applied by the Contractor. The ductile iron operator housing shall be finish coated by the Contractor with a suitable paint that complies with the Painting section.

INSTALLATION

1. Installation shall be performed in accordance with the gate manufacturer's installation instructions and the approved installation drawings.
2. Installation instructions and installation drawings shall be found in the O&M manual.
3. Non-shrink grout or a resilient gasket shall be applied, by the Contractor, between the gate frame and the wall to ensure that there is no leakage around the gate.
4. The material used to mount the gate shall be indicated on the approved installation drawings.

SECTION 11310

SOLIDS-HANDLING SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer’s recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the

project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer
2. Type and Model
3. Rotational speed
4. Major component materials of construction
5. Pump specification describing construction details:
    a. Assembly drawing, nomenclature and material list
    b. Type, manufacturer, model numbers, location and spacing of bearings.
    c. Impeller type, diameter, through-let dimensions, sphere size, number of vanes and identification number.
6. Setting plans shall include:
    a. Installation Drawing
    b. Anchor bolt layout
    c. Anchor bolt dimensions.
    d. Outline dimensions and weights of pumps, bases, motors, and control enclosures.
7. Complete motor performance data including:
    a. Rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to full speed.
8. Warranty for the proposed equipment.

B. The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical

characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One set of mechanical seal assemblies for each size pump.

2. One complete set of gaskets for each size pump.

3. One complete set of bearings for each size pump.

PART 2 - PRODUCTS

2.01 PUMP DESIGN (WET WELL MOUNTED)

A. The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal to metal watertight contact. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90 degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

B. Pump Schedules: Pumps shall be provided to meet to following conditions and duty points.

Pump Name	Feed Forward Pump
Number of Pumps	2
Fluid to be pumped	Returned Activated Sludge
Fluid Specific Gravity	1.05
Fluid Viscocity (cp)	110
Hazardous Location	No

VFD Controlled	Yes
Solids Concentration (mg/l)	8000-15000
Primary Duty Point	
Capacity 1 (gpm)	1667
Total Dynamic Head 1 (ft)	20

C. Pumps shall be submersible, single stage, centrifugal type, supplied with integral electric motor, discharge elbow, guide bar brackets and installation accessories. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 35 degrees to 104 degrees F.

D. Materials and Construction Features

1. Pump casing and construction shall incorporate following features:

a. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel and/or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish or two-part epoxy on the exterior of the pump.

b. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit.

c. Rectangular cross sectioned gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

E. Cable entry

1. The cable entry seal design shall provide strain relief and preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of at least one elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. For units greater than 100 HP, cable entry shall incorporate dual grommets which shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using

the same entry seal. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2. The cable junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression-type terminals. The use of wire nuts or crimp-type connectors is not acceptable.

F. Bearings

1. The integrated pump/motor shaft shall rotate on two (2) sealed and permanently lubricated bearings. External bearing lubrication ports, which allow bearing contamination and over-packing, will not be allowed. The upper bearing, providing for radial thrust, shall be a single row, roller or ball bearing. The lower bearing shall consist of one double row angular contact bearing for combined axial and radial loads. Minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

G. Motor

1. Each pump shall be driven by a vertical, submersible squirrel cage induction motor, shell type NEMA B design, housed in a dry watertight chamber. The motor and the pump shall be produced by the same manufacturer.

2. The stator winding shall be insulated with moisture resistant Class H insulation, rated for a temperature of 180^{O}C. The stator shall be insulated using Class H monomer-free polyester resin, resulting in a winding fill factor of at least 95%. The stator shall be heat shrink fitted into the cast iron stator housing. The use of multiple step dip and bake type stator insulation process is not acceptable. The use of bolts, pins, screws, or other fastening devices used to locate or hold the stator and that penetrate the stator housing shall be rejected. The motor shall be designed for continuous duty, while handling pumped media of up to 104 degrees F. The motor shall be capable of withstanding at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

3. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with, and supplemental to, external motor overload protection, and shall be connected to the motor control panel.

4. The motor service factor (combined effect of voltage, frequency, viscosity, and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for continuous operation in a 40^{O}C. ambient environment and shall have a NEMA Class B maximum operating temperature rise of 80^{O}C. A motor performance curve shall be provided upon request, showing torque as a function of speed, and current, power factor, speed, input power in KW, and efficiency as a function of shaft power.

5. The motor shall be sized to be non-overloading when the pump is operated at any point on the pump performance characteristic curve. See Section 4.0 for application-specific motor performance requirements.

6. Motors shall be 460 volts, 60 Hz, 3 phase.

7. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

8. Motors shall be premium efficiency type.

9. Inverter Duty:

    a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

        i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

        ii Inverter grade, 1,600 volt, Class F insulation.

        iii Service factor of 1.0 when operated from a VFD.

        iv Meeting requirements of NEMA MG1 Part 31.

10. Shaft

    a. Pump and motor shaft shall be a solid continuous unit. The pump shaft is an extension of the motor shaft. Couplings and shafts incorporating sleeves shall not be acceptable. The pump shaft shall be completely isolated from the pumped liquid.

11. Motor Cables

    a. Pump motor power cables installed shall be oil resistant chloroprene rubber jacketed, type SPC multi-conductor cable, suitable for submersible pump applications and heavy mechanical stresses. The power cable shall also be sized according to NEC and ICEA standards. The total length of each cable shall be a minimum of 40 feet long. Power cables shall each include a ground check conductor (see Sec. 5.14).

H. Hazardous location equipment (explosion proof service)

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only motors certified by Factory Mutual for use in such locations shall be used.

2. Specifically, the pump motors used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and

G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

I. Guide bars and brackets (wet well mounted)

1. Guide bar(s) shall be provided for guiding the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow. Guide cables shall not be considered equal to guide bars and will not be accepted. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

2. The anchor bolts, upper guide bar brackets and cable holder shall be fabricated from 300 series stainless steel.

J. Lifting cable and fittings (wet well mounted)

1. Each pump shall be fitted with 20 feet of AISI 304 stainless steel lifting chain, (or stainless steel wire rope), with necessary fittings, capable of lifting the pump and motor.

K. Manufacturer's Warranty

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for five (5) years, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective sixty (60) days after installation, or ninety (90) days after shipment, whichever occurs first.

L. Manufacturers

1. ABS

2. Wilo-EMU

3. Approved equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines as required.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies

B. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

C. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

D. Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

3.04 ACCEPTANCE TESTS

A. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

1. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

2. All automatic and manual controls function in accordance with the specified requirements.

3. All drive equipment operates without being overloaded.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

SECTION 11311

SELF PRIMING PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of self priming pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer’s recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be

included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer
2. Type and Model
3. Rotational speed
4. Major component materials of construction
5. Pump specification describing construction details
6. Outline Dimension Drawing
7. Installation Drawing
8. Complete performance data showing capacity and power input
9. Electrical Data that includes
    a. Motor rating, hp
    b. Motor temperature rating
    c. Motor full load rotational speed
    d. Motor full load current
    e. Motor locked rotor current
10. Motor performance curves showing speed, efficiency, current, power, etc.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

PART 2 - PRODUCTS

2.01 PUMP DESIGN

A. Pumps must be designed to handle raw, screened, industrial waste.

B. Solids Handling Capability – When pumps are used for handling raw wastewater or activated sludge, all internal passages, impeller vanes, and recirculation ports shall pass a 2.5" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer or owner, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

C. Reprime Performance:

1. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

2. Pump must reprime the Maximum Repriming Lift shown in the Pump Schedule at the specified speed and impeller diameter while operating with only one-half of the liquid remaining in the pump casing. (Reprime lift is defined as the static height of the pump suction above the liquid.)

3. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

4. Upon request from the engineer or owner, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

D. Pump Schedules: Pumps shall be provided to meet to following conditions and duty points.

Pump Name	WAS Pump
Number of Pumps	2
Fluid to be pumped	Activated sludge
Fluid Specific Gravity	1.05
Fluid Viscocity (cp)	110
Hazardous Location	No
VFD Controlled	No
Solids Concentration (mg/l)	15000-30000
Primary Duty Point	
Capacity 1 (gpm)	16
Total Dynamic Head 1 (ft)	20

Pump Name	Permeate Pump
Number of Pumps	4
Fluid to be pumped	Water
Fluid Specific Gravity	1

Fluid Viscocity (cp)	1
Hazardous Location	No
VFD Controlled	Yes
Solids Concentration (mg/l)	5-10
Primary Duty Point	
Capacity 1 (gpm)	206
Total Dynamic Head 1 (ft)	20

E. Pumps shall be end suction, single stage, horizontal frame mounted, vertical V-belt type base, self-priming centrifugal type.

F. Materials and Construction Features

1. Pump casing: Casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

   a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

   b. Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.

   c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

2. Coverplate: Coverplate shall be cast iron Class 30. Design must incorporate following maintenance features:

   a. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.

   b. A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS.

   c. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.

   d. Two O-rings of Buna-N material shall seal coverplate to pump casing.

   e. 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.

   f. Easy-grip handle shall be mounted to face of coverplate.

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 following features:

    a. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

        i 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.

        ii The seal cavity shall have an oil level sight gauge and fill/vent plug. 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.

        iii Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

    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 and be secured with a lockscrew and conical washer.

    c. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer or owner, in which case AISI 17-4 pH stainless steel shall be supplied.

    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 be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be AISI 316 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

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.

   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. 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 through the coverplate opening, without disturbing the suction piping. 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.

6. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports and meeting ANSI B16.1,Class 125. 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.

G. Motor

1. Motors shall be squirrel cage induction type, totally enclosed, fan cooled, rated for inverter duty (unless otherwise stated).

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. Motors shall have NEMA Class F insulation.

4. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

5. Motors shall have a 1.15 service factor rating. The pump brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Pump Schedule.

6. Motors shall be premium efficiency type.

7. Inverter Duty:

    a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

        i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

        ii Inverter grade, 1,600 volt, Class F insulation.

        iii Service factor of 1.0 when operated from a VFD.

        iv Meeting requirements of NEMA MG1 Part 31.

H. Hazardous Location Equipment

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only motors certified by Factory Mutual for use in such locations shall be used.

2. Specifically, the pump motors used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

I. Manufacturer's Warranty:

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for five (5) years, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective sixty (60) days after installation, or ninety (90) days after shipment, whichever occurs first.

J. Manufacturers

1. Gorman Rupp

2. Approved equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required.

C. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.04 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

SECTION 11330

AUTOMATIC FINE SCREEN

GENERAL

1.01 DESCRIPTION

A. Scope: This section of the specifications covers the labor, materials, equipment and installation necessary to install three (3) Model FS-1100S automatic bar type fine screens with appurtenances for a complete operating system. Items of equipment include fine screens and shaftless screw conveyor/washer/compactor, discharge chute, anchors and fasteners. All equipment items shall be supplied by a single supplier to insure a complete working system.

B. The fine screen shall be the bar type, cleaned with multiple rakes that engage the screen from the downstream side. Screenings shall be carried up the screen and discharged into the conveyor/washer/compactor for disposal to the Owner supplied container. All materials of construction for the fine screen are corrosion resistant.

C. Design Data:

a. Maximum, peak 2-hour flow, 1100 gpm
b. Box width, 1.67-ft
c. Box depth, 3.0-ft
d. Maximum upstream water depth, 2.15-ft
e. Bar rack incline to horizontal, 60-degrees
f. Clear opening between bars, 2.5 mm

1.02 QUALITY ASSURANCE

A. The fine screen and conveyor/washer/compactor shall be furnished by a single manufacturer fully experienced in the manufacturer of the equipment to be furnished. The fine screen manufacturer shall have a minimum of 10 years of experience in the design and manufacturer of the automatic bar type fine screens. The equipment specified shall be equal to that supplied by Ovivo USA, LLC.

B. The contract documents provide details of a complete equipment installation for the purpose specified. It shall be the responsibility of the Contractor to coordinate all the details required for a complete operating system, such as protective coatings, piping, pumps and wiring. The Contractor shall provide

all work required to properly install, adjust and place into operation a complete working system.

1.03 SUBMITTALS

A. Information required for approval by the Engineer prior to incorporation into the project shall include the following as a minimum requirement:

1. Certified dimension prints detailing all required concrete block-outs, anchor bolt locations and conduit stub-outs.

2. Specifications for all electrical and mechanical components and complete wiring diagrams for all the automatic functions.

3. Manufacturer's recommended procedures for jobsite storage and handling of equipment.

B. Operation and Maintenance Manuals: Prior to delivery of equipment and updated as required during installation of the equipment, the manufacturer shall furnish complete and detailed installation, operation and maintenance manuals which shall include the following as a minimum requirement:

1. Assembly, installation and adjustment instructions.

2. Maintenance instructions.

3. Complete descriptive literature of all materials and components furnished.

4. Erection drawings with equipment mark numbers.

1.04 WARRANTY

The manufacturer shall warrant the fine screens and other associated manufacturer supplied equipment against defects in material or workmanship for a period of one (1) year from the date of start-up.

PRODUCTS

2.01 MATERIALS

A. The fine screen shall be the automatic self-cleaning type with vertical bars and multiple rakes to carry the screenings upward to the discharge point. The bars are inclined 60-degrees to the horizontal and spaced per section 1.01.C Design Data. The bars shall be trapezoidal in shape manufactured from Type 304 stainless steel.

B. The rakes shall be manufactured from 304 stainless steel**.** The rakes engage the screen from the downstream side to remove trapped material from the screen bars. The rakes are attached at both ends to a Type 304 stainless steel carrier chain. The chain is driven by four sprockets, two on top and two on bottom, manufactured from UHMW. The chain rides on UHMW guide strips attached to each side frame. The sprockets are keyed to Type 304 stainless steel shafts that extend across the width of the frame and are supported by bolt-on solid lube bearings. The upper shaft has an internal key for the gearmotor drive shaft attachment.

C. The frame is manufactured from gauge stainless steel formed with a flange on the front and rear to provide rigidity. The frame has a bolt on support stand, is self-supporting and sits in the floor of the bar screen box or influent channel. PVC pipe spacers are bolted across the frame to maintain the uniform width from top to bottom and also provide rigidity.

D. Side seals are furnished along the inclined side frames and attach with Type 304 stainless steel fasteners and a reinforcing strip on the downstream side. The seals are 40 durometer neoprene and overlap and lay against the sides of the screen box or influent channel to form a seal. The front of the screen frame is sloped to the floor and has a hinged plate to access the screen bar clamp. The sides of the frame have neoprene seals bolted on to seal the open area of the channel.

E. The rakes are driven by a high reduction gearmotor. The motor is 0.25 horsepower and is totally enclosed as part of the gear reducer. The motor is 3 phase, 60 cycle, 460 volt power. Fifteen (15) feet of power chord is provided and is sealed to the gearmotor. The gearmotor can be wetted and part of the maintenance program is frequent cleaning. The gearmotor is attached to the frame with a four bolt connection and direct drives the upper shaft of the screen. The motor shall be suitable for operation in a Class I, Division I, Group C or D area. A thermal overload relay shall be provided in the control panel set to trip at 110 percent of full load amps as overload protection for the drive. All mechanical components are designed to withstand 150 percent of the maximum output of the drive.

F. The number of bars on the fine screen can be changed on site to provide a variety of clear openings. The bars can be changed by pivoting the bottom hinged cover plate and removing the clamp plate without removing the screen from the influent channel. This procedure takes no more than 30 minutes to complete. .

G. All materials are corrosion resistant; Type 304 stainless steel, HDPE plastic or UHMW. The gearmotor shall receive two coats of high build epoxy coating at the factory.

H. MBR system control panel will house the circuit breaker, thermal overload relay, HOA switch and time delay relay for proper automatic operation of the screen. A float switch shall be wired to contacts in the panel to initiate operation of the screen and initiate the time delay to terminate screen operation after a 15 second delay.

I. Screenings Washer/Compactor

Design Requirements.

1. Designed to handle intermittent loading of normal screenings from raw domestic sewage.

2. Conveyor: Shaftless screw-type conveyor featuring a lined trough with fill and discharge chutes for wastewater screenings:
    a. The length of the conveyor shall be measured from the center of the inlet chute to the center of the discharge chute.
    b. The section of the conveyor between the inlet chutes and discharge end shall include a bolted cover.

3. The conveyor shall be provided with washwater spray to minimize transported organics. The washwater spray shall include a solenoid valve for on/off control tied to conveyor operation.
4. The screw shall consist of a stainless steel flat bar spiral with drive flange on one end. Lower bearings shall not be required or permitted.

MBR control panel will house all necessary controls excluding motor starter.

Materials and Fabrication.

1. The conveyor trough, chute and supports shall be fabricated from minimum 12 gauge type 304L stainless steel.
    1. The cover for the conveyor trough shall be 16 gauge stainless steel with a stainless steel inlet flume.
    2. The trough liner shall be UHMW polyethylene, minimum 1/4” thickness.
2. The screw shall consist of a 5/8” thick stainless steel 1.5” flat bar x 6.25” OD spiral. A drive shaft with flanged end shall be provided for the shaft-mounted reducer.
3. The upper end of the conveyor screw shall be connected to a flange mounted helical gearmotor as manufactured by SEW Eurodrive, Inc.
    1. The gear shall be oil lubricated and provide the specified output speed.
    2. The motor shall be a 1/3HP, TEFC, 3/60/460 with a 1.15 service factor.

4. Several feet downstream of the spiral the screenings pass through a multi-nozzle spray wash zone utilizing ¼" npt stainless steel spray nozzles. Each nozzle introduces 0.5 gpm at 60 psi of water equal to municipal drinking water quality for a total of 2.0 gpm required.
5. A ½" diameter schedule 40 stainless steel manifold is provided with threaded fittings for attaching each spray nozzle. The manifold includes a solenoid valve for automatic operation and a manual ball valve for shutoff and volume adjustment.
6. Drainage from the wash zone is through a wedgewire screen piece extending a minimum of 3" past the first and last nozzle. Water drains to a drop section of trough and is returned to the wastewater stream via a schedule 80 pvc drain pipe.
7. The compaction zone shall consist of a 6.375" ID stainless steel perforated cylinder that houses the screenings during compaction.
8. Washed/Compacted screenings are discharged from the conveyor via a hinged, weighted end plate down an enclosed chute.

J. CONTROLS

A. The screenings control system shall provide for automatic control of the screen and washer/compactor via a high liquid level using an ultrasonic liquid level control system in connection with a delay timer and HOA switch. All screen and washer/compactor functions shall be programmed in the local PLC provided with the Membrane Bio Reactor. Remote monitoring of the screenings operation shall be the influent channel water level, high level alarm, screens and washer/compactor in standby, screens and washer/compactor in operation and screen or washer/compactor alarm condition.

J. SPARE PARTS

A. The following spare parts shall be provided:

1. One (1) set of rakes for one fine screen.
2. Two (2) fine screen lower bearings and seals.
3. One (1) solenoid valve for the conveyor/wash system.

Spare parts shall be packaged separately and properly labeled as spare parts.

L. INSTALLATION

A. Manufacturer's Service Representative: The fine screens and washer/compactor shall be furnished complete by the manufacturer and assembled, erected and installed by the Contractor as directed by the manufacturer in his working drawings and written instructions. The

installation, alignment and testing shall be checked and approved by a factory representative before acceptance. Service time shall be two (2) trips and three (3) days.

M. TESTING

A. The manufacturer shall demonstrate to the Owner and Engineer that the fine screen cleaning mechanism effectively removes debris from the influent wastewater, the washer/compactor washes and compacts the captured screenings and that all electrical and mechanical equipment functions as intended.

END OF SECTION

SECTION 11350

SLUDGE DEWATERING BOX

CONSTRUCTION AND MATERIAL REQUIREMENTS

Part 1 - Container Construction

1.1 Container Filter shall be a **Sludge Mate® Model SM-30-C-RB** as manufactured by Flo Trend® Systems, Inc. of Houston, Texas (800-762-9893). Alternates or substitutions require approval.

1.2 Dimensions shall not exceed 23'-1" L x 8"-6" W x 7' H nor shall it weigh over 11,680 lb. Internal area shall yield a minimum of 27.20 cubic yards of sludge storage.

1.3 Container Filter shall be constructed of A-36 carbon steel plate with 7-gauge floor and 10 gauge walls. The unit shall be rectangular in shape. Floor cross members are structural channels spaced on 24" centers.

1.4 Container Filter shall have **two 3" threaded drainage ports on each lower side at opposing ends**. Each port to have a 3" hose cam connection with cap and chain. The drainage system shall be constructed in such a way to allow the side walls and vertical center panel to drain into a common drain channel or cavity. Drainage can be either by gravity or by a pump assist.

1.5 Rails are constructed of 6" x 2" x 3/16" structural tubing with 36½" inside spacing.

1.6 The Container Filter shall be equipped with four (4) wheels, 8" diameter x 8" wide diagonally braced. Tracking wheels shall be 4" diameter x 6" wide.

1.7 Wall gussets are 7 gauge formed plate.

1.8 Door sealing face will be totally watertight and have an EPDM gasket on the surface area. Door frame shall be made of 4" x 3" x 3/16" structural tubing and with three steel hinges located on the side. Door sealing shall have 1" ratchet chain binders, one on each side and one in the middle of the door. Hinges are constructed of ½" wall steel tubing and 1" diameter hot rolled bar pins with welded retainer washers.

1.9 Internal filter support system will be comprised of ¼" angles, cold formed channels and removable filter support panels with frames made from 1-1/2 No. 9 flat both sides **hot dipped galvanized expanded metal** and reinforced with flat bars. The vertical center panel will be shelf supporting and made with ¼" structural angles and flat bars.

1.10 All removable filter panels shall have a ¼" x 2" wide neoprene gasket installed between the panel and framework. **Chalking or other sealant is not an acceptable gasket material**.

1.11 Filter media shall be four pieces made from Flo Trend® Systems **Poly 2000**. This material consists of a polyester blend, plain weave, 26.7 ounces per square yard, 600 x 800 micron opening, with 26% open area, .047" thickness, 758 CFM @ ½" W.G. air permeability and tensile strength @ break will be 747 pounds per linear inch. A commercial heat knife and hole-maker shall be used for cutting ends and locating holes. Alternates or substitutions require approval.

1.12 Filter media shall be installed on each long side wall and both faces of the vertical center panel. **The filter media shall be 57" minimum in vertical height on all faces**. All filter panel supports, bars and media are bolted into place with **stainless steel fasteners consisting of studs, flat washers and acorn nuts.**

~~1.13 Peaked roof constructed of 10 gauge A-36 carbon steel plate with four (4) bolt down, hinged, gasketed hatches 32" x 36"~~

Part 2 - Material Specifications

2.1 Hot-rolled structural steel shapes and plates shall be ASTM A36.

2.2 Hot-rolled carbon steel sheet and strip structural quality shall conform to ASTM-A570 grades D & E.

2.3 Hot-formed welded and seamless steel tubing shall conform to ASTM A500 grade B.

2.4 Welded and seamless steel pipe shall conform to ASTM A53 grade B.

2.5 Stainless steel fasteners shall conform to AISI grade 304/305.

2.6 Welding electrodes are E70S used in gas metal arc process conforming to the specifications for mild steel electrodes for gas metal ARL welding AWS A518.

2.7 All exposed welds shall be cleaned of welding slag and rounded. All exposed sharp edges and corners shall be rounded.

2.8 **All steel metal surfaces shall be sandblasted to near white metal** and commercially coated with a two-part epoxy primer.

2.9 The external final surface shall receive 5 mils dry Corothane II industrial/marine coating.

2.10 Interior surfaces will have a final coating of coal tar epoxy applied totaling 5 mils dry.

Part 3 - Miscellaneous

3.1 Unit shall be water tested for complete water tightness.

3.2 The manufacturer shall be responsible for supplying written instructions, which shall allow the operator to operate and maintain the equipment supplied. Instructions shall assume that the operator is familiar with pumps, motors, piping, valves, and controls, but that he has not previously operated and/or maintained the exact equipment supplied.

The instruction shall be prepared as a system manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

A minimum of two (2) operation and maintenance manuals with spare parts lists shall be provided at no additional cost.

SECTION 11355

POLYMER INJECTION AND MIXING SYSTEM

MINIMUM STANDARDS OF CONSTRUCTION

The Polymer Injection and Mixing Unit shall include a single tank with an electric agitator as the polymer/mixing device. A top opening shall be included for adding a predetermined amount of liquid polymer to the clean water in the tank while the agitator is running. The resultant mixture shall be blended until a homogeneous solution of dilute polymer is obtained.

The unit shall be a **Model PM250E Poly-Mate® Polymer Injection and Mixing System** as manufactured by Flo Trend Systems, Inc. of Houston, Texas (800-762-9893), or approved equal. Unit shall be constructed per the following specifications:

1. A 500-gallon polypropylene tank with a flat area to mount the mixing agitator with motor.
2. A 3/4 H.P. electric agitator with an electric TEFC motor, mixing shaft, and two-(2) stainless steel mixing blades to be attached to the shaft and held into place with suitable locking screws or pins.
3. 3/4 H.P. electric motor with a variable speed D.C. controller will be coupled to a moyno progressive cavity pump rated for at least 4 gpm of diluted polymer.
4. Sludge mixing shall be by a patented Model MM-400 Mix-Mate® static mixing manifold with 3" inlet and 3" outlet. Mixing nozzle will be designed for sludge flow-rates from 50 to 100 gpm – depending on the total solids percent being handled.
5. The control panel shall have a sight flow indicator tube to provide a visual indication of diluted polymer being injected into the waste stream.
6. Mixing motor on/off switch to be installed on a Nema-4 rated panel and mounted on the control stand.
7. All components less the tank will be mounted on a common steel channel base, wired, and with manifold for customer hookup at site.
8. The polymer mixing tank will be shipped complete with a hose feed supply, disconnect and cutoff valve.
9. All steel parts are to be sandblasted to white metal and coated with a two-part epoxy primer, and the final upper or top coat will be an industrial/marine red epoxy.
10. The equipment is designed to handle only liquid polymer.
11. All standard units are to be wired for 110-volt single-phase power. Maximum amp breaker to be 15 amps.
12. Tank with agitator dimensions: 48" diameter x 84" high
13. Weight: 180 lbs.
14. Skid mounted unit dimensions: 36" L x 20"W x 48"H
15. Weight: 290 lbs.

MANUFACTURER'S SERVICES

The successful bidder shall furnish the services of a qualified field engineer to perform the following functions in the designated periods of time as detailed by the contract. These services are to be performed at the jobsite. A minimum of one (1) visit to the job site shall be required. The visit will include equipment installation check, start up of the equipment and initial operators training.

OPERATION AND MAINTENANCE MANUALS

The manufacturer shall be responsible for supplying written instructions, which shall allow the operator to operate and maintain the equipment supplied. Instructions shall assume that the operator is familiar with pumps, motors, piping, valves, and controls, but that he has not previously operated and/or maintained the exact equipment supplied.

The instruction shall be prepared as a system manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

A minimum of two (2) operation and maintenance manuals with spare parts lists shall be provided at no additional cost.

SECTION 11375

POSITIVE DISPLACEMENT BLOWERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor

1.02 SCOPE

A. Provide all labor, materials, tools and equipment required to furnish and install, in good workmanlike manner, Positive-Displacement Rotary 3-lobe blower units with integrated pulsation cancellation. Blower units shall be complete and operational.

B. Blowers(s) shall be designed for continuous duty operation, to provide the air volumes as defined in the Blower Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. Blowers and appurtenances shall be supplied by a CE certified blower manufacturer with a Quality Control System certified in accordance with ISO 9001. Units shall be furnished as a complete system

B. All equipment furnished under this section shall be furnished by a single manufacturer who shall assume complete responsibility for the design and performance of the equipment. The manufacturer shall have a minimum of five (5) years experience in producing blower equipment and shall produce evidence of at least five (5) installations of similar size in satisfactory operation in the United States.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the blowers(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be

highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. ASME PTC – 9 Performance Test Results
2. Manufacturer of all components supplied
3. Model numbers of all component supplied
4. Rotational speed
5. Capacity in scfm and icfm
6. Discharge pressure
7. dB(A) noise pressure level
8. Weights of each item of equipment
9. Major component materials of construction
10. Blower specification describing construction details
11. HP required at rated capacity and pressure
12. Outline Dimension Drawing
13. Installation Drawing
14. Complete performance data showing capacity and power input
15. Electrical Data that includes
    a. Motor rating, hp
    b. Motor temperature rating
    c. Motor full load rotational speed
    d. Motor full load current
    e. Motor locked rotor current
    f. Motor performance curves showing speed, efficiency, current, power, etc.
16. List of recommended spare parts broken down into on hand parts and long term for 2 years operation and 3 to 5 years operation.

17. Manufacturer’s warranty

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include blower and blower package outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One complete set of gaskets, seals, V-belts, as required for each blower size.

2. One additional set of filter elements for each air inlet filter for each blower size

B. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

C. One set of Tools required for changing oil and performing belt maintenance shall be provided for each blower size.

PART 2 - PRODUCTS

2.01 BLOWER DESIGN

A. Site Conditions

1. Elevation: [800] feet above sea level

2. Maximum inlet temperature: [95] deg F

3. Maximum humidity (at maximum temperature): [80] %RH

B. Blower Schedules: Blower packages shall be provided to meet to following conditions and duty points.

Blower Name	Pre-Aeration (Process) Blower & MBR Scour Air Blower
Number of Blowers	5
Maximum Blower Capacity	350 SCFM
Minimum Blower Capacity	85SCFM
Maximum Differential Pressure (excluding internal blower losses)	8]psig
Indoor/outdoor	Indoor
Hazardous Location	No
VFD Controlled	Yes

C. Blowers shall be sized so that maximum duty point does not exceed 90% of maximum blower speed.

D. Blowers shall be rotary-lobe, dynamically and statically balanced, tri-lobe design with an equalization chamber integral to the blower housing.

E. The blower rotors are to be balanced according to ISO 1940 class Q 2.5. With respect to acceptable vibration levels, the blowers must operate between effective vibration speeds of 2.8 to 7.0 mm/sec. (0.11 to 0.276 inches/sec.) measured at the bearing housing per VDI standard 2056. For acceptance, all blowers must conform to ISO 2373, Machine Group T.

F. Each blower shall be factory tested per ASME PTC-9 performance test to verify flow, BHP, and slip at design conditions as well as blower maximum conditions. Slip test only shall not be acceptable. The acceptance criteria are +5% tolerance on power and –5% tolerance on flow regardless of the size of the machine. The performance test can be performed in accordance with other internationally recognized standards, such as ISO.

G. Materials and Construction Features

1. Blower Housing

   a. Housing shall be fabricated of close grained high strength cast iron construction with DIN inlet and outlet connections, provided with a built-in "equalization" chamber, and drive-end head-plate integral to the cylinder.

2. Rotors

   a. Rotors shall be stiff-shaft design with the first lateral critical speed at least 120% of the maximum allowable speed.

   b. Any torsional natural frequency shall be at least 10% above or 10% below the operating speed range of the blower.

c. The rotor and shaft assembly shall be a one-piece design constructed of ductile iron.

d. Rotors shall be solid or have closed ends.

e. Rotors shall have an integral sealing strip for improved efficiency.

3. Timing Gears

a. Timing gears shall be spur type, precision ground, hardened and carburized, AGMA Grade 11 equivalent quality or better, with minimum service factor of 1.7 at the maximum operating point.

b. Gears shall be secured by bolting and interference fit on precision ground tapered shaft ends.

4. Bearings

a. Bearing shall be high standard cylindrical roller bearings with an L-10 Life of at least 40,000 hours at maximum speed and maximum differential pressure.

5. Seals at Rotor Chamber

a. Rotor chamber seals shall be non-rubbing, vented, labyrinth-type seals. Each seal assembly shall consist of four (4) hardened steel piston rings, an oil deflector, a grooved labyrinth sleeve, and casing wear ring. There are a total of (16) sixteen piston ring seals.

b. Provision for venting to atmosphere between the oil-side and the air-side seals shall be included.

c. The use of lip-type seals for internal rotor shaft sealing is not acceptable.

d. Replaceable casing wear rings to protect the seal bores in the headplates are required.

6. Input Shaft Lip Seal

a. The input shaft seal shall be a lip type seal

b. The seal assembly must include a shaft sleeve, precision ground, with a titanium dioxide coating and a relief taper at the dust lip to reduce friction and heat.

c. The seal assembly must be fully serviceable without removing the front oil chamber cover.

2.02 BLOWER PACKAGE

A. Each blower shall be supplied with a sound enclosure covering the entire blower package including the drive motor, the inlet silencer, and the discharge silencer. The sound enclosure must be designed for easy inspection and maintenance of all blower package components. The enclosure shall provide suitable protection for outdoor installation under the specified site conditions.

B. The free field noise pressure at 3 feet from the enclosure shall not exceed [80] dB(A) at the listed operating conditions.

C. The packages shall be driven through V-belts and sheaves. The drive assembly shall be of the high capacity type, oil and heat resistant, with a minimum service factor of 1.5.

D. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base with adjustable spring assistance and visual indication of V-belt tension shall be provided to insure the V-belts remain properly tensioned with minimal maintenance and to extend V-belt, sheave, and bearing life.

E. The drive guard shall be the manufacturer's standard sheet metal with provision for ventilation. The installed guard shall be fully enclosed, easily removable, and designed to meet current OSHA recommendations and CE standards.

F. The base shall be an elevated, rigid, fabricated steel design with a solid sub-base. The discharge silencer must be integral to the frame in order to minimize space requirements.

G. To prevent transmission of vibration and noise, the base shall include vibration isolators made of rubber in a steel footing. The vibration isolators are to be mounted between the blower base and the package sub-base.

H. Each blower shall be supplied with a combination inlet filter and silencer. Filter element shall be washable by maintenance personnel as a preventative maintenance procedure.

I. Each blower shall be supplied with one inlet silencer. The inlet silencer shall be a combination chamber and absorptive design for maximum sound attenuation. Inlet silencer performance losses shall be included by the blower vendor in the blower performance calculation.

J. Each blower shall be supplied with a discharge silencer. The discharge silencer shall be designed to reduce the pressure noise level emitted by the piping leaving the blower package to 85dB(A) over the entire range of operation, based on a carbon steel, schedule 40 piping of a diameter equal to the blower package nominal connection size.

K. Each blower shall be supplied with a single pressure safety valve on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve. The safety valve shall be set to protect the

blower from exceeding its maximum pressure rating. The materials selected for the valve internals shall enable safe and reliable operation at the site conditions. The single valve shall be sized to pass 100% of the design flow. The valve shall be field adjustable, spring loaded, and have a proportional operating characteristic with respect to the pressure set point.

L. Each blower shall be supplied with one check valve that shall be installed on the discharge line. The vendor shall include the pressure losses produced by the check valve in the blower performance calculation.

M. Each blower package shall be supplied with flexible connector(s) or connection to the plant piping. The flexible connectors shall be sized for a standard, schedule 40 pipe diameter and shall prevent the transmission of noise and vibrations from the blower package into the piping. The flexible connectors shall be suitable for the maximum operating temperature and pressure ratings of the equipment in the air stream.

N. A sound enclosure shall be provided as standard, shipped fully assembled and shall be the product of the blower manufacturer to insure proper integration. The sound enclosure shall be sheet steel construction with powder coat finish. The enclosure shall have hinged and/or removable panels to allow maintenance access. Panels shall incorporate locking closures.

O. The enclosure shall have acoustic foam insulation. The sound absorbing material must be self-extinguishing and meet the standard of UL 94, Section HFI.

P. At a minimum, each blower shall be supplied with the following instrumentation:

1. One pressure gauge to measure the discharge pressure. The pressure gauge shall read 0-15 PSI. The pressure gauge shall have a stainless steel case and be glycerin-filled for pulsation dampening.

2. A filter maintenance indicator.

3. One combination temperature gauge/switch, with adjustable switching point and contact, to measure the discharge temperature. As an option, a separate temperature gauge and switch may be supplied.

Q. Blower Motor

1. All blower motors shall be supplied mounted and aligned within the blower enclosures.

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. The motors shall have NEMA Class F insulation and limited to Class B rise.

4. The blower motors shall be NEMA Premium efficiency type.

5. Winding Over Temperature Protection

    a. Embedded thermostats, one (1) per winding, normally closed contact, shall be provided for an external thermal alarm or motor cut out for all motors 40 Hp and above, unless otherwise shown. Thermal cutout leads shall be brought out to the motor terminal connection box. Connection of the over-temperature protection to the control system is the responsibility of the Contractor.

6. Blower motors shall have a 1.15 service factor rating. The blower brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Blower Schedule.

7. Inverter Duty:

    a. All motors for blowers indicated in the Blower Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

        i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

        ii Inverter grade, 1,600 volt, Class F insulation.

        iii Service factor of 1.0 when operated from a VFD.

        iv Meeting requirements of NEMA MG1 Part 31.

R. Blower Enclosure Cooling Fan (when required)

1. When required for the proper functioning of the blower, blower enclosure fan(s) shall be mounted in the sound attenuating enclosure.

2. When blower enclosure fans are motor-operated, each fan shall be driven by a separate motor to ensure adequate cooling at all blower operating speeds.

3. Enclosure cooling fan motors shall be of the same operating voltage as the blower motor.

S. Hazardous Location Equipment

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only motors certified by Factory Mutual for use in such locations shall be used.

2. The blower motors used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

T. Manufacturer's Warranty

1. The blower manufacturer shall warrant the blower equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. Rotary blowers shall be warranted against defects in material and workmanship for a period of (60) sixty-months from shipment. All other package components shall be warranted for a period of (18) eighteen months from shipment or (12) twelve months from start-up, whichever occurs first.

U. Manufacturers

1. Aerzen

2. Kaeser

3. Approved equal

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. Manufacturer shall factory-test equipment to detect any defects and demonstrate that they will function satisfactorily under the conditions specified. Testing shall include slip testing and mechanical run testing at full pressure and full speed. Manufacturer shall not supply blowers that do not meet the performance standards

3.02 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete blower package and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer’s representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Contractor shall install, level, and align blowers package(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on blower piping. Install and secure all service lines as required.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed blower packages(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all blowers, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the blower package(s) and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

SECTION 11376

DIFFUSER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. The CONTRACTOR shall provide a complete strip diffuser system for the aeration basins as indicated in this section. The system shall be capable of intermittent operation without negative effects. There shall be provided all necessary distribution pipes, couplings, supports, hold-downs, anchors and accessories.

B. All the equipment specified under this Section shall be furnished by a single Supplier (the Aeration Equipment Manufacturer) fully experienced, reputable, and qualified in the manufacture of the equipment specified. The basin has been designed to accommodate equipment supplied by Ovivo USA, LLC.

C. Related Sections:

1. Section 11375 Positive Displacement Blowers

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.03 SUBMITTALS

A. Prior to release for manufacture of equipment, the CONTRACTOR shall submit shop drawings of all equipment. The submittal shall include the following:

1. A complete system description.

2. The number of complete diffuser assemblies.

3. The recommended minimum, design and maximum air flow per diffuser.

4. Head loss versus air flow rate for components of the diffuser assembly at the specified design conditions.

5. A layout of the diffuser system including couplings, fittings and pipe supports.

6. A complete materials list.

7. The equipment supplier's recommended installation procedures.

8. A testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies.

9. A curve showing the oxygen transfer efficiency of the proposed system for a representative layout section at different air flux rates in the design range. The flux rate (scfm/sqft) shall be based on the horizontally projected area of the diffuser.

10. Submit clean water test data from prior tests performed or witnessed by independent test organizations to demonstrate the capacity of the proposed equipment to meet the specified oxygen requirements. Tests shall have been performed in test tanks or process basins and shall be witnessed by an independent third party knowledgeable about clean water test procedures.

11. Submit a reference list of at least 5 different applications in domestic wastewater treatment plants of not less than 1 mgd, with at least 5 years of successful operation, where the manufacturer has supplied equipment substantially the same regarding design, materials of construction, structural elements and other characteristics to that proposed for this project.

1.04 DESIGN CRITERIA

A. The strip diffuser system shall have the capability to transfer the specified amount of oxygen at standard conditions, Standard Oxygen Transfer Rate or SOTR at standard conditions (14.7 psia, 20° C, zero dissolved oxygen) at the side water depth and maximum allowed air rate and pressure specified below.

B.

Condition	SOR (lb/day)	Air Flow Rate (scfm)	Immersion Depth (ft)	Min SOTE (%)
Average Condition	374	454	15.5	2.1
Peak Day	4576	561	15.5	2.0

C. Strip diffusers system must be capable of operating at 0.6 to 4.8 scfm/sq ft flux rate continuously and at a rate pf 0.3 to 0.6 and 4.8 to 7.0 scfm/sq

ft for several hours per day in mixed liquor.

The design shall allow a complete flexing cycle to be performed to maintain the membrane and its perforations in a clean state. When the pressure in the air distribution system is brought below the hydrostatic pressure at the depth of the diffusers, then the pressure on the inside of the membrane shall also be below the hydrostatic pressure and the membrane shall collapse on to the flat base plate causing a flexing movement of the membrane.

D. Strip diffusers shall be AEROSTRIP® (Q, T) Type as supplied by Ovivo. The proposed fine bubble strip diffuser shall be a flat strip design using a flexible membrane installed on the basin floor to utilize the full side water depth. The system shall be designed to withstand the design air pressure plus a 1.5 psig surge factor.

PART 2 - PRODUCTS

2.01 STRIP DIFFUSER ELEMENTS

A. Membrane

1. The strip diffuser membrane shall be a homogenous thermoplastic material from the polyurethane family. The membrane shall have a proven record of performance in more than 25 installations. The membrane must be manufactured as a seamless, calendered sheet without defects or repairs. Membrane materials containing plasticizers or softeners are not acceptable. The surface of the membrane must be smooth to prevent biological growth from attaching. Membrane shall be capable of producing fine bubbles of 1 mm in diameter across the entire surface. Air flow shall be uniform across the entire membrane surface. EPDM, Teflon coated EPDM, and silicone based membranes are not allowed on this project.

B. Frame

1. The frame shall provide structural support for the strip diffuser membrane and be structurally self-sufficient. In addition to securing the entire perimeter of the membrane with an airtight sealing mechanism, the frame shall provide the necessary mechanism for even distribution of air. No fasteners shall be allowed to penetrate the membrane. No discs or tube diffusers are allowed on this project. Only strip diffusers are allowed on this project.

2. Air shall be supplied to the strip diffuser through a fitting in the end of the diffuser. The air feed fitting shall be made from PVC / PE and is bonded to the base profile.

C. Assembly

1. The outside dimensions of the strip diffuser shall be approximately 180 mm wide and long. The strip diffuser shall be shipped totally assembled by the supplier, ready for installation by the CONTRACTOR.

D. Supports and Anchors

1. Anchors shall be fabricated from minimum 3/8-inch diameter type 304 stainless steel threaded rod. Anchors shall be suitable for insertion into concrete slab with epoxy adhesive and shall be sized for a pull out strength 5 times the calculated buoyant forces.

2. Support profiles, nuts, bolts, washers, and other fasteners shall be made from 304 stainless steel.

3. Consumables such as thread lubricants, epoxy, teflon tape, etc. shall be supplied by the CONTRACTOR.

2.02 DROP PIPE AND AIR DISTRIBUTION SYSTEM

A. The aeration system supplier shall supply all necessary distribution piping for the system and in conformance with this section.

B. Connections to Main Air Supply

1. The drop pipe shall be polyethylene #-inch diameter and meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8,3/SDR 17.6. The pipe shall be connected to the air main piping by a #-inch king nipple (304 SS), supplied by the CONTRACTOR, attached to a high temperature rated flexible hose supplied by the strip diffuser supplier.

C. Distribution Pipe and Fittings

1. Polyethylene piping shall be 1-inch in diameter and meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8,3/SDR 17.6

2. All polyethylene shall be provided in continuous lengths. No field welding shall be required.

3. Provide compression fittings to connect PE piping to diffuser and air header piping.

4. All feed assemblies shall be fabricated for field installation using standard components and couplings.

5. Feed lines shall be easily connected and disconnected to allow purging of debris after installation but before operation. Each distribution pipe shall be supplied with a removable end cap or plug to allow purging of the air lines.

D. Couplings, Pipe Supports and Anchors

1. All supports, anchors and fasteners shall be from 304 stainless steel.

2. Attach supports to the tank floor using epoxy type concrete anchors designed for embedment in 3,000 psi concrete. Space supports at 6 feet (maximum) center to center. Size anchors for pull-out strength 5 times the calculated buoyant forces.

E. Service Conditions

1. The piping system shall be designed to withstand the specified field operating conditions including expansion and contraction. The piping system shall be sized to supply acceptable head loss for the specified air flow rates to avoid poor distribution between diffusers.

2.03 SPARE PARTS

A. Provide a minimum of # spare complete diffusers assemblies for each diffuser size supplied including accessories for connection to the air headers and attachment to the threaded rods.

2.04 STORAGE AND INTALLATION

A. All materials and equipment shall be stored, handled and installed in such a manner as not to degrade quality, serviceability or appearance. The equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture as well as extreme temperatures. Crates with strip diffusers as well as individual strip diffusers need to be stored to avoid exposure to direct sunlight and heat (not to exceed104°F).

B. The strip diffuser system shall be installed in accordance with approved procedures submitted with the shop drawings and as indicated, unless otherwise approved. The individual diffusers shall not be installed until all other work in the basin has been finished. Care shall be taken to protect the diffusers from physical damages and prolonged exposure to weather without protection. When the diffusers are covered, adequate ventilation has to be provided. Installation during warm weather and in

circumstances where diffuser temperature exceeds 104 F (e.g., under tarps receiving direct sun, improper planning of work, delays in submerging diffusers with water) or freezing conditions is associated with additional risks and voids supplier's warranty unless the supplier's instructions for those conditions are strictly followed and documented daily.

C. The entire system shall be designed, manufactured, and installed in such a manner that all diffuser elements are within ±1/4 inch of a common horizontal plane. At the end of the break-in period, the air distribution shall be uniform over the entire basin.

D. All air piping shall be purged of debris before the aerators are connected and the basins are filled with water.

E. After the system has been installed and the air piping purged, all connections shall be tested for leaks. The basin shall be filled with clean water to a level a few inches above all connections and run at the design air flow rate without any visible leaks. Care should be taken to ensure that the air is properly cooled before entering the PVC piping and diffusers.

F. The tanks shall not be filled with wastewater until the Engineer receives certification from the supplier that the complete system has been installed and tested in accordance with the written instructions of the supplier and that the system is ready for operation.

PART 3 - SERVICE OF MANUFACTURER

3.01 INSPECTION, STARTUP AND FIELD ADJUSTMENT

A. The Manufacturer shall furnish an authorized service representative for a minimum of two separate trips and a minimum of 4 days total on-site service. The authorized representative shall also furnish instruction of the OWNER'S personnel in the operation and maintenance of the equipment. The first trip is recommended before the diffusers are removed from the crates so that the Contractor may gain additional instruction and reduce chances of voiding the warranty.

B. The test runs on the diffuser system shall be undertaken with water in the aeration tanks filled up to the high water elevation shown on the Drawings. The Contractor shall be responsible for providing sufficient water, or treated wastewater for filling the tanks for the test runs on the diffusers. The test runs on the diffusers shall confirm acceptable operation.

PART 4 - WARRANTY

4.01WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B. its factory, any part or parts returned to it which examination shall show to have failed under normal use and service by

the user within eighteen (18) months following initial shipment or twelve (12) months following operation start up, whichever occurs first.

END OF SECTION

SECTION 11385

SUBMERSIBLE MIXERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible mixer(s) described in this Specification.

B. Each mixer shall include a submersible power cable, guide rail system, power cable support, lifting cable, and controls as required in this specification.

C. Mixer(s) shall be designed for continuous duty operation, to provide complete mixing within the basin volumes defined, and to keep solids from settling in the tank.

1.03 QUALITY ASSURANCE

A. The mixer and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the mixer(s) and associated accessories. The mixer should be supplied by MBR supplier only.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the mixer(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer
2. Type and Model
3. Rotational speed
4. Major component materials of construction
5. Mixer specification describing construction details
6. Outline Dimension Drawing
7. Installation Drawing
8. Complete performance data showing capacity and power input
9. Electrical Data that includes
    a. Motor rating, hp
    b. Motor temperature rating
    c. Motor full load rotational speed
    d. Motor full load current
    e. Motor locked rotor current
    f. Power cable data
10. Motor performance curves showing speed, efficiency, current, power, etc.
11. Moisture sensor protection characteristics and wiring diagram
12. Mixer Mast Assembly
    a. Hoist and Mast Assembly specification
    b. Hoist details and materials of construction
    c. Mast assembly details and materials of construction

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include mixer outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection

information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS

A. Furnish one (1) complete set of mechanical, lip and O-ring seals for each mixer type or size furnished. All spare parts shall be provided in a separate container that clearly identifies to which mixer they belong.

PART 2 - PRODUCTS

2.01 MIXER DESIGN

A. Service

1. All mixing equipment shall be designed to satisfactorily operate continuously in a submerged waste treatment plant environment.

2. The mixer(s) shall be designed to be easily raised, lowered, removed for inspection or service, and rotated horizontally without the need for personnel to enter the tank. A single cast sliding guide bracket shall be an integral part of each mixer. The single cast guide bracket shall guide the mixer into position and be capable of carrying the entire weight of the mixer and the maximum loads created by the mixer. The mixer, with its appurtenances and power cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 ft. FM approved mixers have a depth limit of 57 ft.

B. Performance

1. The mixing equipment shall be designed based on the following design conditions and criterion.

Basin Name	Anaerobic Basin
Number of Basins	1
Fluid to be mixed	Returned Activated Sludge
Hazardous Location	No
Solids Concentration (mg/l)	6000 -15000
Basin Dia. (ft)	Pl refer the layout
Minimum SWD (ft)	14
Maximum SWD (ft)	16
Overall Tank Depth (to top of wall, ft)	18

Basin Name	Pre - Anoxic Basin
Number of Basins	1

Fluid to be mixed	Returned Activated Sludge
Hazardous Location	No
Solids Concentration (mg/l)	6000 -15000
Basin Dia. (ft)	Pl refer the layout.
Minimum SWD (ft)	11
Maximum SWD (ft)	13
Overall Tank Depth (to top of wall, ft)	18

Basin Name	Post Anoxic Basin
Number of Basins	1
Fluid to be mixed	Returned Activated Sludge
Hazardous Location	No
Solids Concentration (mg/l)	8000 -15000
Basin Dia (ft)	Pl refer the layout
Minimum SWD (ft)	13
Maximum SWD (ft)	15
Overall Tank Depth (to top of wall, ft)	18

C. General

1. Each mixer shall be of the closed-coupled, direct drive, submersible type design. All components of mixer, including the motor and power cable shall be capable of continuous underwater operation while the mixer propeller is completely submerged. In addition, all components of the mixer shall be capable of operation in air, completely unsubmerged for two (2) hours.

D. Materials

1. Major mixer components shall be of cast iron/carbon steel or 316 stainless steel construction. All exposed hardware shall be 316 stainless steel. All surfaces coming into contact with tank fluid other than stainless steel shall be protected by a two-part epoxy paint.

E. Propeller

1. The propeller shall be 316 stainless steel having 2 or 3 self cleaning backward curved blades capable of handling solids, fibrous materials, heavy sludges and other matter normally found in wastewater treatment applications. Each blade shall be precision cut and welded to the hub. Propeller shall be dynamically balanced so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations.

F. Fasteners

1. All bolts, nuts, washers and other fasteners shall be 316 stainless steel.

G. Cable Entry

1. The electrical power cable entry shall be an integral part of the slide bracket.

2. The cable entry seal system shall be composed of elastomer grommets flanked by stainless steel washers all designed with close clearance fits against the cable outside diameter and the cable entry inside diameter.

3. A cable entry seal system shall provide a watertight seal between the electrical connection chamber and motor preventing fluid leakage into the motor.

4. Epoxy cable entry sealing systems are not considered equal or acceptable.

H. Shaft

1. The propeller and motor shaft shall be in integral unit. The shaft material shall be 316 stainless steel designed to meet the maximum loads generated by the mixer.

I. Propeller Shaft Seal

1. The mixer shall be provided with a double seal system consisting of a mechanical seal on the propeller (outer) side of the oil chamber and second mechanical seal on the motor (inner) side, each working independently of the other.

2. The mechanical seal shall require neither maintenance or adjustment, shall not be damaged when the mixer is run dry, shall be easy to check and replace, shall be capable of running in either direction without damage, and be readily available from any major seal manufacturer. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

J. Bearings

1. The mixer shall rotate on two (2) permanently lubricated bearings. Bearings shall be lubricated for life design and sized to transfer all radial and axial loads to the mixer housing and minimize shaft deflection for increased bearing and seal life.

2. Bearings shall not require pre-loading and shall be maintenance free with a minimum L10 (B10) bearing life of 100,000 hours at design conditions. Mixer’s having bearings that require pre-loading or periodic lubrication will not be considered acceptable or equal.

K. Sealing of Mating Surfaces

1. All mating surfaces of the mixer shall be machined and fitted with static nitrile or viton O-rings providing watertight sealing. Mating surfaces shall be designed to provide watertight seals when metal to metal contact is made resulting in controlled O-ring compression without special torque requirements. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used as a means of sealing.

L. Motor

1. The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable).

2. The motor shall have a minimum 1.1 service factor, a minimum of 30 feet of power and control cable, be of the squirrel-cage, induction, shell type NEMA B design, housed in an air filled watertight chamber.

3. Stator winding and leads shall be insulated with moisture resistant Class F insulation, or better, which will resist a temperature of 155 deg C (311 deg F).

4. The stator shall be dipped and baked three (3) times in Class F varnish.

5. The motor shall be designed for continuous duty, capable of sustaining (10) evenly spaced starts per hour.

6. The rotor bars and short circuit rings shall be constructed of aluminum.

M. Thermal Protection

1. Each phase of the motor shall contain a bi-metallic temperature monitor in the upper portion of the stator windings to monitor stator temperatures. The temperature monitors shall be imbedded in the stator winding coils, connected in series and coupled to the motor contactor coil providing single switch shutdown capability.

2. The temperature setting shall be a minimum of 260 deg F and will automatically reset once the stator temperature returns to normal.

3. Temperature monitors shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

N. Moisture Sensor

1. Each mixer shall be equipped with an electrical probe to detect the presence of moisture in the oil chamber before bearing and motor damage occurs.

2. The moisture detection probe will provide the capability for remote monitoring of the state of the moisture probe either by monitoring a dry contact or through the generation of a 24 VAC or 120 VAC discrete signal.

O. Galvanic Corrosion Protection

1. When necessary to prevent galvanic corrosion, the mixer guide bracket shall have a chemical and abrasion resistant polyurethane liner and guide rollers preventing metal to metal contact between the guide bracket and the mounting and support system. Also, a polyurethane bushing shall be provided between the lifting cable shackle and the lifting clamp. The chemical and abrasion resistant liner, rollers and bushing are to provide galvanic corrosion protection by completely separating the mixer from the mounting system.

P. Hazardous Location Equipment

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only mixers certified by Factory Mutual for use in such locations shall be used.

2. Specifically, the mixers used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

2.02 MOUNTING AND SUPPORT SYSTEM

A. Power Cable Support

1. A 30 feet long, ¼ inch diameter, 304 or 316 stainless steel power cable support cable shall be provided with each mixer and be permanently attached to the mixer shackle on one end and the upper guide bracket of the mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of 5 feet intervals.

B. Lifting Cable

1. A 30 feet long, ¼ inch diameter, 304 or 316 stainless steel lifting cable shall be provided and attached to the lifting clamp shackle on the mixer. A cable cleat shall be provided to store the cable when needed..

C. Mounting System

1. A mounting system shall be supplied by the mixer manufacturer and used to mount the mixer and guide it during installation and removal without entering or emptying the tank. The upper guide bracket shall have a positioning locking plate and locking pin that securely positions the guide rail system at any position within a 150 degree arc in 15 degree increments without entering or emptying the tank. The mixer shall rest on a stop near the bottom of the tank preventing the mixer blades from contacting the tank floor. A 304 stainless steel mast system shall be used to guide and securely hold the mixer in place and be designed to withstand the maximum loads produced by the mixer. The mast shall interface with the guide brackets to guide the mixer securely into position.

2. To ensure the integrity of the mounting system the mixer manufacturer shall supply the support guide brackets. The mast may be is supplied by others.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following inspections shall be performed as a routine quality check on each mixer prior to shipment from the factory.

1. Propeller size, motor rating, voltage, phase and frequency shall be checked for compliance with purchase order and specifications.

2. Motor and power cable shall be checked before submergence for insulation damage and the presence of moisture.

3. Pressurize the motor with dry air check for leaks at joints and seals.

4. Before submergence run the mixer to check for correct rotation and ensure mechanical integrity.

5. The mixer shall be submerged in a tank containing water and run completely submerged to check amp readings under load.

6. Motor and power cable shall be checked after submergence for insulation damage and the presence of moisture after removing the mixer from the tank.

B. A quality control check sheet showing that the above testing procedure has been performed and that the mixer successfully passed the tests shall be completed. The quality control check sheet shall be supplied with the final documents.

3.02 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer’s representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Install, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed mixers(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all mixers and control systems shall be conducted to determine if the installed equipment meets the purpose and

intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the mixers and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

SECTION 11900

COMPOSITE SAMPLERS

PART 1 - GENERAL

1.1 Scope

Under this section the Contractor shall furnish and install one ISCO 6712FR Fiberglass Refrigerated Samplers or approved equal as specified herein.

PART 2 - PRODUCTS

2.1 Instrument

A. There shall be furnished refrigerated samplers equally suited for sequential and composite sampling applications. Additionally the units shall be suitable for outdoor installation without the requirements for additional enclosures for weather protection. The instrument shall be capable of collecting samples from a variety of sources including open channels, sewers and storm water conduits. The instrument shall route samples to storage containers for collection and off-site analysis. The instrument shall be suited to collect priority pollutant or general purpose samples in multiple bottles or a single bottle. The unit shall have 120 volt, 60Hz, single phase power supply.

2.2 Physical Description

A. The controller cover, exterior and base of the refrigerator shall be constructed of resin transfer molded fiberglass reinforced plastic with a UV resistant gel-coat, providing exceptional resistance to corrosion and weathering. The interior of the refrigerator shall be food grade ABS plastic for easy cleaning and shall inhibit bacterial growth. The copper refrigeration lines shall be protected with polyester tubing or phenolic resin. The condenser coil shall be powder coated with polyester for additional corrosion resistance. The refrigerator evaporator plate shall be aluminum and powder coated with a food grade epoxy to resist corrosion. The refrigerant used shall be a non-CFC refrigerant with an ozone depletion potential of zero

B. The refrigerator shall include 1-1/2 inches of rigid foamed-in-place urethane insulation on the sides to aid in sample preservation. The top insulation shall consist of 3 inches of rigid urethane insulation. The insulation shall use a non-CFC foaming agent. The refrigerator shall have a hinged, reinforced fiberglass controller cover which is capable of being locked. The unit shall have a temperature control knob located under this cover. The refrigerator's door shall also have hasps capable of accepting a

padlock to prevent unauthorized tampering with the sample compartment contents. A magnetic gasket shall be used to seal the refrigerator door. The refrigerator power supply and solid state thermostat shall be contained in a sealed, NEMA 4X equivalent, irridited aluminum enclosure inside the refrigerator base. All exposed metal components used in the construction of the refrigeration system shall be either plated aluminum, or stainless steel.

C. The unit shall include long-life electronic temperature sensing devices that shall measure the ambient air temperature, evaporator plate temperature, and internal air temperature. Built-in control circuitry shall utilize these sensors to control operation of the compressor, built-in heaters, and the self defrosting cycle of the evaporator plate. The built-in heaters shall prevent collected samples from freezing if the ambient air temperature drops below freezing. The unit shall use a condensing coil with forced air cooling and the air intake shall be filtered to prevent dirt and other contaminants from entering the condenser.

D. A compressor with a minimum rating of 1/5 horsepower shall be used. The compressor shall be equipped with a temperature safety cutout that will disengage the compressor if a temperature of 221°F (105°C) is reached. The refrigeration system shall contain HFC-134a as the refrigerant. The refrigerator shall have a 5 minute typical recovery time to return to 39(F (4°C) after the door has been opened for 1 minute in 75°F 24° (C) ambient conditions. The collected samples shall be stored in an enclosure capable of operating in ambient temperatures from -20°to 120°F (-29° to 49°C)

2.3 Sampler Controller

A. All electrical components shall be housed in a single controller. There shall be no external electrical or control components. The controller shall use a 4 line, 20 character per line, 80 total character display to show sampler and attached module status and program information. This display shall be angled for easy viewing and backlit for easy use in all light conditions. A 17 position keypad shall be used for all program entries, manual control of the sampler, and data transfer functions. The sealed control unit shall be removable to allow use with either a portable or refrigerated sampler. Program firmware shall be stored in Flash memory. This shall allow program software updates to be transferred to the sampler without opening the sampler enclosure.

B. The control box shall be constructed of 1/4" thick Noryl™ plastic (or equal) and the enclosure shall conform to NEMA 4X,6 (IP 67 control box,

IP 17 pump) standards for water tight, dust tight, and corrosion resistance and

submersion. A desiccator shall be located inside the control box to prevent moisture damage to electrical components.

C. Samples shall be collected using a peristaltic pump. This pump shall produce typical line velocities of 3.0 feet per second in a 3/8 inch (0.95 cm) ID suction line at 3 feet (1 m) of head. At 25 feet (7.6 m) of head the pump shall typically produce a line velocity of 2.2 feet (0.67 m) per second. The pump shall be capable of lifting a sample 28 feet (8 m). The body of the peristaltic pump shall be an integral part of the sampler controller. The pump shall be constructed of high strength Noryl (plastic and designed for corrosion resistance and long tubing life. Before and after each sample is collected, the pump shall air purge the suction line. Pre-purges and post-purges shall be automatically controlled, and no pre-calibration adjustments are required. User selectable purge lengths shall also be available. The sample stream shall be a direct path from sample source to sample bottle. Samples shall not pass through metering chambers or other diversions. The pump shall include a latched cover and thumbscrew opening for the replacement of pump tubing. The pump shall include a built-in safety interlock. With the opening of the pump's latch and band, all power shall be removed from the sampler's pump motor, to eliminate the possibility of a pump activation injuring personnel.

D. The sampler shall typically deliver sample volumes with an accuracy of 10 ml or 10%, whichever is greater, of the programmed value. The sample volume repeatability shall be 5 ml or 5%, whichever is greater, of the average of the maximum and minimum sample volume in the sample set. The user can select sample volumes from 10 to 990 ml in 1 ml increments. The liquid detector also monitors for anomalies in the sample collection process. If no liquid is detected the sampler shall be capable of retrying the sampling sequence up to three times. Additionally the sampler shall be capable of being programmed to rinse the suction line with the source liquid up to three times.

E. Liquid Detector

1. The sampler shall utilize a non-wetted, non-conductive detector to sense the presence of the liquid. The sensor shall not be dependent on, or affected by the chemical, or physical property of the liquid or its contents. The sensor shall not require routine maintenance or

cleaning. The liquid detection system shall minimize the effects of changing head, intermittent flow in the suction line, or variable battery conditions on sample volume. After initial detection of liquid, the sensor shall monitor for the presence of liquid during the sample collection sequence. Additionally, the liquid detector shall be used to detect bottle full conditions when the sampler is operated in the single bottle sampling mode.

F. Pump Revolution Counter

1. After liquid detection, the pump revolution counter shall count actual pump revolutions to determine sample volume delivery to the storage containers. If liquid flow is interrupted during the sample collection sequence, the detector shall inhibit the pump revolution counter from incrementing until liquid flow is restored. Automatic compensations for air slugs in the sample shall be made by the delivery system. Additionally, the pump revolution counter shall monitor the total number of pump revolutions and alert the user when a pre-selected number of counts has been reached. This tubing life indicator shall alert the user to the need to replace the pump tubing. This indicator shall be on the sampler's display screen. The pump tubing used shall be specially treated to minimize water extractable pollutants. Specially designed bands shall indicate the correct placement of the tubing inside the pump. The tubing shall typically last for a minimum of 1,000,000 pump counts. One pump revolution is equivalent to 12 pump counts.

G. The sampler controller shall have two programming modes; standard and extended. Additionally, two styles of programming shall be available, quick view and sequential programming styles. There shall be a sequence available to select either standard or extended programming. On-line help shall be available to direct the user through the programming sequence or refer to specific sections in the instruction manual. The sampler shall provide battery backed memory with a minimum life of five years. This memory shall maintain the sampler's program settings, stored programs and the results of the last sampling sequence when the sampler is turned off or an external power interruption occurred. A user initiated diagnostics routine shall determine the operational status of the sampler. Any error conditions detected by the diagnostic routines shall be displayed to the user.

H. Standard programming shall allow the user to define specific program operational parameters. Additionally, the sampler shall be able to be programmed to operate on specific days of the week. An option shall be available to automatically re-run the active program. No user re-activation shall be required if this option is selected. The user can program the

sampler to collect sequential or composite samples at user-definable intervals. A delay to first sample collection shall be programmable in minutes from 0 to 9,999 or by the real time clock or eliminated. The user shall be able to enter a 10 character alpha numeric description as a sampling site name.

1. Time Pacing, Standard Programming: The sampler shall use an internal real-time clock to provide time and date information. Uniform time paced samples shall be collected at regular time intervals from 1 minute to 99 hours and 59 minutes.

2. Flow Pacing, Standard Programming. The sampler shall accept a 12V DC flow proportional pulse or isolated dry contact closure from an external flow meter for flow pacing. The pulse or contact closure shall be at least 50 ms in length. The user shall select the number of flow pulses as the flow interval for each sample collection. If connected to a 700 series flow module, flow pacing shall be stated in interval flow volume between each sample.

I. Extended programming shall allow the user to enter intricate programs for sample collection. All options available in standard programming mode are available with extended programming. The sampler shall have the ability to be programmed for up to 2 real time pause/resume sampling times. The pause/resume routines and delay to the first sample are independent of the sample pacing interval. The sampler shall be capable of storing up to 5 sampling routines. The duration and frequency of purges can be controlled by the user in this mode. Sample retries and line rinses shall be selectable from 0 to 3. The user shall be able to enter a 10 character alpha numeric description as a sampling site name. The user shall also be able to enter 10 character alphanumeric names for each stored sampling program.

1. Two part programming shall provide multiple sample pacing for collecting independent samples in distinct bottle sets. This shall be used for storm water runoff monitoring or other applications. Sample volumes and intervals for the independent samples shall be separately programmed. All programming options shall be available for the independent programs. These two distinct programs shall be capable of being initiated separately by external conditions.

2. Time Pacing Of Samples, Enhanced Programming: The sampler shall use an internal real-time clock to provide time and date information. Uniform time paced samples shall be collected at regular time intervals from 1 minute to 99 hours and 59 minutes. Additionally, non-uniform time interval sampling shall be available. These non-uniform time intervals shall be capable of being paced by clock time, or in specific

minute intervals for each sample collected. An additional non-uniform timed sampling mode shall allow the user to enter the number and volume of samples to collect and a time period to complete the sampling routine. The sampler shall then randomly select and record when each sample collection.

3. Flow Pacing Of Samples, Enhanced Programming The sampler shall accept a 12V DC flow proportional pulse or isolated dry contact closure from an external flow meter for flow pacing. The pulse or contact closure must be at least 50 ms in length. The user shall select the number of flow pulses as the flow interval for each sample collection. If connected to a 700 series flow module, flow pacing can also be stated in interval flow volume between each sample.

4. Flow Dependent Sample Volumes: For extended programs that are uniform time paced, a flow-dependent-sample-volume option shall be offered. If a flow module is attached, the flow source may be the module's flow volume -- Otherwise, it shall the flow pulse count at the external flow meter connector. The user shall enter the amount of flow required for each 10 ml of sample. At sample time, the sample volume shall be calculated based on the flow that occurred since the last sample. This sample volume will be at least 20 ml, but not more than the bottle volume (or 9990 ml, whichever is smaller). No sample shall be taken at the start time.

5. Event Paced Sampling: This mode of sampling shall allow the user to select specific external events to pace a sampling routine. A sample shall be collected when specific external events occur. Sampling shall cease after the external event is terminated and shall not begin again until the next occurrence of the external event.

6. Command Driven Mode There shall be provided an operational mode where the sampler shall be fully controlled through an external device. The external controller shall be responsible for determining when to take a sample, how much volume to pump, and where to put the sample. The external controller shall directly interface to the sampler via an RS-232 communications port at 2400 baud, 8 data bits, 1 stop bit, and no parity. A comma-separated-value protocol is used by the external controller to make requests, and by the sampler to report results. At the appropriate time as determined by the external controller, a command is sent to the sampler. The sampler shall move to the appropriate location and collect the volume of sample directed by the controller. After sample collection, the sampler shall signal

back to the controller that the sample was successfully captured, or any operational faults that can be detected by the sampler.

J. Sample distribution shall be through the use of a worm gear drive mechanism. This system shall lock the corrosion resistant distribution arm above the appropriate sample container. A dual optical sensor shall be used for positive location of the distributor arm. A single adjustable distributor arm shall be used for all bottle configurations and sampler mounting possibilities.

K. The sampler program shall allow the user to select from 3 types of sample distribution: samples per bottle, bottles per sample, and multiple bottle compositing. In the samples per bottle mode, a minimum of 15 samples shall be capable of being deposited in each sample container. In the bottles per sample mode all sample bottles shall be capable of being filled with a single initiation. Multiple bottle compositing shall allow the user to place multiple samples in a single bottle while simultaneously creating a duplicate bottle or set of bottles. The sampler shall switch bottles after a period of time has elapsed, or a predetermined number of samples have been collected.

2.3.1 Sampler Outputs

A. Optional analog outputs shall be available. A maximum of three programmable analog outputs shall be available. These outputs shall be configurable to either 4-20 mA or 0-20 mA. These outputs shall be programmable for any parameter measured by the sampler with the exception of rainfall.

B. A serial data output shall be available. ASCII data shall be transmitted at user selectable intervals of 15 seconds, 1 minute, 5 minutes, or 15 minutes. Additionally the data out put can be accessed by sending a specific command to the sampler. Baud rates shall be selectable from: 1200, 2400, 4800, or 9600. At all baud rates, the data shall be sent with no parity, 8 data bits, and one stop bit. Data shall be is in a comma-separated-value format.

C. There shall be available a programmable input/output (I/O) port that shall initiate a signal based on monitored events. This signal shall be a contact closure type of signal for controlling external devices or signaling other equipment. These outputs shall be programmable through the front panel and can be re-configured by the user.

D. For those programs that have delayed or scheduled start times, parameter readings shall be displayed while waiting for the start time. At the start time for the sampling program, the totalizer shall be reset to display total

flow information for the sampling program. Parameter and flow readings shall also be displayed after the program is complete. Additionally, the 6712 sampler shall be capable of operating as a display and logging unit only.

2.3.2 Sampler Controller Inputs

A. The sampler controller will include an SDI-12 input interface. The controller will function as a SDI-12 logger. A maximum of 10 input devices can be attached to the sampler controller. A maximum of 8 parameters from the sensors which may include multi-parameter sondes can be stored in the controller's memory, and an additional 8 parameters can be used for program initiation or event paced sampling. The controller will accept Isco compatible sondes with a minimum of additional programming. Other fully compatible SDI-12 sensors must be programmed for the type of parameter and units selected for measurement.

2.3.3. Power Sources

A. The sampler controller shall require 12 volt DC power for operation. This power will be supplied from a power converter located inside the sampler operating on 110V, 60 Hz AC Power.

2.3.4. Suction Lines and Strainers

A. The sampler shall require a suction line and strainer. The suction line shall be made of 3/8 inch (.95 cm) ID Teflon® with a length of 25 feet and all stainless steel low flow strainer shall be supplied.

2.3.5. Sample Collection Containers

A. The sampler shall be supplied with sample collection containers. The containers shall be 24 wedge 1000 ml polypropylene.

PART 3 – EXECUTION

Contractor shall supply one sampler for use on the influent as shown on the plans. The sampler shall be compatible with signals from their respective flow meter.

END OF SECTION

SECTION 13030

MEMBRANE BIOREACTOR SYSTEM

PART 1 - GENERAL

1.01 DEFINITIONS

A. MBR System Supplier / Supplier: The company responsible for providing all equipment and services as described herein and for providing warranty support.

B. Contractor: The company responsible for construction and installation of the MBR System, including, but not limited to, site preparation, tank and basin construction, and mechanical and electrical installation.

C. MBR System: A collective term for all process and membrane zones that make a complete biological treatment system.

D. Process Train: A stand-alone combination of Process Zones designed and operated to achieve specific treatment objectives.

E. Process Zone: An area in a Process Train designed and operated to meet a specific biological treatment objective.

F. Membrane Zone: Any Membrane Tank or MBR containing membranes.

G. Membrane Basin / MBR: A tank or basin containing one or more Membrane Units that are operated as one unit.

H. Membrane Sheet: A flexible, backwashable assembly consisting of two filtration layers and a drainage layer. Membrane Sheets are combined to make a Membrane Cassette.

I. Membrane Cassette: Also called a Small Membrane Subunit, the Membrane Cassette is the smallest assembled unit of the Membrane Unit that is designed to be removed from a Membrane Unit and replaced as a complete unit.

J. Membrane Unit: Also called a Large Membrane Subunit, the Membrane Unit is an assembly consisting of one or more Membrane Cassettes and an integral diffuser module. The Membrane Unit is intended to be installed and replaced as a unit.

K. Production Capacity: The net permeate flow rate over a given period of continuous operation accounting for CIP procedures and relaxation. Production capacity requirements are given in terms of:

1. Average Annual Flow (AAF): The net daily flow requirement generally occurring during dry weather conditions and lasting nine (9) months.

2. Maximum Monthly Flow (MMF): The net daily flow requirement generally occurring during wet weather conditions and lasting three (3) months.

3. Peak Daily Flow (PDF): The net daily flow required during peak daily flow conditions and lasting 24hr.

4. Peak Hourly Flow (PHF): The net peak hourly flow requirement generally occurring during wet weather flow conditions and lasting 4hr.

5. Peak Instantaneous Flow: The highest allowable flow rate under any conditions.

L. Flux: Gallons of permeate flow per day per square foot of membrane area (gfd). Additional definitions of flux that are used to characterize design criteria and membrane performance include:

1. Gross Flux: Calculated by dividing measured permeate flow rate by working membrane area at any instant.

2. Instantaneous Flux: See Gross Flux.

3. Net Flux: Calculated by dividing the total amount of permeate produced (available for discharge) in a given time frame by the working membrane area.

M. Maintenance Clean: Synonymous with chemically enhanced backwash and CIP. A Maintenance Cleaning is performed in-situ and in mixed liquor or activated sludge. The procedure is conducted by charging cleaning chemicals to membranes in the reverse direction of permeate flow with a soak time lasting more than 0.5hr. Typical Maintenance Cleaning characteristics are provided below.

Summary of Maintenance Cleaning Characteristics

Parameter	Value (Condition)	Type
Membrane Soak Time	> 0.5hr	Primary
Conducted In Mixed Liquor	Yes	Primary
Conducted In-Situ	Yes	Secondary
Typical Duration	0.5hr – 2.0hr	Secondary
Fill Direction	Reverse	Secondary
Tank Fill/Drain	No	Secondary
Chemicals Required	Yes	Secondary

N. Recovery Cleaning: Synonymous with intensive cleaning and CIP. A Recovery Cleaning is performed in-situ or ex-situ and in water or dilute chemical. The procedure is conducted by charging cleaning chemicals to membranes in either direction with variable soak times. Typical Recovery Cleaning characteristics are provided below.

Summary of Recovery Cleaning Characteristics

Parameter	Value (Condition)	Type
Membrane Soak Time	Optional	Primary
Conducted In Mixed Liquor	No	Primary
Conducted In-Situ	Optional	Secondary
Typical Duration	6.0hr – 24.0hr	Secondary
Fill Direction	Optional	Secondary
Tank Fill/Drain	Optional	Secondary
Chemicals Required	Yes	Secondary

O. Mechanical Cleaning: Synonymous with manual cleaning, physical cleaning and hand cleaning. Mechanical Cleaning is any instance where membranes are cleaned by hand or machine (water jetting or other) for the purposes of removing fouling or localized dewatering.

P. Localized Dewatering: Synonymous with clogging, sludging and plugging. Localized dewatering is the excessive accumulation of solids at a membrane surface in the form of refractory cake and generally in discrete, localized areas. Often caused by excessive filtration in combination with unequal or inadequate air scouring.

Q. Cycle: A continuous period of operation lasting 1,440 minutes.

R. Days: Defined as calendar days.

S. MLSS: Mixed liquor suspended solids reported as mg/l.

T. Permeability: Equals the instantaneous flux rate divided by the transmembrane pressure (TMP). The units of permeability are gfd/psi.

U. Relaxation: A temporary suspension of membrane filtration with continued air scouring for the purpose maintaining treatment capacity or reducing CIP requirements.

V. Transmembrane Pressure (TMP): The effective pressure differential across the membrane during normal operation. Reported as psi.

1.02 DESCRIPTION OF WORK

A. This Section specifies the requirements for the furnishing, installing, testing, training, and startup of all process equipment required for a submerged membrane ultra-filtration bioreactor system for the treatment of wastewater.

B. The MBR System Supplier shall furnish and commission the MBR System as described in this specification, inclusive of all equipment, instrumentation, scope-specific piping systems, controls, and integration.

C. The MBR System Supplier shall provide the Engineering and Design Services in support of the treatment system design as described in this specification.

D. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the MBR System in accordance with the installation instructions provided by the Supplier. Once installed, the MBR System shall be complete and operational with all control equipment and accessories as specified herein and described in the Contract Documents.

1.03 SUBMITTALS

A. Project Submittal: The MBR System Supplier shall submit to the Engineer complete manufacturer's descriptive information for all equipment, instrumentation, and components in the Supplier's Scope of Supply for the Engineer's approval prior to purchase of equipment. The Supplier is to provide three hard-copies and three CDs containing all submittal information organized by component, clearly marking options, models, materials, etc. The Project Submittal shall contain the following:

1. Membrane installation drawings, detailing membrane unit dimensions, materials, weights, locations of lifting lugs/points, and anchor bolt locations.

2. MBR basin mechanical layout drawings, detailing the number of membrane units, air and permeate piping distribution, piping supports, in-basin instrumentation and valves, and all other components comprising the MBR basin systems. Drawings will detail information in plan and elevation/section views and include details as necessary to completely describe the installation requirements. Drawings will be based on the basin/structural design provided by the Engineer.

3. Plan view equipment and instrument drawings showing the location of all components provided by the MBR Supplier. Locations and installation details are to be coordinated with the Engineer's drawings to avoid conflicting information.

4. Manufacturer's literature for all equipment in MBR Suppliers scope of supply. Literature will include (as applicable):

    a. Pump curves

    b. Blower curves

    c. Mixer velocity distribution profiles

    d. Materials of construction

    e. Shop drawings showing all dimensions, sizes and locations of anchors

    f. Minimum, maximum, and design duty points (flow rates and pressures/TDH)

g. Unit performance and efficiency data

h. Motor horsepower and voltage

i. Complete wiring and control diagrams which show the point of connection for the power supply and control system

j. All project-specific installation data for used by the Contractor.

5. Where manufacturers' standard literature is submitted, it shall be clearly marked to indicate which features are to be furnished under this contract.

6. Process and Instrumentation Diagrams (P&IDs) showing all equipment and instrumentation which will be controlled by the MBR supplier's control system, including components provided by others. P&IDs will differentiate which components are supplied by MBR Supplier. Unless otherwise directed by the Engineer, the MBR supplier is responsible for establishing the tagging scheme for the P&IDs. Tagging scheme will assign a unique tag to all components and their associated I/O. Tagging scheme will organize components by subsystem and train.

7. Instrumentation list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, ranges, materials of construction, installation details, power supply voltage, wiring information.

8. Valve list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, Cv range, materials of construction, pressure rating, and dimensions.

9. Valve actuator manufacturers' literature and cut sheets, clearly identifying models, motor horsepower and voltage, control wiring, installation/connection details, torque rating, actuation times, duty cycle, and materials of construction.

10. Control panel drawings, detailing the interior and exterior layouts, components, panel dimensions, and panel materials of construction and NEMA rating.

11. Control panel component manufacturers' literature, clearly denoting model numbers of all PLC components, relays, terminal blocks, power supplies, buttons, switches, fuse blocks, etc.

12. Control panel wiring schematics.

13. Warranty information, detailing membrane design fluxes for all seasonal flow conditions.

14. System start-up and test procedures.

B. Installation and Operations Manual (IOM): The MBR Supplier shall furnish an Installation and Operations Manual at least 2 weeks prior to the deliver of the

Supplier's equipment on site. The IOM will include Supplier and manufacturer's manuals and drawings detailing dimensions, locations, wiring information, and any other information necessary to convey the correct assembly and installation of the MBR System components provided by the Supplier. In addition to installation documents, the IOM shall include requirements for the Mechanical Inspection and a schedule of events for the System Commissioning. The Supplier is to provide three hard-copies and three CDs containing all information organized by component.

C. Plant Operations Manual (POM): The MBR Supplier shall furnish a Plant Operations Manual within 6 weeks after completion of the System Commissioning. The supplier is to provide 3 hard copies and 3 CDs containing the following information:

1. HMI (operator interface) Users manual, detailing screens and functions within the operator interface program.

2. Process variables and final control narrative

3. As-built P&IDs

4. As-built electrical schematics and control panel drawings

5. Safety guidelines

1.04 QUALITY ASSURANCE

A. All the equipment and services specified under this Section shall be furnished by a single manufacturer, and shall be standard units of proven ability as manufactured by a competent organization that is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

B. To show evidence of being able to provide the quality of equipment and services described in this specification, the Membrane System Supplier shall submit their quality system ISO 9001 certification. The quality procedures shall provide for a means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited by a third party independent inspector. Certification shall remain in effect throughout the project startup.

C. All equipment furnished under this Section shall be new and unused and shall be the standard products of a Membrane Manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of eight (8) years.

D. The MBR System Supplier shall have a minimum of ten-year history of designing wastewater treatment facilities.

E. In addition to qualifications specified elsewhere in the Contract Documents, the MBR System Supplier shall provide the location, size, and start-up dates of five representative installations that meet the following MINIMUM criteria in order to be considered qualified:

1. Utilize the same type of membrane system proposed for this project.

2. Have a plant or process train design capacity equal to the listed MMF (±50%).

3. Utilize the same type of headworks (aperture/slot size) and MBR as the proposed system.

4. Use similar aeration and CIP strategies as that of the proposed system.

5. Have been in operation for at least one year at time of bid.

6. Have operated within 25% of nominal rated capacity for a minimum of 12 months at time of bid.

1.05 WORK BY OTHERS

A. The following work and scope of supply is specifically excluded from the MBR Supplier scope:

1. Design and Engineering:

a. Architectural

b. Buried pipe, including soil requirements, thrust blocks, galvanic protection

c. Concrete basins

d. Wall penetrations

e. Support of piping outside of MBR scope

f. Seismic design or calculations other than for seismic anchorage of the Membrane Units.

g. Sealing of calculations and drawings

2. Structural:

a. Building(s) for housing MBR.

b. Concrete tankage for process and membrane zones.

c. Imbedded wall spools, pipe sleeves, pipe seals in concrete tank walls for the various process pipe connections/penetrations.

d. Covers or grating over process and membrane zones.

e. Equipment access platforms, walkways, stairs, etc.

f. Protective coatings for concrete.

g. Anchor bolts for any equipment outside of MBR basin.

3. Mechanical:

a. Permeate piping downstream of permeate header isolation valve and/or tie point as identified in the Contract Drawings.

b. Mixed liquor recycle piping, including branch connections and headers.

c. Process air piping.

d. MBR scour air supply piping upstream of tie point as identified in the Contract Drawings.

e. Membrane CIP piping, including branch connections and headers.

f. Pipe supports and hangers unless otherwise noted.

g. Hoist equipment above the membrane basin for installation and removal of the membrane subunits.

h. Membrane tank drain piping, valves, operators, and pumps, if required.

i. Installation of any kind, including equipment and piping within or outside of Scope of Supply.

j. Installation materials for instrumentation and automatic valves, including, but not limited to, air / sample line tubing, fittings, and mountings.

4. Electrical:

a. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the electrical power source to the MBR System Control Panel.

b. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from MCC to all field equipment.

c. Instrumentation wiring, conduit and other appurtenances required to provide connections as needed between the terminal boxes at the MBR, pumps, etc., and the membrane PLC control panel.

d. Motor control centers, adjustable speed drives, panel boards, transformers, and other equipment necessary to provide power distribution and control for all equipment.

e. Network communications connection to the Plant SCADA and the MBR System SCADA systems (if the two are different).

5. Other:

a. Receiving, unloading and safe storage of equipment at site or a storage facility until ready for installation.

b. Equipment installation.

c. Instrumentation installation including continuity checks and assistance with related loop checkout.

d. Raw materials, chemicals and utilities during equipment testing. This includes potable water for system function testing and seed sludge per supplier requirements.

e. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.

f. Onsite painting or touch-up painting of MBR, with the exception of painting required due to damage incurred prior to equipment being received onsite.

1.06 WARRANTY

A. MBR System Supplier shall warranty and replace the membranes under warranty for a period of 10 years. The warranty shall not be pro-rated. All warrantee support, as defined in the warranty statement, shall be provided by the MBR System Supplier directly or through certified sub-contractors.

B. MBR System Supplier shall warrant Membrane Units under the following terms:

1. MBR System Supplier shall replace any units that fail before 5 years from the date of successful completion of the System Commissioning.

2. Failure is defined as any of the following:

a. Inability to meet production capacity requirements as specified herein.

b. Inability to meet TSS and turbidity requirements as specified herein.

3. The following are specifically excluded from warranted failure conditions:

a. Exceeding TSS or Turbidity limits due to physical damage of the membranes and/or loss of piping integrity.

b. Loss of capacity due to failure to operate within design fluxes and permeability limits as defined in this Section.

c. Loss of capacity due to failure to perform required Maintenance cleans.

C. Supplier shall warranty all other equipment, not specifically mentioned above, against defects in workmanship and materials for a period of 1 year. The warranty period shall begin following completion of the System Commissioning as specified herein.

PART 2 - PRODUCTS

2.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES

A. The MBR System Supplier will provide the following services for items in their Scope of Supply:

1. Biological Process Design Verification – The MBR Supplier shall support the Engineer in providing analysis and verification of the biological process design using EnviroSim BioWin wastewater modeling software and the customer's influent mass loading, diurnal flow curves, peak flow/loading numbers, and permit limits. The Suppler shall verify basin volumes, recycle rates, aerations requirements, chemical dosing requirements, and waste solids projections. The supplier shall provide a written report summarizing the modeling results.

2. Piping Hydraulic Analysis and Design – The MBR Supplier shall provide a detailed hydraulic analysis and mechanical design documentation of each process subsystem contained in the MBR system scope of supply. Using Pipe-Flo simulation software, subsystem piping designs shall be analyzed to verify flow distribution between membrane units, pump duty points and turn down, and flow control valve Cv and rangeability. The supplier shall supply piping design of each system in 3D using Autodesk Inventor, utilizing 1:1 representation of all fittings, instruments, and equipment. Piping design files shall be provided to the Engineer for integration into the design package. The subsystems included in the hydraulic analysis shall include:

    a. Recycle pump systems

    b. Process air distribution systems

    c. Scour air distributions systems

    d. Permeate systems

    e. WAS systems

3. Equipment Sizing and Installation Details – The MBR Supplier shall verify duty points and turn-down, supply voltages, materials of construction, communications IO, equipment access and serviceability, area classifications, and pressure ratings for the MBR system's pumps, blowers, mixers, and valves. In addition to identifying manufacturers and specific part numbers for each component, installation details and 2D/3D CAD blocks shall be provided for integration into the Engineer's design package.

4. Instrumentation Design – The MBR Supplier shall provide the Engineer with complete specification and documentation of all MBR system instrumentation. Each instrument's manufacturer, model, size, range, power, communications protocol, units, materials, connections, and area classification shall be documented in ISA Specification forms. Installation details shall be provided in AutoCAD format for integration into the Engineer's design package.

5. Controls Design – The MBR Supplier shall supply MBR system Process and Instrumentation Diagrams utilizing the Supplier's standard symbols and tagging schemes, MBR system control panel layout/fabrication details, and MBR system control panel wiring schematics in AutoCAD for integration into the Engineer's design package. Additional controls documentation shall include PLC architecture diagrams, control panel BOM, panel IO arrangement, loop drawings, and a control narrative of the overall plant control scheme.

6. Specifications - Using CSI MasterFormat 2004, the MBR System Supplier shall provide the Engineer with complete bid specifications for the MBR system and all supporting equipment, instrumentation, piping systems, valves, and control systems for integration into the Engineer's contract and bid documents.

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. The MBR System tankage and pumping systems will be sized to hydraulically convey the seasonal and diurnal flows shown in Table 2-1.

Table 2-1: Plant Hydraulic Loading Criteria

Parameter	Influent		Event Duration		
Average Annual Daily Flow (AAF)[1]	0.4	MGD	275 days		
Maximum Month Daily Flow (MMF)[2]	0.4	MGD	30 days		
Peak Daily Flow (PDF)[3]	0.8	MGD	24 hr		
Peak Hourly Flow (PHF)	0.8	MGD	4 hr		

B. Operation outside the flow ranges described in 2.02.B shall be permissible provided membrane permeability does not decrease below 5 gfd/psi and/or TMP does not increase above 3 psi for more than six hours of operation in any calendar year of operation.

C. The MBR System shall be capable of treating raw wastewater at listed flows to the specified effluent criteria shown in Table 2-3

Table 2-3: Plant Pollutant Loading and Effluent Criteria

Parameter	Influent[1]				Effluent Limit/ Performance Requirement
Average Annual $CBOD_5$	600	mg/l			<=5 mg/l
Average Annual TSS[4]	500	mg/l			<=5 mg/l
Average Annual Daily TKN	100	mg/l			3
Average Annual Daily TP	10	mg/l			<=1 mg/l
Total N NH3-N NOX (NO3+NO2) Organic N	80	mg/l			<=1mg/l <=7 mg/l <10 mg/l
Turbidity[3]	--	--			<=1 NTU (ave.) <=2[NTU (max.)
Minimum Daily Average Temperature (MMF)	10	Deg C			--

Notes:

D. System Configuration

1. The headworks will consist of two duty and one standby fine screen, each identically sized with sufficient capacity to handle 50% of the maximum hydraulic flow as stated in Table 2-1 and as described in this specification's Scope of Supply.

2. The MBR system shall consist of following process trains,

   a. One anaerobic basin with a minimum volume of 16,756 gallons.

   b. One pre-anoxic basin with a minimum volume of 34036 gallons.

   c. Three pre-aeration basin with a minimum volume of each 30281 gallons.

   d. One post-anoxic basin with a minimum volume of 40394 gallons.

   e. Three MBR basin with a minimum volume of each 16126 gallons.

E. The sludge retention time (SRT) shall be between 15-20 days.

F. The design MLSS in the MBR shall be 10000-15000 mg/l.

G. [The MBR System shall meet the average annual daily flow and maximum month daily flow listed in Table 2-1 with one Membrane Basin out of service.]

H. The MBR system shall be capable of handling the peak daily flow listed in Table 2-1 for a period of 24 consecutive hours without loss of treatment efficiency or damage to the system.

I. The allowable MLSS concentration in the Membrane Zones shall range between 10,000 mg/l and 18,000 mg/l.

J. An MBR shall be considered part of the biological process when calculating aerobic volume requirements.

K. The MBR shall be designed to operate at or below a trans-membrane pressure (TMP) of 3.0 psig.

L. Each in-place cleaning shall not require the MBR to be drained.

M. Each in-place cleaning shall not require the MBR to be taken out of service for more than 6 hours.

N. The MBR shall utilize self-priming centrifugal pumps to filter water. No additional components such as vacuum pumps and air separators shall be required for filtrations purposes.

O. Site Conditions

1. Ambient air temperatures shall be between20 °F and 100 °F.

2. The elevation above sea level is 680 ft.

3. Influent wastewater shall contain less than 20 mg/l fats, oils and grease (FOG).

4. No substances shall be placed in the system in quantities which are not biodegradable or toxic to the biological system.

5. The influent wastewater pH shall be between 6-8 SU.

6. Water hardness shall not exceed 300 mg/l as CaCO3.

2.03 SUBSYSTEM SCOPE OF SUPPLY

MBR System Supplier shall furnish the Subsystem Components listed below in accordance with the requirements of this the project Specifications and Contract Documents All components shall be shipped loose for installation by installing Contractor unless otherwise noted.

A. Headworks

1. Fine screens with one standby of equal capacity.

2. Basin high and low level switches

3. Conveyor, washer, compactor

B. Anaerobic Basins

1. Mixers

C. Pre-Anoxic Basins

1. Mixers
2. Basin high and low level switches
3. Basin level sensor/transmitter

D. Pre-Aeration Basins

1. Fine bubble diffusers
2. Combination DO/temperature sensor/transmitter

E. Post-Anoxic Basins

1. Mixers

F. Membrane Basins

1. Membrane Units.
2. In-basin interconnecting air and permeate piping.
3. Permeate header piping and valves terminating with a permeate header isolation valve after the final Membrane Unit branch connection.
4. Air header piping and valves terminating with an air header isolation valve after the final Membrane Unit branch connection.
5. Pipe supports and support anchors for all Supplier-provided piping.
6. Basin high and low level switches

G. Permeate Collection System

1. MBR permeate pumps
2. MBR permeate control valves
3. MBR permeate process instrumentation
4. MBR permeate turbidimeters

H. Cleaning Systems

1. Maintenance Clean system pumps, valves, instrumentation, and tanks (if necessary).

I. WAS Handling System

1. WAS pumps
2. WAS control valves
3. WAS instrumentation

J. Supplemental (Process) Aeration System

1. Process air blowers with one standby of equal or greater capacity
2. Process air flow control valves
3. Process air instrumentation

K. Membrane Zone (Scour) Aeration System

1. Scour air blowers with one standby of equal or greater capacity
2. Scour air flow control valves
3. Scour air instrumentation

L. Internal Recycle System

1. RAS pumps with standby of equal capacity
2. RAS flow control valves
3. RAS instrumentation

M. Controls

1. MBR control panel
2. MBR Operator Interface
3. SCADA and PLC programming

2.04 GENERAL EQUIPMENT DESIGN AND FABRICATION REQUIREMENTS

The requirements listed below are in addition to those called out in the Specifications listed in Part 1.01 of this Specification.

A. Screens

1. Fine screens shall be designed specifically for the MBR System. The screens shall be capable of handling the peak flows described in this Specification.
2. Redundancy shall be required such that a single screen failure shall not reduce plant capacity or compromise Supplier Warranty coverage

3. The screens shall include sufficient instrumentation so as to support automatic start-up, shut-down, and alarming of high levels.

4. Screens shall be self cleaning and supplied with conveyors, washers, and compactors to facilitate the removal and minimization of the removed solids.

B. Submersible Mixers

1. Submersible mixers shall be direct driven, close-coupled, guide-rail-mounted, non-clogging propeller type designed for mixing of raw or processed sewage. All components of the mixer shall be capable of continuous submerged operation. The mixer shall be sized to provide complete mixing.

2. All major components of the submersible mixers shall be manufactured of 316 stainless steel. All bearings shall have a minimum B-10 rated bearing life of 100,000 hours.

3. Mixers shall have integral motor thermal overload protection and seal failure (moisture) sensor.

4. The mixers shall be provided with guide rails, guide brackets, and lifting cables.

C. Mixed Liquor Recirculation Pumps

1. Mixed liquor recirculation pumps shall be capable of passing a three-inch spherical solid.

2. Major pump components shall be cast iron, ductile iron, or stainless steel.

3. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

4. Submersible pumps: Pumps shall have integral motor thermal overload protection and seal failure (moisture) sensor and be provided with guide rails, guide brackets, and lifting cables.

5. Dry-mount pumps: Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling municipal waste.

D. Fine Bubble Diffuser Systems

1. Fine bubble diffuser systems shall include in-basin aeration piping, pipe drops, submerged manifolds, laterals, diffusers, drain pipes, pipe supports, and purge system.

E. Membrane Units

1. Membrane Units shall:

a. Be the OV480 type as manufactured by Ovivo. Alternate membrane units or suppliers shall be strictly prohibited.

b. Be constructed of type 304 stainless steel, PVC, and PE components as necessary for operation submerged in mixed liquor as part of an MBR System.

c. Meet Buy America requirements.

d. Be retrievable as a unit including Diffuser Case (one pick removal and install).

e. Be furnished with anchors for securing Membrane Units within the basin.

f. Include one Permeate Module, Mounting Hardware, one Diffuser Case and one Diffuser Assembly.

2. Permeate Modules are:

a. Assembled with permeate piping (manifolding) and four Membrane Cassettes each housing 25 Membrane Sheets.

i Cassettes are manufactured from long-lasting PVC sheets fastened with SS hardware.

b. Equipped with one permeate pipe connection consisting of Schedule 80 PVC, ANSI flange.

c. Furnished with all fittings as necessary to make the connection to a common header.

d. Approved by the California Department of Health Services (DHS) under the California Recycled Water Criteria (Title 22 of the California Code of Regulations). Submitters shall provide a copy of the DHS acceptance letter and test report.

3. Mounting Hardware

a. Includes all internal supports and fasteners as required for installation (304 SS).

b. Includes a top support system consisting of two yokes for easy installation and removal

c. Can include all pipe supports and access platforms as necessary for maintenance (optional).

4. Diffuser Cases shall:

a. Be fabricated from 304 SS

b. Be attached to the Cassettes to accommodate retrieval without lowering water level

c. Accommodate both coarse bubble and medium bubble Diffuser Assembly options

5. Medium Bubble Diffuser Assembly

   a. Consist of separate Aerostrip Diffusers, each fed by a common manifold and easily replaceable

   b. Adjustable Diffuser orientation for rise rate and oxygen transfer efficiency (OTE) optimization ±20º (total of 40º) in fixed 5º intervals

6. Aerostrip Diffusers are:

   a. Manufactured from polyurethane (PE) strips

   b. Non-clogging type that do not require mixed liquor for cleaning

   c. Designed to last a minimum of 10 years

   d. Provide a minimum of 1.3%/ft OTE

7. Membrane Sheets shall be:

   a. Ultrafiltration (UF) type with a nominal (average) pore size of 0.04 microns as manufactured by Microdyn-Nadir.

   b. Comprised of two PES (polyethersulfone) filtrations layers uniformly fused to and separated by an integral polyester (PE) drainage layer.

      i Sheet shall be 2mm in thickness, 8 mm apart and sufficiently flexible to minimize or prevent the effects of localized dewatering

      ii Sheet shall be ultrasonically welded on all sides and backwashable

   c. Capable of being aerated during periods of no filtration

   d. Easy to recover localized dewatering or clogging in the event of misoperation or operation outside of normal operating conditions.

      i Only a routine Maintenance Cleaning shall be required following a dewatering event to recover Specified performance

      ii In situ physical or mechanical cleaning only; no manual cleaning shall be required to recover

   e. Be Resistant to damaging debris and self-heal in terms of effluent quality per the following:

i Turbidity shall recover to specified limits within 10 minutes of a damaging event or occurrence provided the resulting cut or abrasion is less than 4” in total length.

F. Permeate Pumps

1. Permeate pumps shall be required when the hydraulic loading as described in this Specification can not be met using gravity filtration.

2. Pumps shall be sized to handle peak instantaneous flow as defined in this Specification as well as rates associated with backwashing, maintenance cleaning, and aerator flushing.

3. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

G. Blowers

1. Blowers shall be provide complete with sound enclosure, inlet filters, discharge silencers, pressure relief valves, check valves, motors, temperature and pressure gauges, over-temperature sensor/switch, expansion joints, belts, and baseplates.

2. Process aeration blowers shall be sized to maintain a residual DO of 2.0 mg/l at MMF flow rates and loadings and a minimum of a 2:1 turndown. Process aeration system shall include a standby blower of equal or greater capacity than the duty blowers.

3. MBR scour air blowers shall be sized such than sufficient scour air is provided to support MMF flows as described in this Specification without requiring additional maintenance cleans. The scour air system shall include a standby blower of equal or greater capacity than the duty blowers

4. MBR scour air blowers shall accommodate a minimum surge or 1.5 psig under normal operating conditions.

H. Cleaning Systems

1. The Cleaning Systems shall include backwash, maintenance clean, and recovery clean systems as required by the Supplier’s specific systems.

2. Cleaning Systems shall be inclusive of all chemical feed day tanks, chemical feed pumps, valves, instrumentation, controls, and all other ancillary equipment necessary for a complete cleaning operation.

3. Supplier shall define building space shall to be allotted for all Cleaning systems, including space for:

a. Chemical storage

b. Mix tanks

c. Cleaning system equipment

d. Safety equipment

e. Containment and neutralization of spent chemicals. Containment space shall include space necessary for separation of incompatible materials to meet International Building Codes and International Fire Codes.

4. The system shall be designed to clean the Membrane Units in-place without requiring their removal from tanks.

5. The cleaning systems shall be sized to clean one Membrane Zone at a time and allow the other Membrane Zones to remain in production.

6. All components of the cleaning systems shall be compatible with cleaning solutions recommended by the Supplier for its system.

I. Waste Activated Sludge (WAS) Pumps

1. WAS pumps shall be capable of passing a three-inch spherical solid.

2. The pumps shall be sized to transfer the expected MMF waste sludge volumes in less than 3 hours.

3. Major pump components shall be cast iron, ductile iron, or stainless steel.

4. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

5. Submersible pumps: Pumps shall have integral motor thermal overload protection and seal failure (moisture) sensor and provided with guide pipes, guide brackets, and lifting cables.

6. Dry-mount pumps: Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling municipal waste.

J. Valve Actuators

1. In order to reduce operating noise levels to nearby residents, it is preferred that all valves be electric actuated valves.

2. If pneumatic valves are provided by the Supplier

a. Air supply requirements shall be defined by the MBR System Supplier

b. Supplier’s scope shall include a duty and standby compressed air package. Each package compressor unit shall consist of skid mounted three lobe positive displacement blowers in noise suppression enclosures with as maximum of 85 decibels at 3-feet, intake filters, noise suppression discharge piping, and electrical motors and soft starters.

K. Piping

1. All MBR System air scour piping shall be Type 304 stainless steel above the waterline. PVC shall be permissible for air scour piping below the water line.

2. Permeate piping shall be schedule 80 PVC.

3. Piping shall have welded, glued, flanged, or mechanical groove (Victaulic) connections.

4. Pipe supports shall be 304 stainless steel Unistrut (or equivalent) systems or 304 stainless steel angle and structural shapes with stainless hardware, clamps, and guides

5. Transitions from MBR Supplier piping to Contractor's piping shall use ANSI 150 pound flanges unless otherwise noted or coordinated with the Contractor.

6. Insulation, heat tracing and or painting shall be provided by the Contractor

L. MBR SYSTEM CONTROLS

1. The MBR System controls shall be housed in a panel. The control panel will house the MBR system PLC and valve Open/Close/Auto switches. The control panel PLC is to be sized to handle all I/O for components in the MBR System as indicated on the P&IDs.

2. The MBR System shall include one Operator Interface containing graphical representations of all equipment and instrumentation and indication and trending of all process values.

3. The Supplier shall be responsible for all programming for the MBR System PLCs, database creations and generation of all graphic display screens, alarm configurations and trends for the operator stations.

4. MBR System controls shall be designed to allow for full manual (hand) operation in the event of PLC failures. Hand operations shall be manageable by two operators for a period of 72hr.

2.05 SPARE PARTS AND SPECIAL TOOLS

A. MBR Supplier shall furnish one set of special tools required for normal operation and maintenance of the MBR Units.

PART 3 - EXECUTION

3.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES

A. Supplier shall provide the MBR product engineering and design services called out in this specification in accordance with Table 3-1.

Table 3-1: Engineer and Design Services

Design Documents	Required for 60% Design	Required for 90% Design	Required for 100% Design
MBR Process drawings: piping/instrumentation drawings, for all equipment supplied by Supplier.	✓	✓	✓
MBR Mechanical drawings: dimensioned membrane arrangement plans, sections and details; dimensioned mechanical piping plans, sections, and details	✓	✓	✓
MBR electrical, instrumentation, and control drawings: power/wiring plans and details, one line diagrams, instrument plans, control plans	✓	✓	✓
Manufacturer cut sheet: all manufactured MBR equipment supplied by Supplier showing dimensions and physical and electrical requirements	✓	NA	NA
MBR Installation Instruction Manual for the MBR system supplied by Supplier	NA	NA	✓
MBR Equipment list: all Supplier supplied equipment	✓	✓	✓
MBR system control strategy		✓	✓
MBR Calculations: includes the design data (biological, flow, pressure, volumes, etc.) for the MBR system.	✓	NA	✓

B. The MBR System Supplier shall attend the following design coordination meetings at the Engineer's facility. Allow 1 full day per meeting.

1. Project kick-off meeting

2. 60% design review meeting

3. 90% design review meeting

3.02 PROJECT EXECUTION

A. Unless otherwise required in the Contract Documents, the MBR Supplier shall provide all submittal documentation as described in this Section no later than 8 weeks after receipt of purchase order and notice to proceed.

B. Unless otherwise required in the Contract Documents, the MBR Supplier shall deliver all components in their Scope of Supply, as described in this Section, no later than 18 weeks after receipt of written submittal approval.

3.03 CONTROL SYSTEM FACTORY ACCEPTANCE TEST

A. The MBR System Supplier shall coordinate and conduct a factory acceptance test (FAT) of the MBR control system during which:

1. The PLC control logic and HMI operability shall be demonstrated by systematically forcing I/O to verify all controls functions and HMI screen representations defined in the system control narrative.

2. The MBR control panel shall be inspected for completeness, and workmanship.

B. The MBR Supplier shall provide a minimum of 2 weeks notice to the Owner and Engineer prior to the FAT. The Owner and Engineer may, at their option and the expense of others, choose to attend and witness the FAT.

C. Whether or not the Owner and/or Engineer attend the FAT, the MBR Supplier shall provide written documentation and certification of the completed FAT.

3.04 MATERIALS INSPECTION

A. The Contractor shall inspect delivered equipment upon arrival on site for completeness of scope delivery and to verify that all components have arrived undamaged. The Contractor is responsible for notifying the Supplier of deficiencies in quantities or conditions within 28 days from the ship date.

B. The Contractor shall provide all labor, materials, and equipment for unloading, de-crating, organizing, and compiling take-off of received MBR equipment, components, and instrumentation.

C. The Supplier shall make available, upon the request of the Contractor, personnel to assist in the inspection of the Supplier's equipment upon unload at the site. Supplier's personnel shall provide services in accordance with their standard daily rates.

3.05 MECHANICAL INSPECTION PRIOR TO COMMISSIONING.

A. The Contractor shall schedule with the MBR System Supplier to perform a Mechanical Inspection at least 2 weeks prior to the scheduled Commissioning of the System.

B. The MBR Suppler shall conduct a Mechanical Inspection of the MBR System to verify that the installation is complete and ready to begin Commissioning activities. The Supplier shall verify the following:

1. Installation of all equipment per the Engineer's and Supplier's drawings and Supplier's IOM information.

2. Installation of all instrumentation per the Engineer's drawings and IOM information.

3. Completeness of all piping installations.

4. Completeness of all electrical installations.

5. Proper installation of the MBR Membrane Unit diffuser assemblies per the Submittal and IOM information.

6. Completeness of all basins, including removal of all debris that may cause damage to the Membrane Sheets.

7. Review of all pipe integrity testing (leak checking) results.

C. Upon completion of the Mechanical Inspection, the Supplier shall provide written documentation of the inspection results.

1. If the MBR System is complete per the requirements of the Mechanical inspection, the MBR Supplier shall schedule the System Commissioning with the Contractor. The date for the System Commissioning is to be established within 2 weeks of the successful completion of the Mechanical Inspection.

2. If the MBR System is not complete at the time of the Mechanical Inspection, the Supplier shall document system deficiencies to the Contractor, Engineer, and Owner. The Contractor will then complete all necessary work and provide documentation (including digital photographs) of the completed work. After all noted deficiencies are resolved to the satisfaction of the Engineer, Owner, and Supplier, the date for the System Commissioning is to be established within 2 weeks.

3. If the Mechanical Inspection deficiencies are deemed as sufficiently important by the Supplier, Owner, or Engineer, the Contractor shall arrange for the Mechanical Inspection to be repeated at the Contractor's expense

3.06 SYSTEM COMMISSIONING

A. The MBR System Supplier shall coordinate with the Contractor, Engineer, and Owner for execution of the System Commissioning. In advance of System Commissioning the MBR System Supplier shall perform an onsite Mechanical Inspection of the facility and generate a punchlist of inconsistencies. The Contractor is required to resolve the punchlist items to the satisfaction of the System Supplier, prior to scheduling System Commissioning. The System Commissioning will consist of the following:

1. General inspection of systems (lubrication, rotation, calibration).

2. Loop checking, instrumentation, and control system verification.

3. Pipe loss testing.

4. Clean water permeability testing.

5. Sludge seeding.

6. Training

B. The Contractor shall provide materials and personnel in support of the System Commissioning to fill basins with clean water, transfer fluids, repair/remedy any and all electrical and mechanical issues, provide temporary tie-ins, temporary piping, transfer pumps, etc.

C. The Contractor shall coordinate with the Engineer and Owner to seed the MBR system with sludge at the conclusion of the clean water testing. The MBR Supplier is not responsible for supplying the seed sludge.

D. The System Commissioning shall begin at the Contractor's discretion, within the limits defined herein:

1. Successful completion of a pre-commissioning Mechanical Inspection is required.

2. Start of Commissioning shall be no later than 60 days after completion of Mechanical Inspection.

E. The Owner shall operate the plant during the Commissioning Period; however, Supplier and Contractor shall be allowed to provide onsite assistance.

F. Supplier is responsible for monitoring operating conditions and performance during the Commissioning Period.

G. Supplier shall provide the Owner with a Plant Operations Manual at the end of the Commissioning Period. The manual shall include at a minimum:

1. As-built drawings

2. Safety Manual

3. HMI Users Manual

4. As-built control schematics

5. Process variables and control narrative.

H. Supplier shall submit the Plant Operations Manual within 30 days following the end of the Commissioning Period.

I. Membrane permeate quality shall be evaluated to determine compliance of the MBR System with Performance Requirements. If the MBR system fails to comply with requirements of membrane permeate quality, Supplier shall proved the Owner and the Engineer a written plan of modifications to the system (such as repairing damaged fibers, replacing seals, complete replacement of system) to achieve compliance with the requirements. Upon implementation of modifications plan, the permeate quality tests shall re-commence in their entirety.

3.07 TRAINING

A. The MBR System Supplier shall provide Training in the maintenance and operation of all systems included in the Supplier's control system.

B. Training shall be completed prior to the completion of the System Commissioning. All training shall be performed by the Supplier or a factory-certified representative of the supplier or component supplier. Training is to include:

1. Navigation of all HMI screens and menus.
2. Review of automatic operations and controls.
3. Changing process set points
4. Overriding controls from the HMI
5. Manual operation of the system in the event of a power failure
6. Maintenance cleaning
7. Trouble shooting.

3.08 PROJECT SCHEDULE

A. The MBR System Supplier shall provide the Scope of Supply and associated services specified in this specification in accordance with the Table 3-2.

B. Firm dates for Deliverables as listed in Table 3-2 will be established by Engineer, Contractor, and Customer upon initiation of the project.

Table 3-2: Project Schedule

Deliverable	Due Date
Design Kick-off Meeting	To be completed within two weeks after notice to proceed.
Submittal of 60% Design Documents	Six weeks after completion of Design Kick-off Meeting
60% Design Review	Within two weeks of Submittal of 60% Design Documents
Submittal of 90% Design Documents	Six weeks after completion of Design Kick-off Meeting
90% Design Review	Within two weeks of Submittal of 90% Design Documents
100% Design Completion	Three weeks after completion of the 90% Design Review
Submittal Documentation	Eight weeks after notice to proceed Three with design scope, eight w/o
Installation Documentation (IOM)	Two weeks prior to Equipment Delivery at Site
Factory Acceptance Test	Two weeks prior to Equipment Delivery at Site

Equipment Delivery at Site	18 weeks after receipt of Approved Submittals
Mechanical Inspection	Three weeks prior to System Commissioning
System Commissioning	To be scheduled upon successful completion of Mechanical Inspection
Training	Training to be provided at the conclusion of the System Commissioning
Plant Operations Manual (POM)	Four weeks after completion of System Commissioning

3.09 SUPPLIER SERVICES

A. In addition to the time necessary to complete the requirements established within this specification and elsewhere within the Contract Documents, the MBR System Supplier shall provide on-site visits in support of the Services shown in Table 3-3 .

Table 3-3 MBR Project Execution Services

Item	Service	Estimated Person-Days	Estimated Trips	Notes
1	Project Kick-Off Meeting	1	1	One day meeting. Supplier to provide necessary personnel
2	Material Inspection	2	1	Supplier to verify completed shipment of material at unload
3	Mechanical Inspection	5	1	Per this Section
4	Commissioning and Testing	40	6	Inclusive of clean water testing and seeding support/startup
5	Training	5	1	Training during Commissioning

B. Time spent remedying equipment deficiencies/problems shall not count toward the listed durations and trips.

C. MBR System Supplier shall be given a minimum of two-week advance notice prior to the scheduling of any of the listed Services.

D. All service shall be provided by a factory representative or certified subcontractor.

E. Supplier shall provide telephone support for a minimum period of 5 years following commissioning during normal working hours.

F. Supplier shall provide a phone number for support during nights, weekends, and holidays in event of an emergency.

END OF SECTION

SECTION 13040

PLANT INFLUENT FLOW METER

PART 1 - GENERAL

1.1 SCOPE

A. This section describes the requirements for a flow sensor.

B. Under this item, the contractor shall furnish and install the flow measurement equipment and accessories as indicated on the plans and as herein specified.

1.2 QUALITY ASSURANCE

A. Referenced Standards and Guidelines - Complies with applicable portions of ANSI/AWWA Standards and NSF/ANSI Standard 61, Annex G. There are currently no AWWA standards that specifically address electromagnetic metering.

1. Flow measurement function complies with Industry Standards

a. ANSI B16.5 Class 150 RF
b. AWWA Class B
c. NEMA 4X/6P (IP66/IP67)
d. CSA

1.3 SUBMITTALS

A. The following information shall be included in the submittal for this section:

1. Outline dimensions, conduit entry locations and weight

2. Customer connection and power wiring diagrams

3. Data sheets and catalog literature for microprocessor-based transmitter and transducer

4. Interconnection drawings

5. Installation and operations manual

6. List of spare parts

7. Complete technical product description including a complete list of options provided

8. Any portions of this specification not met must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification

1.4 SYSTEM DESCRIPTION

A. Electromagnetic flow meter is intended for fluid metering in industries including water, wastewater, food and beverage, pharmaceutical and chemical. Measures fluid flow of water or fluids which are highly corrosive, very viscous, contain a moderate amount of solids, or require special handling. No moving parts are in the flow stream. Amplifier can be integrally mounted to the detector or can be remote-mounted. Unit is ideally suited for measuring dynamic, non-continuous flow. In applications where a minimum and/or maximum flow rate must be tracked and monitored, the unit provides pulse signals that can be fed to dedicated batch controllers, PLCs and other more specialized instrumentation.

1.5 DEFINITIONS

A. Amplifier – Device used for increasing the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with larger amplitude.

B. ANSI – (American National Standards Institute) A private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States. The organization also coordinates U.S. standards with international standards so that American products can be used worldwide.

C. AWWA – (American Water Works Association) An international non-profit professional organization founded to improve water quality and supply.

D. Detector Coils – Also called an “induction loop”, an electromagnetic communication or detection system which uses a moving magnet to induce an electrical current in a nearby wire.

E. Electrode – An electrical conductor used to make contact with a nonmetallic part of a circuit (e.g. a semiconductor, an electrolyte or a vacuum).

F. Modbus RTU – a serial communications protocol published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). This is used in serial communication & makes use of a compact, binary representation of the data for protocol communication.

G. NEMA – (National Electrical Manufacturers Association) Is the 'Association of Electrical Equipment and Medical Imaging Manufacturers' in the United States. Its approximately 450 member companies manufacture products used in the generation, transmission, distribution, control, and end use of electricity. These products are used in utility, industrial, commercial, institutional, and residential applications.

H. NSF – (National Science Foundation) A United States government agency that supports fundamental research and education in all the non-medical fields of science and engineering.

I. PLCs – (Programmable Logic Controller) A digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines.

J. PTFE – (Polytetrafluoroethylene) A synthetic flouropolymer of tetrafluoroethylene that finds numerous applications. The best known brand name of PTFE is Teflon by DuPont Co.

K. Serial Communications – In telecommunication and computer science, serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus. This is in contrast to parallel communication, where several bits are sent as a whole, on a link with several parallel channels.

PART 2 – PRODUCTS

1.1 APPROVED MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with specifications, provide flow measurement equipment by one of the following:

1. Badger Meter M2000, or equal

1.2 OPERATING CONDITIONS

A. System Components

1. Metering Tube (Detector)

a. Consists of stainless steel tube lined with a non-conductive material. Energized detector coils around tube create a magnetic field across the diameter of the pipe. As a conductive fluid flows through the magnetic field, a voltage is induced across two electrodes; this voltage is proportional to the average flow velocity of the fluid.

2. Signal Amplifier

a. Consists of unit which receives, amplifies, and processes the detector's analog signal. Signal is converted to both analog and digital signals that are used to display rate of flow and totalization. Processor controls zero-flow stability, analog and frequency outputs, serial communications and a variety of other parameters. Integrated LCD display indicates rate of flow, forward and reverse totalizers and diagnostic messages. Display guides user through programmable routines.

B. Operational Requirements

1. Electromagnetic Flow Meter

a. The flow meter system shall operate with a pulsed DC excitation frequency, and shall produce a signal output that is directly proportional and linear with the volumetric flow rate of the liquid flowing through the metering tube. The metering system shall include a metering sensor tube (detector), a signal amplifier, and the necessary connecting wiring. The metering system shall have the ability to incorporate a meter mounted or remote mounted amplifier.

b. Engineering Units:

1) The signal amplifier shall be program selectable to display the following units of measure: U.S. gallons, imperial gallons, million gallons (U.S.), cubic feet, cubic meters, liters, hector-liters, oil barrels, pounds, ounces or acre feet.

c. Operating Principle: Electromagnetic Induction

d. Metering Tube (Detector)

1) The metering tube (detector) shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.

2) The metering tube (detector) shall be available in line size from ¼" [6 mm] to 54" [1400 mm].

3) The metering tube (detector) end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.

4) The insulating liner material of the metering tube (detector) shall be made of a hard rubber elastomer and NSF-listed for meter sizes 4” and above, in conformance with manufacturer’s recommendation for the intended service or an NSF-listed meter option with PTFE liner.

5) The metering tube (detector) shall include two self-cleaning measuring electrodes. The electrode material shall be corrosion resistant and available in Alloy C or 316 stainless steel.

6) The metering tube (detector) shall include a third “empty pipe detection” electrode located in the upper portion of the inside diameter of the flow tube in order to detect an empty pipe condition when the flow tube is running partially empty. Empty pipe detection that is not activated until the pipe is 50% empty is not acceptable.

7) The metering tube (detector) housing shall be constructed of carbon steel, welded at all joints, and rated to meet NEMA 4X/6P (IP66/IP67) ratings.

8) For remote amplifier applications, the metering tube (detector) junction box enclosure shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.

9) When installed in non-metallic or internally lined piping, the metering tube (detector) shall be provided with a pair of corrosion resistant grounding rings. The grounding ring material shall be 316 stainless steel.

10) Fluid Temperature Range

NOTE TO SPECIFIER: Select the appropriate application and liner material:

i. For remote amplifier applications, the fluid temperature range shall be 32°F to 178°F [0°C to 80°C] at a maximum ambient temperature of 122°F [50°C] for the hard rubber liner material.

ii. For remote amplifier applications, the fluid temperature range shall be -4°F to 248°F [-20°C to 120°C] at a maximum ambient temperature of 122°F [50°C] for the PTFE liner material.

iii. For meter-mounted amplifier applications, the fluid temperature range shall be 32°F to 178°F [0°C to 80°C] at a maximum ambient temperature of 122°F [50°C] for the hard rubber liner material.

iv. For meter-mounted amplifier applications, the fluid temperature range shall be -4°F to 212°F [-20°C to 100°C] at a maximum ambient temperature of 122°F [50°C] for the PTFE liner material.

e. Signal Amplifier

1) The signal amplifier shall be microprocessor based, and shall energize the detector coils with a digitally controlled pulsed DC. The excitation frequency shall be program selectable for the following: 1Hz, 3.75Hz, 7.5Hz, or 15Hz. (factory optimized to pipe size and application)

2) The signal amplifier electrical power requirement shall be 85-265VAC, 45-65Hz. The power consumption shall not exceed 15W.

3) The signal amplifier shall have an ambient temperature rating of -4°F to 140°F [-20°C to 60°C].

4) The signal amplifier shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.

5) Automatic zero stability, low flow cut-off, empty pipe detection and bi-directional flow measurement shall be inherent capabilities of the signal amplifier.

6) All signal amplifier outputs shall be galvanically isolated to 250 volts.

7) The signal amplifier and remote junction enclosures shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.

8) Outputs:

The signal amplifier shall provide a total of four digital outputs, one analog output and one digital input.

i. Up to four open collector digital outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, reset output, error alarm and 24V supply.

ii. Up to two active digital (24 Volt) outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, preset output, error alarm and 24V supply.

iii. Up to two AC solid-state relay outputs, program selectable from the following: Frequency output, flow set point, empty pipe alarm, flow direction, preset amount and error alarm.

iv. One digital input, program selectable from the following: Remote reset, batch reset and positive return to zero.

v. Advanced protocol support using Modbus/RTU.

vi. One analog output programmable and scalable from the following: 0-10mA, 0-20mA, 2-10mA or 4-20mA. Voltage sourced and isolated. Max. loop resistance = 800 ohms.

f. Control and Programming

1) The signal amplifier shall be programmed via three function buttons. The programming functions shall be available in a user-friendly, menu driven software through the four-line LCD interface. The signal amplifier shall accommodate the following languages: English, German, Czech, French or Spanish.

2) Programmable parameters of the amplifier include, but are not limited to: calibration factors, totalizer resets, unit of measure, analog and pulse output scaling, flow-alarm functions, language selection, low-flow cutoff, noise dampening factor and excitation frequency selection.

3) The signal amplifier shall have a programming option allowing entry of a selected numeric password value for tamper protection.

g. System Performance

1) The metering system shall operate over a flow range of 0.10 to 39.4 ft/s [0.03 to 12.0 m/s].

2) The metering system shall perform to an accuracy ± 0.25 percent of rate for velocities greater than 1.64 ft/s [0.50 m/s], ± 0.004 ft/s [± 1 mm/s] for velocities less than 1.64 ft/s [0.50 m/s].

3) The metering system shall be capable of measuring the volumetric flow rate of liquids having an electrical conductivity as low as 5.0 micromhos per centimeter.

4) The system measuring repeatability shall be <0.10% of full scale.

h. Indication

1) The signal amplifier shall include a four-line, 20-character, backlit LCD interface to display the following values:

i. Flow rate in selectable rate units
ii. Forward totalizer in selectable volume units
iii. Reverse totalizer in selectable volume units
iv. Net totalizer in selectable volume units
v. Error or alarm messages
vi. Software revision level

PART 3 - EXECUTION

1.1 INSTALLATION

A. Follow manufacturer's recommendation for installation. Installation will conform to the guidelines provided by the Installation & Operation Manual.

B. Straight pipe requirement shall be an equivalent of three diameters on the inlet (upstream) side, and two diameters on the outlet (downstream) side.

C. For best performance, place meter vertically, with liquid flowing upward and meter electrodes in a closed, full pipe.

1.2 CALIBRATION

A. Each meter shall be hydraulically calibrated in an ISO 9000-certified testing facility, which utilizes a computerized gravimetric testing method with a measuring uncertainty of 0.1%.

B. Each meter shall be provided with a calibration certificate indicating the measured error (percent deviation) at three different flows, respectively equivalent to 25%, 50% and 75% of the nominal flow rate for each size.

1.3 MANUFACTURER'S WARRANTY

A. Terms

1. The manufacturer of the above specified equipment warrants the Product to be free from defects in materials and workmanship appearing within the earlier of either: One (1) year after installation; or one (1) year and six (6) months after shipment from manufacturer.

END OF SECTION

SECTION 13050

PLANT EFFLUENT FLOW METER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all equipment, accessories and material required for the installation of the plant effluent flow metering equipment in accordance with the Specifications. Any material and/or equipment necessary for the proper operation of the system not specified or described herein shall be deemed part of this Specification.

B. The Contractor shall warrant the equipment to be new and free from defects in material and workmanship, and within one year from date of substantial completion, repair or replace all or any part of the equipment found to be defective. This warranty shall not apply if damage is caused by abuse, accident, improper operation or negligence. Warranty maintenance shall be provided by the contractor during his normal working hours at no expense to the Owner. The Contractor also agrees that service shall be furnished at other than normal working hours and charged for at current rates.

The equipment supplier shall show satisfactory evidence upon request that he maintains a fully equipped service organization with standard replacement parts. All installation and service performed shall be by factory trained personnel.

C. All wiring shall be installed in approved conduit unless otherwise noted.

1.02 SUBMITTALS

A. Shop Drawings

(1) Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

(2) Include manufacturer's name, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagram, and conduit layouts.

B. Manuals

(1) Submit complete operating and maintenance manuals listing the manufacturer's name including technical data sheets as described in Section 01600.

(2) Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

PART 2 - PRODUCTS

2.01 General:

The open channel flowmeter sensor and converter shall receive a signal proportional to the level. In the amplifier the signal is linearized from the sensor so it is proportional to the volume. The flowmeter calculates flow on the basis of inserted formulas for dimensions of the flume.

2.02 Product Manufacturer:

The unit shall be a Model Accuron 7200 as manufactured by Eastech Flow Control, Tulsa, OK or approved equal.

PART 3 – EXECUTION

3.01 Deliver each piece of equipment in durable shipping cartons. Maintain cartons through shipping, storage and handling as required to prevent damage and eliminate dirt and moisture. Store cartons inside and protect from weather.

3.02 Install system and materials in accordance with manufacturer's instructions and rough-in drawings, and details on drawings. Install electrical work and use electrical products complying with requirements of applicable Division 16 sections of these specifications.

3.03 Term 'wiring' is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connecting all required devices.

3.04 All equipment shall be installed as shown on the PLANS and shall be held firmly in place. Fasteners and supports shall be adequate to support the required load.

3.05 After completion of installation, adjust relays, signals and similar equipment provided as work of this section. Final adjustments shall be performed by specially trained personnel in direct employ of manufacturer of system equipment. Manufacturers representative shall also provide four (4) hours of instruction to Owner's operating personnel.

END OF SECTION

SECTION 13270

DIGESTED SLUDGE PUMPS

Part 1 – General

1.01 Description

A. Related work specified elsewhere

1.1.1	Submittal:	Section 01300
1.1.2	Painting:	Division 9
1.1.3	Electric motors:	Division 16

1.02 Scope

A. The work to be performed under this section of the Specifications shall consist of furnishing and installing horizontal, motor driven, progressive cavity pumps with an in-line drive arrangement. The pumping assemblies are to be installed as shown on the Plans.

1.03 Quality Assurance

A. Manufacturer Qualifications

The pumps, motors, and drives shall be a product of manufacturers regularly engaged in the manufacturing of equipment having similar service and equal size for a minimum of eight years. The pumps shall be Progressive Cavity Pumps type BN 35-6LS as manufactured by Seepex, or approved equal.

B. Manufacturing Listing

The fact that a manufacturer's product is listed above does not imply that its standard product is acceptable. The successful manufacturer will be required to conform to all the written and implied specifications.

1.04 Submittals

A. Submittals are required after award of the contract and prior to equipment construction. The contractor shall submit per Section 01300 the following:

1. Performance curves
2. Complete specifications for each part to assure compliance with these Specifications.

3. Construction drawings showing complete dimensions, anchor bolts locations and flange details.
4. Weights
5. Warranty

B. Submittals required after construction and prior to shipment.
1. Factory test data
2. Four bound copies of operation and maintenance manuals, each copy to include:

a. Sectional drawings
b. Parts list with recommended spares
c. Operation instructions
d. Maintenance Instructions

1.05 Testing - Pump, Motor and Drive

A. All complete pumping units (this includes pump, motor and drive) will be tested on water as a complete unit at the manufacturer's plant before shipment. The testing shall be a complete performance test and is to include head and capacity, brake horsepower, and efficiency to prove that the pumps to be shipped conform to the requirements of the Specification.

B. The CONTRACTOR, acting under the instructions of the pump supplier's field representative, shall perform a functional field test of all the equipment to prove to the ENGINEER that all components of the system are properly installed and that all equipment will perform in accordance with this Specification.

1.06 Warranty

A. The pump manufacturer shall guarantee the complete pumping assemblies for a period of 12 months after acceptance or 18 months after shipment, whichever occurs first. The warranty as specified here shall cover all defective parts, material and workmanship.

The responsible manufacturer shall replace all items deemed by the manufacturer to be defective without cost to the Owner.

PART 2 – PRODUCTS

2.01 General - Unless otherwise stated, the sludge pumps shall be progressive cavity Moineau principle type suitable for pumping sludge as indicated below:

A. The liquid being pumped will be municipal wastewater sludge.

B. The progressive cavity pumps shall meet the following performance parameters:

FLOW:	80 GPM
DISCHARGE PRESSURE:	19 psi
MAXIMUM RPM:	1730
MINIMUM HORSEPOWER:	4.5 HP
MOTOR:	VARIABLE SPEED, 460 V, 3 Phase, 60 Hz.

2.02 Pump Construction

A. Pump Suction and Discharge Casing

The pump casing shall be designed for the type of service specified and shall be of sufficient strength**,** weight and metal thickness to ensure long life, accurate alignment and reliable operation. The suction casing shall be constructed of close-grained cast iron and have two clean out ports. The casing shall have connection for vents, drains, and gauges.

The suction and discharge connections shall be ANSI/B16.5 flanges sized for the pump specified. The discharge flange shall have a vent/gauge connection that can be rotated in 90 degree increments. The discharge support feet shall be separate from the discharge flange.

The pump shall be supplied with adequate NPT connections for stuffing box drainage, pump drainage, flushing and gauge connections.

B. Stator

The pump's Stator shall be formed from Nitrile rubber. The stator shall be affixed to the suction casing by the use of four (4) thru-, bolts for easy removal and replacement. Stators shall not be affixed to the suction casing by threaded connections or by snap rings. The suction edge of the stator shall be chambered to allow for unrestricted flow into the pumping elements. The rubber shall be molded around the ends of the stator tube sealing at the suction and discharge to prevent leakage. The use of separate o-rings or flat rings for stator sealing shall not be required.

C. Rotor

The rotor shall be precision machined from tool steel with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy layers of hard chrome plating. The rotor shall be driven by means of a heavy duty sealed drive train.

D. Drive Train

The rotor shall be driven by means of a heavy duty drive train. The rotor shall be joined to the drive shaft by means of a 316 stainless steel connecting rod with sealed gear type universal joints at each end. The sealed gear type universal joints shall be factory lubricated with oil and completely sealed from the abrasive fluid being pumped. To optimize seal and gear joint life, the connecting rod shall be of sufficient length to maintain its operating angle within 1 degree. Flexishafts are not acceptable.

E. Gland Housing and Stuffing Box

The pumps shall be constructed with adequately sized stuffing boxes capable of sealing the pumpage within the pump casing. The glad housing shall be field replaceable as a separate casting. The stuffing box shall be drilled and tapped for water flush or grease seal and supplied with a Teflon lantern ring. Furnish a grease zerk fitting on the box.

F. Pump Drive Shaft

The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear gear joint. Maximum shaft deflection under normal operating conditions shall not exceed .002". The portion of the drive shaft which passes through the stuffing box shall be hard chrome plated.

The solid drive shaft shall be mounted in a single row ball bearing on the coupling side of the drive shaft and a double row ball bearing on the stuffing box side of the drive shaft. The ball bearings shall be adequately sized to handle the radial and thrust forces, with a minimum B-10 bearing life of 100,000 hours. Upon written request, the Manufacturer shall supply to the Owner all bearing life calculations. Hollow or telescoping designed drive shafts are not acceptable.

The universal joint head shall be removable from the drive shaft to allow access to the stuffing box or mechanical seal without disturbing the drive end of the pump.

G. Bearing Frame

The pump bearing frame housing shall be a one piece rigid cast iron casting, providing a self-centering and self-indexing fit with the casing of the pump, to insure proper alignment of the bearings and stuffing box. The bearing housing shall be equipped with lip type grease seals and deflectors to prevent the entrance of contaminants. The bearings shall be grease lubricated.

2.03 Design Features

A. Pump Performance

The suction body of the pump shall be oversized at the entrance of the rotor and stator pumping elements to allow the free flow of high solids materials. The rotor joint head shall be set back from the stator and the leading edge of the stator shall be chambered so not to restrict the flow into the pumping elements. If the pump does not incorporate the aforementioned features, the use of a rag deflector shall be required.

2.04 Testing

A. Factory Testing

All pumping units shall be tested on water as a complete unit (this includes pump, motor and drive) at the manufacturer's plant before shipment. The testing shall be a complete performance test and is to include head and capacity, horsepower and efficiency to show conformance to the requirements of the performance specifications. All testing shall conform to the Hydraulic Institute standards and be certified by a Professional Engineer. The test can be witnessed at the Owner's option.

PART 3 – EXECUTION

3.01 The pump shall be installed as shown on the Plans.

3.02 FABRICATION

A. All equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detailed drawings, specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer.

3.03 FIELD TESTING AND FIELD SERVICE

A. The manufacturer's field engineer or representative shall be on hand to inspect and check the installation at the time of the initial start-up and operational testing of the equipment; and, therefore, to provide operation and maintenance instructional services for plant personnel.

END OF SECTION

SECTION 13420

MBR PROCESS INSTRUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor
-	Process and Instrumentation Diagrams (P&IDs)

1.02 SCOPE

A. The Contractor shall furnish and install all instrumentation and instrumentation installation hardware, conduit, and wiring necessary to provide for the complete installation of all instrumentation described in this specification. At a minimum the Contractor shall be responsible for:

1. Purchasing of all instrumentation tagged on the P&ID drawings, instrumentation schedule, or others listed in these specifications.

2. Installation and termination of all instrument and power wiring.

3. Installation and connection of all instrument pneumatic tubing and related controls.

4. Performance of instrument calibration and loop checks.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

1.03 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:

1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.

2. A complete set of submittal information in PDF format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.04 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting & installation information, electrical connection information, calibration instructions, maintenance information and a trouble shooting guide.

PART 2 - PRODUCTS

2.01 DISOLVED OXYGEN SENSOR/TRANSMITTER

A. Sensor

1. The sensor shall be a continuous-reading probe that utilizes luminescent sensor technology.

2. All parts of the probe shall be corrosion resistant and fully-immersible.

3. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.

4. The operation of the analyzer shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2-1.

5. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.

6. The sensor cap shall be warranted for one full year against defects in material and workmanship.

7. The probe shall be warranted for three full years against defects in material and workmanship.

8. Sensor shall be self-calibrating with a response time to 90% in less than 430 seconds or to 95% in less than 60 seconds at 20 deg C.

9. Measurement accuracy shall be +/-.1ppm below 1 ppm and +/-.2 ppm above 1 ppm.

10. The sensor shall be approved for operation from 32 to 122 deg. F.

B. Controller/Transmitter

1. The controller shall be a microprocessor-based instrument.

2. Connections between the sensors and the controller shall be “plug and play.”

3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

4. The interface unit shall include two analog 4-20 mA outputs.

5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.

6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hz.

8. The controller shall be UL certified.

9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers

1. Hach LDO sensor with SC100 controller

2. Approved equal.

2.02 TURBIDITY SENSOR/TRANSMITTER

A. Sensor

1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument

2. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU

3. Accuracy shall be ±2% of reading or ±0.015 NTU (whichever is greater) from 0 to 40 NTU; ±5% of reading from 40 to 100 NTU

4. Displayed resolution shall be 0.0001 NTU from 0 to 9.999 NTU and 0.001 NTU from 10.000 to 9.999 NTU.

5. Repeatability shall be better than ±1.0% of reading or ±0.002 NTU (whichever is greater).

6. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.

7. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.

8. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.

9. The turbidimeter body shall be corrosion-resistant.

10. An internal bubble removal system shall be included to vent entrained air from the sample stream.

11. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.

12. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.

13. Connections between the turbidimeter(s) and the controller shall be “plug and play.”

14. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

15. The interface unit shall include two analog outputs and 3 unpowered SPDT alarm contacts.

B. Controller/Transmitter

1. The controller shall be a microprocessor-based instrument.

2. Connections between the sensors and the controller shall be “plug and play.”

3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

4. The interface unit shall include two analog 4-20 mA outputs.

5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.

6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hz.

8. The controller shall be UL certified.

9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers

1. Hach 1720E with SC100 controller.

2. Approved equal.

2.03 MIXED LIQUOR SUSPENDED SOLIDS (MLSS) SENSOR/TRANSMITTER

A. Sensor

1. The sensor shall use dual-beam infrared/scattered light photometer for measuring suspended solids. The LED shall transmit light at 45 degrees to the sensor face and the back-scatter photoreceptors shall detect scattered light at 140 degrees to the transmitted beam.

2. The sensor shall provide color-independent measurement.

3. The sensor shall be equipped with self-cleaning device to prevent erroneous values and maintenance problems.

4. The signal averaging time shall be user selectable ranging from 1 to 300 seconds.

5. The sensor shall be capable to measure from 0.001 mg/l to 50,000 mg/L.

6. Measurement accuracy shall be less than 5% of reading.

7. Measurement repeatability shall be less than 3% of reading.

8. The sensor shall be approved for operation from 32 F and 104 F.

9. The sensor shall be warranted for one full year.

10. The sensor shall be enclosed in stainless steel or PVC and shall include a silicon wiper blade and integral cable.

B. Controller

1. The controller shall be a microprocessor-based instrument.

2. Connections between the sensors and the controller shall be “plug and play.”

3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

4. The interface unit shall include two analog 4-20 mA outputs.

5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.

6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hz.

8. The controller shall be UL certified.

9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers

1. HACH SOLITAX with SC100 controller

2. Approved Equal

2.04 pH SENSOR/TRANSMITTER

A. Sensor

1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.

2. The pH sensor shall have a built-in preamplifier to enable the signal to be transmitted upto 100m (328 ft) with standard cabling and upto 1000m (3280 ft) with a termination box.

3. The pH sensor shall have NTC 300 ohm thermistor for automatic temperature compensation and shall have a analyzer temperature readout.

4. The measurement range shall be -2 to 14 pH.

5. The measurement sensitivity shall be ± 0.01pH.

6. The sensor shall be suitable for operation from 23 F to 158 F.

7. The sensor material shall be PEEK® or approved equal, salt bridge of matching material with Kynar® (or approved equal) junction, glass process electrode, titanium ground electrode, and Viton® (or approved equal) O-ring seals.

B. Controller

1. The controller shall be a microprocessor-based instrument.

2. Connections between the sensors and the controller shall be “plug and play.”

3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

4. The interface unit shall include two analog 4-20 mA outputs.

5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.

6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hz.

8. The controller shall be UL certified.

9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers

1. HACH Differential pH with SC100 controller

2. Approved equal

2.05 ORP SENSOR/TRANSMITTER

A. Sensor

1. The ORP sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.

2. The ORP sensor shall have a built-in preamplifier to enable the signal to be transmitted upto 100m (328 ft) with standard cabling and up to 1000m (3280 ft) with a termination box.

3. The ORP sensor shall have NTC 300 ohm thermister for analyzer temperature readout.

4. The ORP sensor shall include a titanium ground electrode(standard) to eliminate ground loop currents in the measuring electrodes.

5. The measurement range shall be -1500 to +1500 mV.

6. The measurement sensitivity shall be ± 0.5 mV.

7. The sensor shall be suitable for operation from 23 F to 158 F.

8. The sensor material shall be PEEK® or approved equal, salt bridge of matching material with Kynar® (or approved equal) junction, glass and platinum process electrode, titanium ground electrode, and Viton® (or approved equal) O-ring seals.

B. Controller

1. The controller shall be a microprocessor-based instrument.

2. Connections between the sensors and the controller shall be “plug and play.”

3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.

4. The interface unit shall include two analog 4-20 mA outputs.

5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.

6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hz.

8. The controller shall be UL certified.

9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers

1. HACH Differential ORP and SC100 controller

2. Approved equal

2.06 HYDROSTATIC LEVEL TRANSMITTER

A. The level transmitter shall be a hydrostatic pressure sensor with an integral baffle plate to protect the sensing element from debris.

B. The level transmitter shall measure up to 23 ft of water head.

C. The level transmitter shall have a static accuracy of 0.5% FSO BFSL and one year stability of 0.20% FSO.

D. The response time shall be less than 5 ms.

E. The signal output shall be 4-20 mA DC two wire twisted pair grounded shield cable @ 0.042 ohm/ft.

F. The transmitter shall be approved for operation from -20 F to 190 F.

G. The transmitter and sensor shall be made of 316 stainless steel. The cable shall be polyurethane-jacketed cable with 40 ft of length.

H. The transmitter shall require 10-30 VDC unregulated power.

I. Manufacturers

1. Blue Ribbon Bird Cage Level Transmitter

2. Endress and Hauser FMX Level Transmitter

3. Approved equal

2.07 ULTRASONIC LEVEL TRANMITTER

A. The transmitter shall use the Sonic Intelligence® echo processing technology.

B. The measuring range shall be 0.8 ft to 26 ft.

C. The accuracy shall be 0.25% of measuring range (in air)

D. The transmitter shall be suitable for operation under ambient temperature conditions from -40 F to 140 F and shall include built-in temperature compensation.

E. The Power supply required for the transmitter shall be 12 to 28 V DC, max 0.1 A. The max power consumption shall be 0.75 W (25 mA at 24 V DC).

F. The output signal shall be 4-20mA and max load shall be 600Ω in the loop at 24 V DC

G. The transmitter shall have CE, CSA $_{NRTL/C}$, FM and 3A certificates and approvals.

H. The transmitter electronics enclosure shall be made of PVC and transducer shall be made of PVDF copolymer.

I. Manufacturers

1. Siemens Milltronics Level Transmitter

2. Approved equal

2.08 LEVEL SWITCH

A. The level switch shall be an enclosed, narrow angle, mechanical float switch designed for use in sewage environments.

B. The level switch shall utilize mechanically-activate microswitches for indication of specific water levels. Level switches containing mercury shall not be acceptable.

C. The switches shall be a single-pole, double throw (SPDT) type and have an electrical rating of 10 amps at 120 VAC.

D. The power cord shall be chlorinated polyethylene type SJ00W-300 volt on 16/3.

E. The float shall be ABS or polypropylene material and shall be leak proof, shock proof, and impact resistant.

F. The level switches shall be supplied with an anchor to which the float shall be tethered. The anchor shall allow for adjustment of the actuation level and be of sufficient weight as to hold the floats secure in a well-mixed tank. The anchor shall be constructed of corrosion-resistant material suitable for continuous submergence in mixed liquor.

G. Manufacturers shall be Conery 2902 Series Mechanical Angle float switches, Kobold NAE Series float switches, or approved equal.

2.09 TEMPERATURE SWITCH

A. The enclosure material shall be Die cast aluminum, epoxy powder coated, gasketed and with captive cover screws.

B. The enclosure shall meet NEMA 4X requirements.

C. The set point repeatability shall be within ±1% of adjustable temperature range.

D. The output shall be SPDT snap action switch.

E. The switch shall be electrically rated for 20A 125/250/480 VAC resistive.

F. The temperature dead band shall be within 2% of range under laboratory conditions (70 F ambient circulating bath at rate of ½ F per minute change)

G. The immersion stem shall be made of nickel-plated brass.

H. Manufacturers

1. United Electric

2. Approved equal

2.10 TEMPERATURE GAUGE

A. The temperature gauge shall be hermetically sealed to prevent moisture entry into the casing.

B. The temperature gauge shall be tamperproof with Maxivision dial for accurate temperature readings.

C. The temperature gauge shall be suitable for use in ambient temperature between -40 F and 200 F.

D. The temperature gauge shall measure temperature from 50 F to 400 F.

E. The temperature gauge accuracy shall be 1% full span to ASME B40.3 (Grade A).

F. The bimetal coils used are heat treated for optimum stability and over temperature capability.

G. The temperature gauge case and stem material shall be 304 SS.

H. Manufacturers

1. Ashcroft Bimetal Thermometers

2. Approved equal

2.11 FLOW SENSOR/TRANSMITTER FOR PERMEATE AND MIXED LIQUOR SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 fps shall be ± 0.5% of rate ± 0.02% of full scale (33 ft/see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from ½" to 78".

E. The tube shall be lined with polyurethane and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12" and smaller and AWWA Class D for 14" and larger.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of 316SS material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers

1. Endress & Hauser Model 50W

2. Approved equal

2.12 FLOW SENSOR/TRANSMITTER FOR CLEAN-IN-PLACE CHEMICAL SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 fps shall be ± 0.5% of rate ± 0.02% of full scale (33 ft/see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 1”-12”.

E. The tube shall be lined with PTFE and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12”.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of Alloy C-22 material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16 character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units. The display shall be used in conjunction with integral push buttons for configuration and diagnostic messages.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers

1. Endress & Hauser Model 50P

2. Approved equal

2.13 ROTAMETER (LIQUID SERVICE)

A. The liquid rotameter shall be a variable-area style flow meter.

B. The rotameter shall be rated for service up to 145 psig and temperatures up to 140 deg F with an accuracy of +/- 4% of full scale.

C. The rotameter shall have a polysulfone measuring tube with a direct reading scale which is calibrated for measurement in gallons per minute.

D. The rotameter shall be supplied with PVC socket x half union connections.

E. The float shall be PVDF.

F. The rotameter shall be supplied with EPDM o-rings.

G. Manufacturers

1. Kobold KSM series

2. Approved equal.

2.14 FLOW SENSOR/TRANSMITTER FOR AIR SERVICE

A. The flow meters shall be an insertion-style with an integrally-mounted transmitter.

B. The voltage shall be linearly proportional to flow velocity from 0.65 to 275 feet per second. Standard accuracy of the pulse output between .65 and 275 fps shall be ± 1.5% of reading ± 0.5% of full scale (275 FPS) for all meters. The

installation location shall meet the manufactures installation guidelines for straight run requirements with and without using a flow conditioner.

C. The air flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 3" to 60".

D. The metering mechanism shall be manufactured of 316 Stainless steel sensors shall be of the proper sizes to measure the design flow rate of the piping and shall be noted in the instrument schedule.

E. Repeatability .5% for velocities Above.65 ft/s.

F. The transmitter shall be a three stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC, 45 to 65 Hz. or 20 to 55 V AC, 45 to 65 Hz, or 16 to 62 V DC transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

G. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

H. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

I. Each meter shall be provided with a certificate of a 3-point calibration report exceeding stated accuracy of 1.5% of reading for 100% to 20% of full scale at reference conditions, .3% of full scale for 20% to 1% of full scale at reference conditions.

J. Manufacturer

1. Endress Hauser Model 65I

2. Sierra Model 640S

3. Approved equal.

2.15 ROTAMETER (AIR SERVICE)

A. The air flow rotameter shall be a glass tube variable-area style flow meter.

B. The rotameter shall be rated for service up to 100 psig and temperatures up to 212 deg F with an accuracy of +/- 1% of full scale.

C. The air flow rotameter shall have a tempered glass measuring tube with a direct reading scale which is calibrated for measurement of air in SCFH.

D. The rotameter shall be supplied with 316 stainless steel 150 lb ANSI flanges.

E. The float shall be 316 stainless steel

F. The rotameter shall be supplied with EPDM orings.

G. Manufacturers

1. Kobold KDV series

2. Approved equal.

2.16 PRESSURE SENSOR/TRANSMITTER FOR LIQUID SERVICE

A. A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a + 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be ± 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4…+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers

1. Endress+Hauser PMC131

2. Approved equal.

2.17 PRESSURE SENSOR/TRANMITTER (AIR SERVICE)

A. A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a + 5% zero point adjustment with no on site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process

connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be ± 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4…+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers

1. Endress+Hauser PMC131

2. Approved equal.

2.18 PRESSURE SWITCH

A. The pressure switch shall feature diaphragm sensing technology, a 20 amp snap-acting switch, and adjustable pressure ranges up to 475 psi.

B. The pressure switch should be able to operate in 0 to 160 F (17 to 71 C). Set point shifts less than 1% of range for a 50 F (28 C) ambient temperature change.

C. The pressure switch shall use an EPDM sensor material and should handle a maximum temperature of 250 deg F

D. The pressure switch shall be enclosed in Type 1 Enclosure and shall be made of Zinc plated steel with bright chromate finish.

E. The pressure switch should be surface mounted with two screws through clearance holes, or mounted by pressure connection.

F. The pressure switch shall have electrical rating of 20 A at 480 VAC

G. Manufacturers

A. United electric 25 Series Model 25A1F4A pressure switch.

B. Approved equal.

2.19 PRESSURE GAUGE

A. The pressure shall be solid front and hinged blow-out back style with elastomer compensating diaphragm on the inside of the hinged blow-out back.

B. The pressure gauge accuracy shall be 0.5% full scale to ASME B40.1 standard (Grade 2A)

C. The pressure gauge case and blow-out back shall be made of molded fiberglass reinforced thermoplastic and should be fire retardant and impact resistant

D. The pressure gauge lens shall be 4 mm thick laminated safety glass with lens rind made of molded fiberglass reinforced thermoplastic.

E. The fillable liquid used for the pressure gauge shall be glycerin.

F. The Stem and socket connections shall be made of 316 Stainless steel.

G. Manufacturers

    A. McDaniel MPB-S Pressure gauge

    B. Approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner's Representative changes required to resolve interferences.

3.02 IDENTIFICATION PLATES AND CODING

A. All components provided under this section, both field and rack mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Rack mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

B. The Contractor shall attach nametags to control devices with screws, bolts, or wire leader to create a permanent bond.

3.03 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.04 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.05 INSTRUMENT PROCESS CONNECTIONS

A. The Contractor shall complete all necessary connections to process equipment, control panels, and instruments as required to meet the intent of the drawings. All vents and drains from instrument process piping shall be routed to the proper vent

headers or sewers as required for environmental reasons or as provided for in the job specifications and drawings.

B. Over range limit, maximum working pressure and static pressure limits shall not be exceeded to prevent damage to the transmitter. The Manufacturer shall specify all transmitters and measuring elements to be compatible with the pressure and temperature ranges of process parameters.

C. Process temperature limit, ambient temperature limit and storage temperature limit shall not be exceeded in any installation. The Manufacturer shall ensure the installation provides affordable protection to the instrument devices.

3.06 INSTRUMENT SETUP/PROGRAMMING

A. The contractor shall setup and program all instrumentation. As necessary, the Contractor shall have the Manufacturer's Representative on-site to program or setup any instrumentation, and ensure that no warranties are voided.

B. Copies of all software, programs, or equipment setup logs shall be given to the Owner prior to completion of the project. This information shall be made available to the Owner or Owner's Representative upon request at any time during construction or check-out of equipment.

3.07 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.08 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it

is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.09 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

SECTION 13430

MBR CONTROL PANEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
13030	Membrane Bioreactor

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. National Electrical Code (NEC): NFPA 70

2. National Electrical Manufacturer's Association (NEMA):

   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volt Maximum)

   b. NEMA ICS 6 - Enclosures for Industrial Control and Systems

3. Underwriters Laboratories Inc. (UL):

   a. UL 50 - Enclosures for Electrical Equipment

   b. UL 508 - Industrial Control Equipment

   c. UL 508A - Standard for Industrial Control Panels

1.03 SCOPE

A. This Section specifies the hardware requirements for the MBR control panel.

B. The control panel, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 20 MBR SCADA Software and Hardware.

C. The control panel provider shall be responsible for the following:

1. Design of the MBR system control panel.

2. Development of the MBR system control panel submittal documentation and drawing set.

3. Fabrication of the MBR system control panel.

4. Delivery of the MBR system control panel in packaging designed to prevent physical damage.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. All components and equipment shall comply with requirements to meet UL508 listing.

2. All control panels shall be UL 508A labeled unless otherwise allowed for in the Contract Documents.

1.05 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

B. Submit the following control panel shop drawings in a single package:

1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.

2. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross references shall be labeled. Include wiring interface to the SCADA controllers where applicable. Include on these drawings, a tag number to identify each component, referenced to a component identification list.

3. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat

dissipations shall be maximums and shall be given in Btu/hr. Summary shall be supplemented with calculations.

1.06 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the RFP and the Contract Documents. The warranty duration shall be 12 months beyond Final Acceptance. All hardware components that are part of the completed system shall be covered by the warranty. The control panel supplier shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 CABINET

A. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common keyed locks.

B. Cabinets and panels located outdoors or in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction. Cabinets located in chlorine storage/feed areas shall be of nonmetallic, FRP construction, rated NEMA 4X.

C. Cabinets and panels located indoors within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

D. Cabinets and panels shall have doors on the front and shall be designed for front access. All cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

F. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman, Rittal, Saginaw, or approved equal.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Control and data acquisition associated with site equipment shall be performed by a Programmable Logic Controller (PLC).

B. Each PLC and I/O rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source provided by the Uninterruptible Power Supply. Any power

transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. The module shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the required, installed spare I/O capacity.

C. The PLC shall be Allen-Bradley CompactLogix 1769-L32E or 1769-L35E. A minimum of 768 KB of user memory shall be installed. The actual amount of memory supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide industrial Compact Flash module to maintain memory integrity of the PLC program and eliminate the need for downloading system programs from a host computer following temporary (short-term) power failures. PLC shall be capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic.

D. All I/O modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification. All I/O modules shall be Allen-Bradley 1769 series.

E. The PLC shall communicate with the MBR SCADA system over an Ethernet network.

F. I/O count shall be as required to implement the functional requirements of the system.

1. Size the I/O chassis for the required I/O cards plus the greater of 1 spare module or 10% additional spare I/O of each type.

2. If necessary, use expansion chassis to accommodate these requirements

2.03 NETWORK SWITCHES AND MODEMS

2.04 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration.

B. Provide ten percent (rounded up) spare fuses (minimum of 10) of each type and rating supplied.

PART 3 - EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment, and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

   1. Louvered openings near the bottom and top.

   2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

   3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

   4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

E. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the specifications.

F. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

G. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

H. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

I. All interior panel wiring shall be labeled and uniquely identified.

J. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit within and distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

K. The power entrance to the panel shall be provided with a surge protection device.

L. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

1. Solenoid valves

2. Electrically actuated valves

3. Instruments connected to the control panel.

M. Door mounted HOA switches shall be provided for all solenoid and non-modulating valves.

N. Fuse holders shall be indicating type.

O. A panel mounted UPS shall be included in each PLC cabinet. The UPS shall be sized to provide at least 30 minutes of run time for the PLC. The UPS shall also power any door mounted operator interface if included.

P. Intrinsic safety barriers shall be provided for all equipment signals originating in a hazardous area.

Q. Enclosures with any dimension larger than 36 inches shall be provided with fluorescent service lights and 120 VAC duplex receptacles for service equipment. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

END OF SECTION

SECTION 13710

POST AERATION BLOWERS

PART 1: GENERAL

A. The Contractor shall furnish and install, in the manner shown on the Plans, rotary positive displacement air blower packages as manufactured by Roots Division of Dresser Industries, Inc., Aerzen or approved equal. Each blower shall be designed for the following conditions:

Inlet temperature 68°F
Relative humidity 36%
Barometer 14.7 psia
Inlet pressure 14.43 psia (at blower inlet connection)

NUMBER OF BLOWERS	2
ROOTS URAI MODEL NO.	22
INLET ACFM	41
DISCHARGE PRESSURE (psia)	18.63
PRESSURE RISE (psig)	4.2
BLOWER SPEED (rpm)	3629
GEAR TIP SPEED (rpm)	2377
BHP @ SHAFT	1.1
MOTOR HORSEPOWER	1 ½
MOTOR RPM	3600

B. The blower performance shall be guaranteed with an allowable tolerance of plus or minus four (4) percent at the above design conditions.

PART 2: PRODUCTS

2.01 BLOWERS

A. The air blowers shall be of the rotary positive displacement type, and shall be constructed with inlet and discharge connections oriented as shown on the contract drawings. Each blower shall be equipped with steel mounting feet.

B. Casing: The blower casing shall be one-piece with separate headplates, and shall be made of close-grained cast iron.

C. Impellers: Each impeller shall be made from high-strength cast iron. The impellers shall be of the straight, two-lobe involute type, and shall operate without rubbing or liquid seals or lubrication. The impellers shall be dynamically balanced by removing metal from the impeller body, and shall be center-timed to permit rotation in either direction.

D. Shafts: The blower shafts shall be alloy steel, and shall be pressed into the impeller body and pinned.

E. Impeller/Shaft Assemblies: Each impeller and shaft assembly shall be supported by oversized anti-friction bearings engineered for long-service life and fixed to control the axial location of the impeller/shaft in the unit. A cylindrical roller bearing shall be provided at the drive shaft designed to handle the stresses of V-belt drive, while single-row ball bearings shall be used at all other locations.

F. Timing Gears: The impellers shall be timed by a pair of carburized and ground steel spur gears, mounted on the shafts with a tapered fit, and secured by a locknut.

G. Lubrication: Each bearing shall be provided with a positive lip-type oil seal designed to prevent lubricants from entering the air stream. Further provision shall be made to vent the impeller side of the oil seal to atmosphere to eliminate any possible carry-over of lubricant into the air stream.

The drive and bearings shall be grease lubricated, and shall be provided with grease fittings. The timing gears and the gear end bearings shall be lubricated by splash from the gears dipping into the oil.

2.02 DRIVE SYSTEM

A V-belt drive shall be used, with an appropriate service factor applied. A suitable weatherproof guard meeting OSHA specifications shall be supplied.

2.03 DRIVE MOTOR

All the motors shall be 460 V, 3 phase power, furnished for the appropriate RPM, horsepower, and other characteristics as specified.

2.04 INLET FILTER

The inlet filter shall have a weatherhood mounted upright for maximum watershed with capacity equal to or greater than contract conditions.

2.05 INLET SILENCER

The silencer shall be of vertical or horizontal arrangement, rigidly connected to the blower suction, and shall be of multi-chamber design with internal tubing and porting for positive displacement blower suction service. Construction shall be of carbon steel plate and shall incorporate two (2) shell layers.

2.06 COMBINATION BASE/DISCHARGE SILENCER/RELIEF VALVE

The discharge silencer shall be of horizontal arrangement connected to the blower discharge by a reinforced silicone rubber flexible connector to isolate the blower from thermal related stresses. The silencer shall be of multi-chamber design with internal tubing and porting for positive displacement blower discharge service. Construction shall be of carbon steel plate with two (2) shell layers.

The discharge silencer shall be welded to a heavy steel machinery base with anti-vibration welded reinforcements. Bolted construction is not acceptable. Fork lift access shall be provided and identified by prominent markers. The relief valve shall be mounted on the exit chamber of the silencer for longevity of the valve and reduced relieving noise.

2.07 FIBERGLASS ENCLOSURE

A removable fiberglass enclosure shall be provided for each blower. The enclosures shall be sized to completely cover each of the blowers with their accessories and mount on the steel base. The enclosures shall bolt together and to the steel base with stainless steel nuts, bolts and washers.

PART 3: EXECUTION

3.01 The blowers shall be installed as shown on the Plans.

3.02 FABRICATION AND INSTALLATION

A. All equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detailed drawings, specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer.

3.03 FIELD TESTING AND FIELD SERVICE

A. The manufacturer's field engineer or representative shall be on hand to inspect and check the installation at the time of the initial start-up and operational testing of the equipment; and, therefore, to provide operation and maintenance instructional services for plant personnel.

END OF SECTION

SECTION 15063

COPPER PIPING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and install copper piping as shown on the Drawings or as required by these Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Valves and appurtenances are included in Section 15100.

B. Pipe hangers and supports are included in Section 15090.

C. Field painting is included in Division 9.

1.03 DESCRIPTION OF SYSTEMS

A. Copper piping, tubing, and fittings specified herein will be used for water and miscellaneous uses as shown on the Drawings.

1.04 QUALIFICATIONS

A. All copper pipe and fittings shall be preferably of domestic manufacturer and shall be the product of a single manufacturer who is fully experienced, reputab1e, and qualified in the manufacture of the materials to be furnished.

B. The materials shall be manufactured and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.05 SUBMITTALS

A. Submit to the Engineer for approval, six (6) copies of shop drawing, technical specifications and detailed information on all materials to be furnished, including complete, dimensioned piping layout drawings.

PART 2: PRODUCTS

2.01 MATERIALS

A. Copper pipe shall include copper pipe, copper tubing, and fittings as specified herein.

B. Copper pipe and tubing for pressurized systems shall have a minimum working pressure of 150 psig.

C. Copper tubing for above ground water service shall be ASTM Specification B-88,Type L, Hard and Type K, Hard, for below ground service.

D. Copper tubing for connections between supply lines and instrumentation shall be ASTM B-88, Type L, soft. Fittings shall be compression type, flared copper or flareless brass as later specified herein.

E. Copper pipe requiring threaded joints shall be ASTM B-42, seamless, hard drawn regular weight. Fittings shall be of threaded, cast bronze.

F. Unions shall be brass with ground joints.

G. Soldered fittings shall conform to ANSI Bl6.18 and compression fittings shall be flareless equal to Crawford "Swagelok".

PART 3: EXECUTION

3.01 INSTALLATION

A. All piping shall be installed to proper line and grade and rigidly supported. Except as otherwise required, changes in direction shall be made using copper fittings, and piping shall run parallel and at right angles to walls. Systems shall be arranged with low points and drains to permit complete drainage of the system.

B. Where indicated by the Engineer, lines of soft annealed tubing may be bent and neatly installed without fittings, and securely fastened to supporting construction.

C. Unions shall be provided close to main pieces of equipment and in branch lines to permit ready dismantling of piping without disturbing main pipe lines or adjacent branch lines.

D. Joints for copper or bronze solder-type fittings shall be made with solder composed of 95 percent tin and 5 percent antimony. Joints underground shall be made up with 1000 deg. F silver solder. Screw joints shall be made tight with graphite paste or other approved pipe compound. Once a joint has been made, it shall not be broken and remade without thorough cleaning of the pipe and joint.

E. Sleeves or wall castings of the sizes specified in the Drawings or by the Engineer shall be installed for all pipes passing through concrete or masonry floors or walls.

F. In soldered joints, surfaces of pipe and fittings to be joined shall be cleaned with fine sandpaper to bright metal. Both surfaces to be joined shall be completely covered with a soldering flux approved by the Engineer. Joints shall be evenly heated from all sides before applying solder. Excess flux shall be removed from the joint after the solder has hardened. In threaded joints, threads shall be clean and undamaged.

3.02 TESTING

A. Piping shall be flushed clean and tested with the fluid to be used in the pipe at 150 psi pressure, and shall be proved absolutely tight for a period of five minutes

B. The Contractor shall provide all testing equipment and shall conduct the test. Any leaks shall be repaired and the pipe retested.

END OF SECTION

SECTION 15064

PLASTIC PIPE AND FITTINGS

PART l: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install in the locations as shown on the Drawings, the plastic piping and appurtenances as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Valves and appurtenances are included in Section 15100.

B. Pipe hangers and Supports are included in Section 15090.

1.03 DESCRIPTION OF SYSTEM

A. Plastic pipe shall be used for underground plant and potable water piping, and other applications as shown on the Drawings.

1.04 QUALIFICATIONS

A. All plastic pipe shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.05 SUBMITTALS

A. Shop drawings shall be submitted to the Engineer for approval in accordance with Section 01300 and shall include dimensioning, methods and locations of supports, and technical specifications for all piping to be furnished.

PART 2: PRODUCTS

2.01 MATERIALS

A. Plastic pipe (PVC pipe as shown on the Drawings) shall be manufactured from rigid, unplasticized, polyvinyl chloride and chlorinated polyvinyl chloride compound meeting ASTM D-l784, Type 1, Grade 1 (Class 12454-B) and manufactured in accordance with ASTM D-1785, PVC 1220 and CPVC where shown on the Drawings. The pipe shall have a design Stress rating of 2,000 psi at 73 deg. F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and shall be Schedule 80 unless otherwise shown.

B. Fittings shall be the socket type for solvent welded joints as designated in ASTM D-2467 and D-2466, using solvent as specified in ASTM D-2564, except where threaded as shown on the Drawings, and as designated in ASTM D-2464 or flanged as shown on the Drawings and shall he compatible with the pipe where installed. Flanges shall be furnished with l/8-in thick full-faced gaskets. Flange bolts and nuts shall be ASTM A276, Type 304 or 316 stainless steel.

C. Fittings, specials, unions, and flanges shall be of the same schedule number and manufactured of the same materials as the pipe.

D. Caulking for plastic pipe in wall sleeves shall be by a mechanical, modular, rubber sealing element placed in between the sleeve and pipe and expanded to make a tight fit or other method approved by the Engineer.

E. Gaskets in plastic pipe shall be of a material suitably resistant to the fluid within the respective pipelines and shall be subject to the approval of the Engineer.

PART 3: EXECUTION

3.01 INSTALLATION

A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.

B. Joints for plastic pipe shall be solvent welded except flanged or threaded where required. In making solvent welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary, and apply solvent cement of the proper grade. Expansion joints shall be installed every 50 ft on long runs and in every straight run longer than 15 ft.

C. Installation of valves and fittings shall be strictly in accordance with manufacturers instructions. Particular care shall be taken not to over stress threaded connections at sleeves. In making solvent weld connections, the solvent shall not he spilled on valves or allowed to run from joints.

D. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer.

E. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings nor shall plastic piping be threaded into metal valves, fittings or couplings.

F. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and the Contractor shall verify these locations from approved piping layout drawings and the structural drawings.

G. Buried piping shall be snaked along the trench to provide for expansion and contraction. The pipe shall be backfilled with selected fine excavated material and thoroughly compacted to one foot above the top of the pipe and thereafter backfilled as specified in Section 02221.

3.02 FIELD PAINTING

A. Field painting is included in Section 09902.

3.03 INSPECTION AND TESTING

A. All pipelines shall remain undisturbed for 24 hours to develop complete strength at all joints. All pipelines shall be subjected to a hydrostatic pressure test in accordance with the procedures outlined in Section 02600-PLANT GENERAL PIPING.

END OF SECTION

SECTION 15072

DUCTILE IRON PIPE AND FITTINGS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install, in the locations inside and outside of structures as shown on the Drawings, all ductile iron piping, cast iron or ductile iron fittings, and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED

A. Excavation, backfill, fill and grading is included in Section 02221.

B. Concrete work is included in Division 3.

C. Painting, except as specified herein, is included in Division 9.

D. Pipe hangers and supports are included in Section 15090.

E. Valves and appurtenances are included in Section 15100.

1.03 DESCRIPTION OF SYSTEMS

A. Piping shall be installed in those locations as shown on the Drawings.

B. The equipment and materials specified herein is intended to be standard types of ductile iron pipe and cast-iron or ductile iron fittings for use in transporting water, sludges, and other liquids.

1.04 QUALIFICATIONS

A. All of the ductile-iron pipe and cast-iron or ductile iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

1.05 SUBMITTALS

A. Submit to the Engineer within fifteen (15) days after execution of the Contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. All ductile-iron pipe and cast-iron or ductile iron fittings to be installed under this Contract shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results..

C. Shop Drawings including piping layouts within the structures shall be submitted to the Engineer for approval in accordance with Section 01300 and shall include dimensioning, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

PART 2: PRODUCTS

2.01 MATERIALS

A. Ductile iron pipe for underground installation shall meet the following requirements.

1. Ductile iron pipe shall conform to ANSI A2l.51 and AWWA C 151, Class 51, or as shown on the Drawings.

2. The pipe shall be supplied in lengths not in excess of 20 ft. Pipe shall be the rubber-ring type push-on joint, the standard mechanical joint or the flange joint as shown on the Drawings. Fittings shall be ductile iron or cast iron Class 150. Fittings shall meet the requirements of ANSI and AWWA Specifications as applicable. Rubber gasket joints shall conform to ANSI A21.51 for mechanical and push-on type joints. Flanged joints shall be 125 pound ANSI flanges and conform to ANSI B16.l. All pipe and fittings shall have a cement mortar lining and bituminous seal coat on the inside and a coal tar enamel coat on the outside in accordance with ANSI A21.5l except that cement mortar lining shall be 1/8-inch in thickness for pipe 2-in to 12-in diameter, and 3/16-inch for 14-in to 24-in diameter pipe and 1/4-in for 30-in diameter pipe and larger. A plus tolerance of 1/8-in will be permitted.

3. Pipe and fittings shall be as manufactured by the American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, Clow Corp. or equal.

4. All fittings for push-on joint pipe shall have mechanical joints.

B. Ductile-iron pipe for interior use shall meet the following requirements:

1. Flanged ductile-iron pipe shall conform to current ANSI Specification A2l.51 with factory applied screwed long hub flanges except as otherwise specified hereinafter. Flanges shall be faced and drilled after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and shall be flush with end of pipe.

2. Mechanical-joint ductile-iron pipe shall be as specified for the flanged pipe except the joints shall conform to ANSI Specification A21.1l as applicable. Mechanical-joint pipe shall be furnished with sufficient quantities of accessories as required for each joint.

3. Fittings shall be ductile iron or cast-iron as specified above. Except as specified below, flanges and flanged fittings shall conform to ANSI A2l.10 for 150 psi pressure rating.

4. Pipe thickness classes shall be Class 51 for all sizes of pipe.

5. Pipe and fittings shall be cement mortar lined and bituminous seal coated on the inside in accordance with ANSI Specification A2l.4 except that the cement lining thickness shall be not less than 1/8-in for 3-12 inch pipe, 3/16-in for 14-24 inch pipe and 1/4-in for pipe 30-in and larger. A plus tolerance of 1/8-in will be permitted. Ring gaskets shall be of approved composition suitable for the required service.

6. Pipe and fittings exposed to view in the finished work shall not receive the standard tar or asphalt coat on the outside surfaces but shall be shop primed on the outside with one coat of rust inhibitive primer as specified in Section 09901. All other pipe and fittings shall be shop coated on the outside with coal tar enamel in accordance with the above referenced ANSI Specifications and will not require any other coating. Should portions of the pipe inadvertently be given the outside coating of coal tar enamel instead of the rust inhibitive primer as required for exposed piping the surfaces shall be sealed with a non-bleeding sealer coat such as Inertial Tar Stop, or Mobil Anti-Bleeding Aluminum Sealer or equal. Sealing shall be a part of the work of this Section.

C. Sleeve Type Couplings

1. Sleeve-type couplings shall be as made by Dresser Mfg. Div., Bradford, Pa., Smith-Blair, Inc., San Francisco, California, R.H. Baker & Co., Inc., Huntington Park, California, or equal.

2. Couplings for buried pipe shall be of cast iron and shall be Dresser Style 53, Smith-Blair Style 431, Baker Allcast, or equal. The couplings shall be provided with stainless steel bolts and nuts unless indicated otherwise.

3. Couplings for exposed pipe shall be of steel and shall be Dresser Style 38 or 138, Smith-Blair Style 413, Baker Allsteel, or equal. When installed in force mains, harness couplings or joint harnesses shall be provided. The couplings shall be provided with black steel bolts and nuts unless indicated otherwise.

4. All couplings shall be furnished with the pipe stop removed.

5. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe.

D. Wall Castings

1. Wall castings shall be of the sizes and types as shown on the Drawings. Flanges and mechanical joint bells shall be drilled and tapped for studs where flush with the wall.

2. Wall castings shall be provided with an intermediate wall collar. The collar shall be located at the center of the overall length of casting for castings set flush with the wall. For castings which extend through the wall, the collar shall be located such that it is within the middle third of the wall. Collars shall either be cast integrally with the casting or shall be of the assembled type as manufactured by U.S. Pipe & Foundry Company, or equal consisting of two (2) mechanical joint retainer glands with gasket.

E. Base bends and base tees shall have machined and drilled bases.

F. Filler flanges and beveled filler flanges shall be furnished and installed as required. Filler flanges and beveled filler flanges shall be furnished faced and drilled complete with extra length bolts. Filler flanges shall be Clow Fig. F-l984 or equal and beveled filler flanges shall be Clow Fig. F-l986 or equal.

G. Blind flanges shall be furnished and installed as required. Blind flanges shall be furnished faced and drilled to ANSI Bl6.1 125 lb Standard.

PART 3: EXECUTION

3.01 HANDLING PIPE AND FITTINGS

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired.

B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being laid or installed.

C. If any defective pipe is discovered after it has been laid it shall be removed and replaced with a sound pipe in a satisfactory manner at no expense to the OWNER. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

3.02 LAYING EXTERIOR PIPE AND FITTINGS

A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe up to the springline. BLOCKING WILL NOT BE PERMITTED.

B. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by manufacturer. Fitting , in addition to those shown on the plans, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench. Solid sleeves shall be used only where approved by the Engineer.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a Tyton bell or equal shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

D. Joint restraint shall be provided at all fittings and other locations as shown on the Drawings. Except where otherwise shown on the Drawings, restraint shall be provided either by concrete thrust blocks or mechanical joint restraint as specified herein. Where pipe is installed in locations where there is insufficient undisturbed material, mechanical joint restraint shall be used. For concrete thrust blocks, bearing area shall be adequate to prevent any movement of the fitting. Minimum bearing areas shall be as shown on the Drawings. Joints shall be protected by felt roofing paper prior to placing concrete. Concrete shall be no leaner than 1 part cement, 2-1/2 parts sand, and 5-1/2 parts stone. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms shall be provided for thrust blocks.

E. Unless otherwise shown or approved by the Engineer all outside pipe lines shall have a 4 foot minimum cover.

F. Jointing Ductile-Iron Pipe

1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

2. Mechanical joints at valves, fittings, and where designated shall be in accordance with the "Notes on Method of Installation" under ANSI Specification A 21.11 and the instructions of the manufacturer. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no condition shall extension wrenches or pipe over handle or ordinary ratchet wrench be used to secure greater leverage.

3. Flanged joints shall be made using ring gaskets of rubber with cloth insertion. Gaskets 12-in in diameter and smaller shall be 1/16-in thick; larger than 12-in 3/32-in thick. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same American Standard as the flanges. Bolts and nuts shall, except as otherwise specified or noted on the Drawings, be Grade B conforming to the ASTM Standard Specification for Low-Carbon Steel, Externally and Internally Threaded Standard Fasteners, Designation A307-68. Bolt studs and studs shall be of the same quality as machine bolts.

   a. Bolts in flanged joints or mechanical joints shall be tightened alternately and evenly. After installation two heavy bitumastic coatings comparable to Inertial No. 66 Special Heavy shall be applied to bolts and nuts.

4. Prior to installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8-in. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6-in from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. The other pipe end shall be inserted into the middle ring and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares. After the bolts have been inserted and all nuts have been made up finger tight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts. The correct torque as indicated by a torque wrench shall not exceed 75 ft-lb for 5/8-in. bolts and 90 ft-lb for 3/4-in. bolts.

5. If a wrench other than a torque wrench is used, it should be no longer than 12-in, so that when used by the average man the above torque values shall not be exceeded. After assembly and inspection and before being backfilled, all exterior surfaces of buried sleeve-type couplings, including the middle and follower rings, bolts, and nuts, shall be heavily and thoroughly coated with an approved heavy-bodied bituminous mastic. Care shall be taken and appropriate devices used to ensure that the underside, as well as the more readily accessible parts, is well coated.

   Where flanged pipe joints are to be on either side of a sleeve-type coupling in the piping, sleeve-coupling bolts should not be made up until the flanged joints have first been made.

To prevent sleeve-type couplings from pulling apart under pressure, a suitable flange clamp assembly shall be provided and installed where shown on the drawings.

6. All valves, fittings and other appurtenances needed upon the pipe lines shall be set and jointed as indicated on the Drawings or as required.

3.03 INSTALLING INTERIOR DUCTILE-IRON PIPE AND FITTINGS

A. All piping and fittings shall be installed true to alignment and rigidly supported thrust anchors shall be provided where required. Any damage to linings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before erection.

B. Sleeves shall be installed of proper size for all pipes passing through floors or walls as shown on the Drawings. Where indicated on the Drawings or required for liquid or gas-tightness the pipe shall be sealed with a mechanical seal equal to Link-Seal as manufactured by Thunderline Corp., Wayne, Michigan.

C. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and the structural drawings.

D. Except as otherwise shown on the Drawings either split type couplings or flange joints may be used. Prior to approval of jointing method, layouts for hanger and supports shall be submitted to the Engineer for approval.

Pipe for use with non-restrained sleeve type couplings shall have plain ends.

E. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same American Standard as the flanges. Bolts and nuts shall, except as otherwise specified or noted on the drawings, be Grade B conforming to the ASTM Standard Specification for Low-Carbon Steel, Externally and Internally Threaded Standard Fasteners, Designation A307-68. Bolt studs and studs shall be of the same quality as machine bolts.

Gaskets shall be ring gaskets of rubber with cloth insertion. Gaskets 12-in in diameter and smaller shall be 1/16-in thick; larger than 12-in in diameter 3/32-in thick.

F. All valves, fittings, equipment, and appurtenances needed upon the pipelines shall be set and jointed as indicated on the Drawings or as required. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, a certification shall be submitted stating that such requirements have been complied with.

3.04 TESTING

A. All pipe lines shall be hydrostatically tested for leakage in accordance with procedures outlined in Section 02600 - PLANT PIPING - GENERAL for compliance with the specifications.

3.05 SURFACE PREPARATION AND PAINTING

A. All piping and fittings exposed to view shall have its surface prepared and be shop painted as specified in Section 09901. Surface preparation and shop priming is a part of the work of this Section. Pipe marking is included in Section 09902, but it shall be part of the work of this Section to assist as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

END OF SECTION

SECTION 15075

EXTRA HEAVY CAST IRON SOIL PIPE AND FITTINGS

PART 1: GENERAL

1.01 SCOPE

A. This specification covers Extra Heavy Cast Iron pipe, fittings, and compression gaskets used in sanitary drain, waste, and vent (DWV), sewer, and storm drainage applications. This system is intended for use in non-pressure applications**.**

PART 2: PRODUCTS

2.01 Extra Heavy Cast Iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi, and a transverse bend breaking load of not less than 1750 lb. Compression gaskets shall be manufactured from an elastomer meeting the requirements of ASTM C-564.

2.02 Pipe and fittings shall comply with ASTM A-74 and CISPI HS-74. Compression gaskets shall comply with ASTM C 564 and CISPI HSN-85. Each length of pipe shall be hydrostatically tested by the manufacturer to verify compliance. All pipe and fittings shall be made in the United States, and marked with the collective trademark of the Cast Iron Soil Pipe Institute, ®. All pipe and fittings shall be of the same manufacturer. All systems shall utilize a separate waste and vent system.

2.03 Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry and shall conform to all local plumbing, fire, and building code requirements. Joints shall be made with an elastomeric compression gaskets meeting the requirements of ASTM C-564 or lead and oakum. The system shall be hydrostatically tested after installation to 4.3 psi. (10 feet of hydrostatic head). Testing with compressed gas is not recommended.

2.04 Referenced Standards:
ASTM A-74 Cast Iron Soil Pipe and Fittings
ASTM A-74 Cast Iron Soil Pipe and Fittings
ASTM C-564 Rubber Gaskets for Cast Iron Soil Pipe and Fittings
CISPI HS- 74 Cast Iron Soil Pipe and Fittings
CISPI HSN Rubber Gaskets for Cast Iron Soil Pipe and Fittings WW-P-401F Cast Iron Pipe and Fittings
ANSI A 112.5.1 Cast Iron Pipe and Fittings
Note: Latest revision of each standard applies.

PART 3: EXECUTION
(Not Used)

END OF SECTION

SECTION 15090

PIPE HANGERS AND SUPPORTS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts, and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

1.02 RELATED WORK SPECIFIED

A. Concrete is included in Division 3.

B. Miscellaneous metal is included in Division 5.

C. Painting is included in Division 9.

D. Pipe and fittings are included in respective sections of Division 15.

1.03 QUALIFICATIONS

A. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five times the ultimate tensile strength of the material, assuming 10 ft of water filled pipe being supported.

B. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit a certification stating that such requirements have been complied with.

1.04 SUBMITTALS

A. Submit to the Engineer for approval, as provided in Section 01300, shop drawings of all items to be furnished under this section. Submittals shall include pipe support loading calculations, a location plan, and a complete total bill of materials.

PART 2: PRODUCTS

2.01 GENERAL

A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the requirements of Division 5 and shall be furnished and installed under this Section. All pipe supports shall be approved prior to installation.

B. Hangers and supports shall be spaced in accordance with ANSI B3l.l.0 except that the maximum unsupported span shall not exceed 10 feet unless otherwise specified herein.

C. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Grinnell Co., Inc., Unistrut, Corp., Carpenter and Patterson, Inc., or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 PIPE HANGERS AND SUPPORTS FOR METAL PIPE

A. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts as follows:

1. Hangers shall be of the types as shown on the Drawings.

2. Hanger rods shall be machine threaded and the strength of the rod shall be based on root diameter. Hanger rods shall have the minimum diameters as shown on Drawings.

3. Where applicable concrete inserts for hanger rod sizes up to and including 3/4-in diameter shall be continuous metal inserts designed to be used in ceilings, walls or floors as manufactured by the Unistrut Corp., Wayne, Michigan or equal. Series P3200 inserts shall be used where supports are parallel to the main slab reinforcement and Series P3300 where the supports

are perpendicular to the main slab reinforcement. Spot inserts shall be equal to Catalogue No. P3245 or M24 as applicable.

4. All hanger rods shall have turnbuckles to permit vertical adjustment after erection- Turnbuckles shall be equal to Grinnell rig. No. 230.

B. Wall or column supported pipes shall be supported by welded steel brackets equal to Grinnell Fig. 194, 195, and 199 as required. Additional wall bearing plates shall be provided where required.

1. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4-inches and larger and by a U-bolt for pipes smaller than 4-inches. Anchor chairs shall be equal to Carpenter & Patterson Fig. No. l27. U-bolts shall be equal to Grinnell Fig. 120 and l37.

2. Where the pipe is located below the bracket, the pipes shall be supported by hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.

3. Wall or column supported pipes 2-inches and smaller may be supported by hangers equal to Carpenter and Patterson Figures 74, l79, or 237 as required.

C. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-placed concrete supports or adjustable pipe saddle supports. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support is provided), and pipe stanchion type supports shall be used where lateral displacement of the pipes is not probable

1. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Top edges and vertical corners of each concrete support shall have 1-in bevels. Each pipe shall be secured on each concrete support by a 316 stainless steel anchor strap anchored to the concrete with cast-in-place anchor bolts or with expansion bolts as shown on the Drawings. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be 5 feet.

2. Concrete piers used to support base elbows and tees shall be similar to that specified above. Piers may be square or rectangular.

3. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size l50 lb companion flanges or slip-on welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of 4 anchor bolts per flange. Adjustable saddle supports shall be equal to Grinnell Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

4. Floor supported pipes less than 3-inches shall be supported by fabricated steel supports.

D. Vertical piping shall be supported as follows:

1. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within 2 feet of the change in direction by pipe supports as previously specified herein.

2. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.

3. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Grinnell Fig. 261.

E. Anchor bolts shall be equal to Kwik-bolt as manufactured by the McCullock Industries, Minneapolis, Minnesota or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, Colorado.

2.03 PIPE HANGER AND SUPPORTS FOR NON-METAL PIPE

A. Single plastic pipes shall be supported by pipe supports as previously specified herein.

B. Multiple, suspended, horizontal plastic pipe runs, where possible, shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18-inches. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Husky-Burndy Model SCR or equal. Spacing between clamps shall not exceed 9 ft. The cable trays shall provide continuous support along the length of the pipe.

C. Individual clamps, hangers, and supports in contact with plastic pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

D. Pipe supports shall be provided to support the vertical runs of all plastic pipes. The pipes shall be supported by means of a supporting framework suitably anchored into the floor or curbing. The vertical piping shall be suitably secured to horizontal support members connected at each end to vertical support members and spaced as required to provide a rigid installation.

1. The complete supporting system shall be as manufactured by the Unistrut Corporation, Globe-Strut as manufactured by the Metal Products Division of U.S. Gypsum, or equal.

2. Vertical and horizontal supporting members shall be U-shaped channels similar to Unistrut Series Pl000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps equal to UniStrut Series P1100M and Series P2558. All Components shall be of mild steel.

3. The assemblies shall be furnished complete with all nuts, bolts, and fittings required for a complete assembly.

4. The design of each individual framing system shall be the responsibility of the Contractor. Shop drawings shall show all details of the installation, including dimensions and types of supports.

2.04 SPECIAL SUPPORTS

A. Any required pipe supports for which the supports specified in this section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the Engineer.

PART 3: EXECUTION

3.01 INSTALLATION

A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

C. Pipe supports shall be provided to minimize lateral forces through valves and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Pipe supports shall be provided as follows:

1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10 ft-0-in. with a minimum of one support per pipe section at the joints.

2. Supports for multiple PVC pipes shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support spacing shall not exceed 3 feet.

3. Support spacing for copper tubing and pipe shall not exceed 5 -feet. Support spacing for steel pipe greater than 2-in shall not exceed 10 ft.

4. All vertical pipes shall be supported at each floor or at intervals of not more than 15 ft by approved pipe collars, clamps, brackets, or wall rests, and at all points necessary to insure rigid construction.

E. Pipe supports shall not result in point loadings but shall distribute pipe loads evenly along the pipe circumference.

F. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.

G. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, all drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this section.

H. Continuous metal inserts shall be embedded flush with the concrete surface.

3.02 PAINTING

A. Surface preparation and shop priming is a part of the work of this Section and shall be as specified in Section 09901.

B. Finish coating is included in Section 09902.

END OF SECTION

SECTION 15100

VALVES AND APPURTENANCES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and specified herein.

B. The equipment shall include but is not limited to the following.

1. Solenoid Valves
2. Plastic Ball Valves for Polymer Solution
3. Plastic Check Valves for Polymer Solution
4. Gate Valves
5. Check Valves for Water and Natural Gas Service
6. Check Valves for Compressor Service
7. Service Clamps
8. Dielectric Pipe Couplings
9. Plug Valves
10. Reduced Pressure Backflow Preventer
11. Emergency Shower and Eyewash Station
12. Wafer Check Valves for Blower Service
13. Wafer Butterfly Valves for Blower Service
14. Flexible Connectors for Blower Service
15. Small Valves

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Piping is included in the respective sections of Division 15.

B. Pipe hangers and supports are included in Section 15090.

1.03 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein is intended to be standard for use in controlling the flow of wastewater, sludge, water, air, or chemicals, depending on the applications.

1.04 QUALIFICATIONS

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

1.05 SUBMITTALS

A. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 01300.

B. Furnish all information required in Section 01010.

1.06 OPERATING

A. Manufacturer's operating and maintenance instructions in four (4) sets shall be furnished to the Engineer for equipment furnished under this Section and shall be in accordance with Section 1600.

1.07 TOOLS

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

PART 2: PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. All valves and appurtenances shall be of the size shown on the Drawings and as far as possible all equipment of the same type shall be from one manufacturer.

2. All valves and appurtenances shall have the name of the manufacturer, flow directional arrows, and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

3. All valve operators shall be as shown on the PLANS.

2.02 PRODUCTS

A. Solenoid Valves

1. Solenoid valves shall be packless piston type direct acting, 2-way or 3-way, valves and shall be ASCO Valve Red Hat as manufactured by Automatic Switch Co., or equal.

2. All valves shall be of the normally closed or normally open as required to perform their operations.

3. Valves shall have forged brass bodies, NPT end connections of the size shown on the Drawing, 300 or 400 series stainless Steel internal parts, and Buna N or Ethylene Propylene valve Seats. Valves shall have a 150 psig (minimum) safe working pressure and zero minimum operating pressure differential. Connections are to be threaded.

4. Except as otherwise specified herein, valves shall have NEMA 4 solenoid enclosures, shall be suitable for operation on a 120V, 60 Hz, single phase power supply, and shall be provided with a continuous duty Class F coil and manual operator.

B. Plastic Ball Valves for Polymer Solutions

1. Ball valves for polymers solutions 3 inches and smaller shall be rated for safe operation at 150 psi WOG, 68 degrees F.

2. The valves shall be of solvent weld or true union type with PVC body and ball, TFE seats and EPDM ‘O’ rings.

3. Valve shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

4. Ball valves for polymer solutions shall be Chemtrol TU series, GF Plastic systems type 342, Plastic Engineering Products, Inc. or equal.

C. Plastic Check Valves for Polymer Solutions

a. Check valves for polymer solutions 3” and smaller shall be of the ball check, true union type rated for safe operation at 150 psi working pressure.

b. The valve body and ball shall be PVC, the ball seal and body seal shall be Viton.

c. Check valves for polymers and caustic solutions shall be GF Plastic type 360, Chemtrol Series BC or equal.

D. Gate Valves

1. Gate valves 2-1/2-in in diameter and smaller in size, shall have flanged, threaded, or solder ends as required; and shall be bronze, solid wedge, rising-stem type gate valves as manufactured by Kennedy Valve Mfg. Co. or equal. These valves shall be rated for safe operation at 125 psi saturated steam and 200 psi non shock cold water, oil or gas (WOG).

2. Gate valves 3-in to 12-in shall be iron body, bronze mounted, resilient wedge gate valves with flanged or mechanical joint ends conforming to the Standard Specification for Gate Valve for Water and Sewage Systems, Designation C509 latest revision. Gate valves larger than 12-in shall be iron body, bronze mounted, double disc gate valves conforming to the Standard Specification for Gate Valve for Water and Sewage Systems, Designation C500 latest revision. The following additional requirements apply:

a. Rated working pressure of valves installed shall be 200 psi unless otherwise noted on the PLANS.

b. Valves for interior service shall be outside screw and yoke type with rising stem.

c. Bronze gate rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves or other shapes, the rings shall be firmly attached to the gates with bronze rivets.

d. Valves shall turn counterclockwise to open the valves. Handwheels shall be of ample size and shall have an arrow and the word "0PEN' cast thereon to indicate the direction of opening.

e. Stuffing box follower bolts shall be steel and the nuts shall be of bronze.

f. The design of the valves shall permit packing the valves without undue leakage while they are wide open and in service.

g. O-ring stuffing boxes may be used.

h. Valves shall be as manufactured by Clow, Mueller Co., Kennedy Valve Co., or approved equal.

E. Check Valves for Water and Natural Gas Service

1. Check valves for ductile iron and steel pipelines shall be swing type and shall meet the material requirements of AWWA Specification C508 latest revision. The valves shall be iron body, bronze mounted, single disc, 150 psi working water pressure, nonshock, and hydrostatically tested at 300 psi. Ends shall be l25 lb ANSI B16.1 flanges.

a. When there is no flow through the line the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

b. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

c. Valves shall be constructed so that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm with outside lever and weights.

2. Check valves 2-in and smaller for installation in copper and steel pipes shall be bronze, swing type, 200 psi with solder or screwed ends.

F. Check Valves for Compressor Service

1. Check valves for the discharge of reciprocating compressors shall be in-line type rated for safe operation for pneumatic or light liquid service to 750 psig. The valve shall have a maximum pressure drop of 1.01 psig at an inlet pressure of 100 psig.

2. The valve body, spring seat and cages shall be brass. The spring shall be stainless steel and the seat disc and packing TFE.

3. Check valves for compressor service shall be Rego Series CV or equal.

G. Service Clamps

1. Service clamps shall have malleable or ductile iron bodies which extend at least 160 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for either corporation stop threads or IPS as required. Clamps with tap sizes 1-in and smaller shall be of the single strap design. Clamps with tap sizes largerthan 1-in shall be of the double strap design.

2. Service clamps shall be Style 91 or 291 as manufactured by Dresser Industries, Inc., Type 311 or 313 as manufactured by Smith-Blair, Inc., or equal.

H. Dielectric Pipe Couplings

1. Dielectric Pipe Couplings shall be used wherever copper pipe connects to steel or cast iron pipe and appurtenances. Couplings shall have steel bodies with non-conducting bushings on both ends. Ends shall have standard pipe threads. Couplings shall be rated for at least 200 psi at 220 deg. F. Couplings shall be as manufactured by Thermodynamics Corp., Needharn, MA, Water Vallett Co., Detroit, MI, or equal.

I. Plug Valves

1. Valves shall be non-lubricated, eccentric type with neoprene resilient faced plugs and flanged or mechanical joint ends as shown on the PLANS. Port areas of the valve shall be at least 80 percent of full pipe area. Valves shall be semi-steel or cast iron body and plug, raised eccentric seat, with a welded in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. The valves shall have cylindrical seating surfaces that are eccentrically off-set. Valves shall have permanently lubricated, stainless steel bearings in the upper and lower plug stem journals and shall be of the bolted bonnet design.

2. The valve shall be capable of being repacked without removing the bonnet and the packing shall be adjustable without requiring disassembly of the valve. Valve seats shall comply with AWWA Standard C-507, Section 8, Paragraph 7.2 and with AWWA Standard C-504, Section 9, Paragraph 9.4. Bearings shall comply with AWWA Standard C-507, Section 3, Paragraphs 8, 8.1, 8.3, and 8.4 and with AWWA Standard C-504, Section 10. Valve shaft seals shall be Buna and shall comply with AWWA Standard C-507, Section 10, and with AWWA C-504, Section 11. All valve seats shall be installed opposite to the normal direction of the flow. They shall be DeZurik Eccentric Plug Valves or equal.

J. Reduced Pressure Backflow Preventer

1. The reduced pressure backflow preventer, with two independently, manually operated check valves, shall be designed for installation either a horizontal or vertical flow attitude. An independent relief valve shall be located between the two check valves. Valves and assembly shall be in compliance with AWWA C511 and be as approved by the local and state plumbing codes.

2. Isolation gate valves, one on each end, complying with AWWA C500, shall be provided, all as part of a single assembly.

K. Influent Plug Valve

1. Furnish one (1), 6 inch diameter electrically operated flanged plug valve for each basin to control the influent flow.

2. Valves shall be equal to a DeZurik PEC 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, Neoprene coated cast iron plug, assembled and tested with an Auma SG07.1, 115 volt, single phase, 60 cycle open/close service electric actuator. The valve shall be a non-lubricated type with a port area of at least 80% of full pipe size. Valve actuator shall include a compartment heater. Each valve shall include a manual override with limit switch feedback to the micro-processor in both the open and closed positions. Field wiring and junction/box disconnect shall be provided by the installing contractor.

L. Decant Flow Control Valve

1. Furnish 1, 8" diameter electrically operated butterfly valve(s) for each basin to control the decant rate.

2. Valve(s) shall be equal to a DeZurik BAW AWWA C-504 Class 150B electrically operated butterfly valve(s) with ANSI Class 125# flanged end ASTM A-126 Class B cast iron body, cast iron disk with a 316 stainless steel edge, EPDM seat, 304 stainless steel shaft assembled and tested with an Auma SG07.1, 115 volt, single phase, 60 cycle open/close service electric actuator. Valve actuator shall include a compartment heater. Each valve shall include a manual override with limit switch feedback to the microprocessor in both the open and closed positions. Field wiring and junction/box disconnect shall be provided by the installing contractor.

M. Emergency Shower and Eyewash Station

Install an emergency shower and eyewash station as shown on the drawings. The eyewash station shall be a Guardian Model G1902P or approved equal. The eyewash station shall have a 10" safety orange ABS plastic shower head, a 1" chrome plated brass stay open ball valve, two gentle spray eye wash outlet heads, 12" safety orange ABS plastic eye wash bowl, and ½" IPS chrome plated brass stay open eye wash valve. Install weather resistant sign reading "EMERGENCY EYEWASH FOUNTAIN" on the eyewash station behind valve handle as shown on the PLANS. Furnish and install all piping, fittings and valves necessary for complete installation of emergency shower and eyewash.

L. Wafer Check Valves for Blower Service

1. Check valves for the discharge of blowers shall be be double door check valves of compact wafer design for air service to mount between ANSI 125 pound standard flanges

2. The check valves shall be of springless, seatless design with cast iron body (ASTM A48, Class 30), and have aluminum internal assemblies. Sealing material shall be Buna-N rubber.

3. The body shall be designed for 35 psig at 300 degrees F continuous duty.

M. Wafer Butterfly Valves for Blower Service

1. Butterfly valves for the discharge of blowers shall have a cast iron body, ductile iron disc, stainless steel shaft, Buna N seat and be suitable for mounting between ANSI 125 pound standard flanges. The valves shall be lever operated with positive lever position locking arrangement. They shall be as manufactured by Allis-Chalmers Valve Division, DeZurik, or approved equal.

N. Flexible Connectors for Blower Service

1. Flexible connectors for the discharge of blowers shall be flanged type consisting of a fiberglass impregnated silicone rubber hose, two flanges, two pipe nipples, and two hose clamps. They shall be installed at the locations shown on the PLANS.

O. Small Valves

1. Unless otherwise shown on the PLANS, gate valves shall be bronze, single wedge disc, non-rising stem design for use in confined space. Gate valves shall be handwheel operated and designed to operate fully opened or fully closed. They shall have solder joints or screwed ends as required for the installation and be as manufactured by Crane, Lunkenheimer, or approved equal.

2. Check valves 2 inches and smaller shall be bronze body, composition disc, with screwed ends, similar to Crane No. 34-1/2, Lunkenheimer Figure 230-70, or approved equal.

3. Standard screwed end globe valves 2 inches and smaller shall be bronze valves with plug disc and shall be Crane No. 14-1/2 P, Lunkenheimer Figure 73-PS, or approved equal. Needle point globe valves ¾ inch and smaller shall be bronze valves similar to Crane No. 88, Jenkins, or approved equal.

PART 3: EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. After installation, all valves and appurtenances shall be tested at the same duration and pressure as the piping system they are in. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. All materials shall be carefully inspected for defects in workmanship; all debris and foreign material cleaned out of valve openings, etc.; all operating mechanisms shall be operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the OWNER.

3.02 SHOP PAINTING

A. Interior surfaces of all valves except the exterior surfaces of buried valves and miscellaneous piping appurtenances shall be given a shop finish of an asphalt varnish conforming to Federal Specification TT-V5le for Varnish Asphalt.

B. The exterior surface of various parts of valves, operators, floor stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer.

C. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

D. Field painting is specified under Division 9.

3.03 INSPECTION AND TESTING

A. The various pipe lines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.

END OF SECTION

SECTION 15250
MECHANICAL INSULATION

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This Section includes all pipe, duct, electric heat tape and equipment insulation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Section 15145 "Hangers and Supports" for pipe insulation shields and protection saddles.

2. Section 15810 "Metal Ductwork" for duct lining.

3. Section 15100 "Valves" for valve extension handles.

4. Section 15010 “General Mechanical Requirements”

1.03 SUBMITTALS

A. General: Submit the following in accordance with Section 15010 General Mechanical Requirements, Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.

2. Identify insulation thickness and type used for each size of pipe duct or piece of equipment.

3. Provide installation details of field-applied jackets.

1.04 QUALITY ASSURANCE

A. Installer’s Qualifications: The installer shall be an insulating subcontractor who has completed projects of similar scale and complexity.

B. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the

authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

2. Exterior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

1.05 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb/cubic ft.

1.06 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping and duct systems are tested and completed.

1.07 DELIVERY AND STORAGE OF MATERIALS

A. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.

B. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer’s stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.

C. Installed insulation which has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Fiber: - Use for all HVAC piping, duct and Plumbing systems.

a. CertainTeed Corporation
b. Knauf Fiberglass GmbH
c. Manville.
d. Owens-Corning Fiberglas Corporation
e. Or equal

2. Flexible Elastomeric Cellular – Equipment and Condensate only

a. Armstrong World Industries, Inc.
b. Halstead Industrial Products
c. IMCOA.
d. Rubatex Corporation
e. Or equal

3. Heat Tracing Systems.

a. Chromalox.
b. Raychem
c. Or equal.

2.02 PIPE INSULATIONS

A. Glass Fiber: ASTM C 547, Type I; rigid molded, noncombustible.

1. ‘K’ (‘ksi’) Value: 0.23 at 75 F Mean Temperature (0.033 at 24 C).

2. Maximum Service Temperature: 0 F to 850 F (-18 C to 454 C).

3. Vapor Retarder Jacket: AP-T PLUS White kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket.

B. Elastomeric Foam: ASTM C 534, Type I; flexible, cellular elastomeric, molded.

1. 'K' ('ksi') Value: 0.30 at 75°F Mean Temperature (0.04 at 24°C).

2. Maximum Service Temperature of 150°F .

3. Maximum Flame Spread: 25*.

4. Maximum Smoke Developed: 50*.

5. Connection: Waterproof vapor retarder adhesive as needed.

6. UV-Protection: Outdoor protective coating.

* Max 3/4" to achieve 25/50 rating.

C. Field Applied Jackets (See Schedule for Application):

1. PVC Plastic: Zeston 2000, or equal, one piece molded type fitting covers and jacketing material, gloss white.
   a) Connections: Tacks; Pressure sensitive color matching vinyl tape.

2. Canvas Jacket: UL listed fabric, 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

3. Aluminum Jacket: 0.016 inch (0.045 mm) thick sheet, (smooth / embossed) finish, with longitudinal slip joints and 2 inch (50 mm) laps, die shaped fitting covers with factory applied moisture barrier.

4. Stainless Steel Jacket: Type 304 stainless steel, 0.010 inch (0.25mm), (smooth/corrugated) finish.

2.03 EQUIPMENT INSULATION

A. Flexible Fiber Glass Blanket: Manville 812 Spin-Glas or equal meeting ASTM C 553, Type III; flexible.

1. 'K' ('ksi') Value : 0.24 at 75°F Mean Temperature (0.035 at 24°C).

2. Maximum Service Temperature: 450°F (232°C).

3. Density: 1.5 lb/cu ft (24 kg/cu m) density.

4. Vapor Retarder Jacket: Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic as needed.

B. Rigid Fiber Glass Board: Manville 814 Spin-Glas, 3.0 lb. Knauf Insulation Board, or

equal, meeting ASTM C 612, Type IA & IB; rigid.

1. 'K' ('ksi') Value : 0.23 at 75°F Mean Temperature (0.033 at 24°C).

2. Maximum Service Temperature: 450°F (232°C)

3. Density: 3.0 lb/cu ft (48 kg/cu m) density.

4. Vapor Retarder Jacket: Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic as needed.

C. Elastomeric Foam: ASTM C 534 Type II; flexible, cellular elastomeric, or sheet.

1. 'K' ('ksi') Value: 0.30 at 75°F Mean Temperature (0.04 at 24°C).

2. Maximum Service Temperature of 150°F .

3. Maximum Flame Spread: 25.

4. Maximum Smoke Developed: 50 (3/4" thick and below).

5. Connection: Waterproof vapor retarder adhesive as needed.

6. UV-Protection: Outdoor protective coating.

2.04 DUCTWORK INSULATION (External Insulation)

A. Flexible Fiber Glass Blanket: Manville Microlite Type 75, ¾ lb. Knauf Duct Wrap, or Equal, meeting ASTM C 1290 Type III, flexible blanket.

1. 'K' ('ksi') Value : 0.27 at 75°F Mean Temperature (0.040 at 24°) when installed.

2. Operating Service Temperature Limits: 40°F to 250°F
(4°C to 121°C).

3. Density: .75 lb/cu ft (12 kg/cu m).

4. Vapor Barrier Jacket:FSK, Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Rigid Fiber Glass Board: Manville 814 Spin-Glas, 3 lb. Knauf insulation board, or equal, meeting ASTM C 612, Type 1A & IB; rigid board

1. 'K' ('ksi') Value : 0.23 at 75°F Mean Temperature (0.033 at 24°C).

2. Operating Temperature Limits:
   0°F to 450°F (-18°C to 232°C) AP Jacket
   40°F to 450°F (4°C to 121°C) FSK Jacket

3. Density: 3.0 lb/cu ft (48 kg/cu m).

4. Vapor Retardant Jacket: AP, bleached kraft paper bonded to aluminum foil, reinforced with fiber glass yarn; or FSK, Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

C. Canvas Jacket (Per Schedule): UL listed fabric, 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

D. Lagging For Outdoor ducts:

1. Aluminum Jacket: .016 inch (.045 mm) thick sheet, smooth/embossed finish, with longitudinal slip joints and 2 inch (50 mm) laps.

E. Rectangular Duct Liner: Permacote Linacoustic, or equal, meeting ASTM C 1071 with air surface coated with acrylic coating treated with EPA register anti-microbial agent proven to resist microbial growth as determine by ASTM G 21 and G 22.

1. 'K' ('ksi') Value: Per ASTM C 518, 0.25 at 75°F Mean Temperature (0.036 at 24°C).

2. Noise Reduction Coefficient: .70 or higher based on "Type A mounting" and tested in accordance to ASTM C 423.

3. Maximum Velocity: 5,000 ft/min (25.4 m/sec).

4. Adhesive: meeting ASTM C 919. Coverage to be no less than 90% of duct surface.

5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

2.05 DUCT LAGGING MATERIAL

A. Where called for on the Drawings ducts shall have extra heavy material added to the exterior of ductwork in the vicinity of air handling equipment to limit breakout noise. Lagging material shall be Model DL-10 material as manufactured by Unger Technologies, Inc., or equal. Material shall be cut to length and wrapped around duct or

pipe and adhesive, tape, bands or mechanical fasteners. Material shall not contain lead. Shop Drawings are required for material selected.

2.06 SELF REGULATING HEATING CABLES

A. Summary: Extent of electric heating cable work is indicated by drawings and as specified herein. Refer to Division 16 sections for wires/cables raceways, boxes and fittings, which are required in conjunction with electric heating cables, not work of this section.

B. Quality Assurance:

1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric heating cables, of types, sizes and ratings required, whose products have been in satisfactory use in similar service.

2. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electric heating cables.

3. UL Compliance: Comply with applicable torquing requirements of UL Standard 486A; "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide electric heating cables and components which are UL listed and labeled.

4. IEEE Compliance: Comply with applicable recommended installation practices of IEEE Std. 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electric heating cables.

5. NEMA Compliance: Provide electric heating cables and accessories which comply with NEMA standard.

C. Delivery, Storage and Handling: Deliver electric heating cables in factory-fabricated type containers or wrappings, which properly protect cables from damage.

Store electric heating cables in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

Handle electric heating cables carefully to prevent physical damage to cables and components. Do not install damaged cables; remove from site and replace damaged cables with new.

D. Electric Heating Cables:

Provide self-regulating heat-tracing electric heating cable and components which are suitable for freeze protection of metal or plastic piping. Select heater consisting of 2-16 AWG tinned-copper bus wires paralles embedded in a radiation cross-linked conductive polymer core that varies its power output to respond to temperature along

its length, allowing the heater to be crossed over itself without overheating, to be cut to length in the field, and to be used directly on plastic pipe. Cover heater with a radiation cross-linked modified polyolefindielectric jacket. Provide heater with a self-regulating factor of greater than 90% to conserve energy and to prevent overheating. Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output ranging from 40° F (4° C) pipe temperature operation to 150° F (65° C) pipe temperature operation. Cables must be UL listed for the application in which they are being installed.

E. Provide heating system accessories including, but not limited to, tapes, cables ties, warning labels, end seals and splices, thermostats, power connection junction box, and installation clips for the application indicated and for a complete system.

F. Cables for use with pipe sizes up to 1" shall be 3 watt per foot Chromalox SRL3, or equal. Cables for use with pipe sizes 1 1/2" to 4" shall be 5 watts per foot Chromalox SRL5, or equal.

G. Provide where indicated on the drawings at each power connection point, a Chromalox RTSR, or equal, power connection box with ambinet sensing thermostat. All connections shall be for 277 volt, single phase.

2.07 SELF REGULATING HEATING CABLES

A. The Contractor shall furnish and install insulation suitable for use at temperatures up to 1,500 degrees Fahrenheit on the engine generator set exhaust piping and silencer to prevent heat buildup in the room, provide noise reduction, and optimize operator safety. The insulation shall be custom made to fit the actual layout at the job site and the insulating media shall consist of 2 inch molded calcium silicate as manufactured by Celotemp, or equal. The calcium silicate shall be mitered to fit contours and fittings with all voids filled with high temperature insulating cement (asbestos free). Pipe and fitting insulation shall have a finish of 0.016 inch smooth aluminum sheeting held in place by stainless steel bands.

2.08 HIGH TEMPERATURE PIPE INSULATION

A. The Contractor shall furnish and install insulation suitable for use at temperatures up to 1,500 degrees Fahrenheit on the engine generator set exhaust piping and silencer to prevent heat buildup in the room, provide noise reduction, and optimize operator safety. The insulation shall be custom made to fit the actual layout at the job site and the insulating media shall consist of 2 inch molded calcium silicate as manufactured by Celotemp, or equal. The calcium silicate shall be mitered to fit contours and fittings with all voids filled with high temperature insulating cement (asbestos free). Pipe and fitting insulation shall have a finish of 0.016 inch smooth aluminum sheeting held in place by stainless steel bands.

PART 3: EXECUTION

3.01 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
   1. Follow cement manufacturer's printed instructions for mixing and portions.

3.02 INSTALLATION, GENERAL

A. Refer to schedules at the end of this Section for materials, jackets, and thicknesses required for each mechanical system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg F.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Metal ducts with duct liner.

2. Factory-insulated flexible ducts.

3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.

4. Flexible connectors for ducts and pipes.

5. Vibration control devices.

6. Testing laboratory labels and stamps.

7. Nameplates and data plates.

8. Access panels and doors in air distribution systems.

9. Fire protection piping systems.

10. Sanitary drainage and vent piping.

11. Drainage piping located in crawl spaces, unless indicated otherwise.

12. Below grade piping.

13. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.

14. Piping specialties including plug valves and flow regulators.

3.03 FIBERGLASS PIPE INSULATION INSTALLATION

A. Tightly butt longitudinal seams and end joints. Securely place butt strips around butt joint.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

F. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.

G. Exterior Wall Penetrations: For penetrations of below grade exterior walls, extend metal jacket for exterior insulation through penetration to a point 2 inches from interior surface of wall inside the building. Seal ends of metal jacket with vapor barrier coating. Secure metal jacket ends with metal band. At point where insulation metal jacket contacts mechanical sleeve seal, insert cellular glass preformed pipe insulation to allow sleeve seal tightening against metal jacket. Tighten and seal sleeve to jacket to form a watertight seal.

H. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2 inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer.

I. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with firestopping or fire-resistant joint sealer. Refer to Section 15305 for firestopping and fire-resistant joint sealers.

J. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

K. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor retardant coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.

2. Overlap nesting insulation by 2 inches or 1-pipe diameter, which ever is greater.

3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.

4. Insulate elbows and tees smaller than 3-inches pipe size with premolded insulation.

5. Insulate elbows and tees 3 inches and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.

6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.

7. Cover insulation, except for metal jacketed insulation, with 2 layers of lagging adhesive to a minimum thickness of 1/16 inch. Install glass cloth between layers. Overlap adjacent insulation by 2 inches in both directions from joint with glass cloth and lagging adhesive.

L. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

M. Provide insert between support shield and piping on piping 1 ½ inches (38 mm) diameter or larger. Fabricate of Thermo-12 or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths;

½" to 2 ½" pipe size	10" long
3" to 6" pipe size	12" long
8" to 10" pipe size	16" long
12" and over	22" long

N. For pipe exposed in mechanical equipment rooms or in finished spaces below 10 feet (3 meters) above finished floor, finish with Zeston 2000 PVC jacket and fitting covers (or equal), or aluminum jacket.

3.04 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION – CONDENSATE DRAIN AND POTABLE PIPING IN WALL USE ONLY

A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut one side longitudinally and apply to the pipe. Seal seams and joints with adhesive. Loose insulation and visible pipe will be grounds for rejection of system.

B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.

1. Miter cut materials to cover soldered elbows and tees.

2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.05 FINISHES

A. Paint finished insulation as specified in Division 9 Section "Painting."

B. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of protective coating to exposed insulation.

3.06 DUCT INSULATION

A. Ductwork External Insulation:

1. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive.

2. Provide insulated ductwork conveying air above ambient temperature with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.

3. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.

4. The underside of duct work 24" or greater shall be secured with mechanical fasteners and speed clips spaced approximately 18" on center. The protruding ends of the fasteners should be cut off flush after the speed clips are installed, and then, when required, sealed with the same tape as specified above.

5. **For ductwork exposed to physical abuse in mechanical equipment rooms 10 feet or lower above the floor, or in areas where ceilings are not continuous (clouds etc.) , finish with Zeston 2000 PVC jacket, Canvass, Proto, aluminum jacket, or equal. This is required for insulation over mezzanine floors as well. It is not required for ductwork adjacent to mezzanine floors.**

6. For exterior applications, provide insulation with a weather protection jacket, such as Zeston 300 PVC, Proto, .016 aluminum jacket, or equal.

B. Duct Liner:

1. Adhere insulation to sheet metal with full coverage (over 90% coverage) of an Adhesive meeting ASTM C 919.

2. Secure insulation with mechanical liner fasteners as indicated by SMACNA, NAIMA, or manufacturer. Pin length should be such as to limit compression of liner.

3. All exposed edges of the liner must be factory or field coated. For systems operating at 4000 fpm or higher a metal nosing must be installed in all liner leading edges.

4. Repair liner surface penetrations with adhesive meeting ASTM C 919 or SuperSeal.

5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.07 APPLICATIONS

A. General: Materials and thicknesses are specified in following paragraph in schedules at the end of this Section.

B. Interior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

2. Domestic hot water.

3. Recirculated hot water.

4. Sanitary drains for fixtures accessible to the disabled.

5. All interior supply and return hydronic hot, chilled, or heat pump piping valves, specialties, and pumps.

C. Interior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

2. Domestic hot water.

3. Recirculated hot water.

4. All interior hydronic hot, chilled, and heat pump piping valves, specialties, and pumps.

D. Exterior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

E. Equipment: Unless otherwise indicated, insulate the following indoor equipment:

1. Domestic cold water equipment, tanks, and pumps.

2. Domestic hot water equipment, tanks, and water heaters. (not required if internally insulated)

3. Hydronic equipment, tanks, pumps, and heat exchangers.

F. Duct Systems: Unless otherwise indicated, insulate the following duct systems:

1. Interior concealed supply and outside air ductwork.

2. Interior exposed supply and outside air ductwork.

3. Exhaust Ductwork – last 10' prior to exhaust fan.

G. Items Not Insulated: Unless otherwise indicted do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors for ducts and pipes.

2. Vibration control devices.

3. Testing laboratory labels and stamps.

4. Nameplates and data plates.

5. Sanitary drainage and vent piping.

6. Drainage piping located in crawl spaces, unless indicated otherwise.

7. Below grade piping.

8. Chrome-plated pipes and fittings.

3.08 HEAT TAPE INSTALLATION

A. Examination: Examine areas and conditions under which electric heating cables are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Ensure that surfaces, and pipes to which electric heating cables are to be installed are free of burrs and sharp protrusions and that pipes have been pressure tested for leakage. Also ensure that surfaces and substrates where cables are installed are plumb and level. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to Installer.

B. Installation of Electric Heating Cables: Install electric heating cables including components as indicated, in accordance with equipment manufacturer's written

instructions, applicable portions of NEC, and with recognized industry practices to ensure that units fulfill requirements. Comply with applicable installation requirements of NECA's "Standard of Installation."

Coordinate with other work including concrete, finish work, and electrical work as necessary to interface installation of electric heating cables with other work.

Protect installed electric heating cables, including leads, from damage and crushing by construction work.

Connect electrical power, fasten end-seals, and accomplish splicing of electric heating cables properly in accordance with requirements.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

C. Grounding: Provide equipment grounding connections for electric heating cables as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

D. Field Quality Control: Prior to energizing electrical power circuitry, test installed electric heating cabling, including splice and tee connections, for electrical continuity.

After attaching electric heating cables to pipe, test cables for continuity and insulation resistance of 10 megohms, or greater, measured to ground. Where leakage detected, remove cabling and replace with new and proceed with retesting to demonstrate compliance.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

3.09 PIPING INSULATION SCHEDULE

A. FIBERGLASS INSULATION

PIPE SIZES:	runouts up to 2 inch	1 and less	1 to 2	2-1/2 to 4	5&6	8&up
		INSULATION THICKENESS INCHES				
Domestic & Hot Water 105 and greater	0.5	1.0	1.0	1.5	1.5	1.5
Heating Systems (Hot Water)						
105-140	0.5	1.0	1.0	1.0	1.5	1.5
141-200	0.5	1.5	1.5	1.5	1.5	1.5
201-250	1.0	1.5	1.5	2.0	2.0	3.5
251-350	1.5	2.0	2.5	2.5	3.5	3.5
>350	1.5	2.5	2.5	3.0	3.5	3.5
Cooling Systems (Chilled Water, Brine)						
<40	**1.0**	**1.0**	**1.5**	**1.5**	**1.5**	**1.5**
41-60	**1.0**	**0.5**	**0.75**	**1.0**	**1.0**	**1.0**

[IF DIFFERENT GEOGRAPHICAL AREA MAY NEED TO RECALCULATE]

Geothermal Piping	0.5	0.5	0.5	0.5	0.5	0.5

Cold Water	all sizes	1.0
Roof Drain Bodies	all sizes	1.0
Roof Drainage Within 10 Feet (3 Meters) of the Exterior and all horizontal runs	all sizes	1.0
Plumbing Vents Within 10 Feet (3 Meters) of the Exterior	all sizes	1.0
Heat Recovery Water	all sizes	1.0
Piping Exposed to Freezing	all sizes	1.5

B. ELASTOMERIC FOAM

Condensate Piping Only	all sizes	0.75
Refrigerant Suction	all sizes	1.0
Refrigerant Hot Gas	< 1” - 0” , > 1” – 0.75”	

3.10 EQUIPMENT INSULATION SCHEDULE

		THICKNESS Inches
A.	Flexible Fiber Glass Blanket or elastomeric foam	
	Heat Exchangers/Converters	1.5
	Air Separators	1.0
	Hydronic Pump Bodies	1.5
B.	Calcium Silicate	
	Flue Gas Breeching	4.0

3.11 DUCTWORK INSULATION SCHEDULE

		THICKNESS Inch	FINISH
A.	Flexible Fiber Glass		
	Exhaust Ducts Within 10 ft (3 m) of Exterior Openings	1.5	FSK
	Air Ventilation Equipment Casings	1.5	
	Supply Ducts (Cooling Systems)	1.5	FSK
	Return Ducts in Unconditioned Spaces	1.5	FSK
	Outside Air Ducts	2.0	FSK
B.	Rigid Fiber Glass		
	Outside Air Intake Ducts	2.0	FSK
	Plenums (Cooling Systems)	2.0	FSK
	Return and Relief Ducts in Mechanical Rooms	1.5	FSK
	Supply Ducts Exposed to Outdoor	1.5	FSK
	Exhaust Ducts Exposed to Outdoor	1.5	FSK
C.	Duct Liner		
	Where Indicated	1.0	PERMACOTE LINACOUSTIC

NOTE: All Schedules Above - The above listed insulation thickness schedule is recommended for energy conservation and does account for personal protection or condensation control. The minimum R-value of the insulation for the actual operating conditions in the project shall conform with ASHRAE 90.1.

3.12 MISCELLANEOUS INSULATION SCHEDULE

A. VAV Box Reheat Coils: Insulator shall provide spray-on foam to all exposed reheat coil tube ends. This prevents condensation when the coil is off and primary air is chilling the coil's exposed ends.

END OF SECTION

SECTION 15400

BUILDING DRAINAGE AND PLUMBING SYSTEM

PART 1: GENERAL

1.01 WORK INCLUDED

A. Furnish all labor, materials, equipment, and incidentals required and install a complete plumbing system as shown on the Drawings and as specified herein. More specifically, the work shall include, but not be limited to, the following:

1. Installation of sanitary, acid resisting waste, rainwater leader, and equipment drainage systems.

2. Installation of potable water systems.

3. Plumbing fixtures, wash-hose stations, emergency showers, eye-wash fountains, emergency water alarm and floor drains.

4. Water mixers for showers and shower stalls.

5. Potable water heaters with temperature and pressure relief valves.

6. Water and drain outlets left for connections required by miscellaneous mechanical and process equipment.

7. Sump pumps, frames and covers furnished under Division 11.

8. Installation of toilet, drying, locker and janitor's room accessories furnished under Division 10.

9. All parts necessary to make a complete plumbing system ready for continuous operation.

B. The work of this Section shall also include the installation of valve tags furnished by the CONTRACTOR. All valves provided under this Section shall be tagged.

1.02 RELATED WORK

A. All piping systems in the building other than the plumbing work specified in this Section.

B. Yard piping for sanitary and storm drains beyond 5 feet outside the building unless otherwise indicated.

C. The following items are related work:

1. Small Plumbing Valves are included in this Division, Section 15100.

2. Hangers, Supports and Anchors are included in this Division.

3. Painting is included in Division 9.

4. Cutting and Patching are included in Divisions 3 and 4.

5. Manholes, Catch Basins, and Buried Pipe Encasement are included in Division 2.

6. Ductwork is included in this Division.

7. Toilet, Shower, Drying, Locker, and Janitor's Room Accessories are included in Division 10.

8. Electrical is included in Division 16.

9. Excavating and Backfilling is included in Division 2.

10. Concrete is included in Division 3.

11. Portable Fire Extinguisher is included in Division 10.

12. Mechanical Identification Markers, Tags and Plates are included in this Division..

13. Sewer and drain pipe is included in Division 2.

14. Pressure pipe is included in Division 2.

1.03 SYSTEM DESCRIPTION

A. Mention herein or indication on the Drawings of equipment, materials, operation or methods shall require that each item mentioned or indicated be provided to make a complete system of plumbing ready for continuous operation.

B. The location of all equipment, fixtures and piping shall be considered as approximate only and the right is reserved by the ENGINEER to change at any time, before the work is installed, the position of such equipment and piping to meet structural conditions and to provide proper headroom clearance or for other sufficient causes and such changes shall be made without additional expense to the OWNER.

C. Attention is called to the necessity for elimination of transmission of vibration from mechanical equipment to building structures. All equipment, therefore, shall be carefully selected and installed to meet this condition and isolators shall be provided for all equipment with rotating parts.

D. Instruct such persons as designated by the OWNER in the care and use of all plumbing equipment and piping systems installed.

E. Unless otherwise shown, floor drain inlets, process drainage and maintenance sinks and floor drainage sumps shall not be vented where they drain to an inside sump due to being below flood water and are pumped out by sump pump. Only when such facilities drain to outside chambers or pipes which might contain sewer or sludge gases shall they be vented and trapped and such traps shall be accessible either on the inlet or outlet ends. The drain pipe of such systems shall not have any source of sewer or sludge gases which were not already produced in the building by spillages from processes and equipment maintenance.

1.04 DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed Drawings shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fittings nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, all necessary parts to make complete working systems ready for use shall be furnished without extra charge.

B. All piping shall be installed as closely as possible to walls, ceiling and other structural parts (consistent with proper spacing for covering, removal of pipe, and access to accessories, such as valves, strainers, etc.), so as to occupy the minimum space, and all offsets and fittings required to accomplish this shall be furnished without additional expense to the OWNER.

C. Refer to the Structural and Architectural Drawings which indicate the type of construction in which the work shall be installed. Locations shown on the Plumbing Drawings shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.

1.05 REFERENCES

A. Kentucky Building Code

B. Kentucky State Plumbing Law, Regulations and code

1.06 SUBMITTALS

A. Furnish to the ENGINEER for review, as provided in the General conditions, shop drawings and technical literature covering details of all equipment, fixtures and accessories being furnished under this Section prior to fabrication, assembly or shipment.

B. Furnish to the ENGINEER for review no less than 120 days before start-up, a schedule of all exposed valves installed under this Section. The schedule shall include each valve the location, type, a number, words to identify the valve function, and the normal operating position.

1.07 CODES, ORDINANCES AND PERMITS

A. Comply with all the laws, ordinances, codes, rules and regulations of the local and State authorities having jurisdiction over any of the work specified herein.

B. Obtain all required permits, pay all legal fees and tap-on fees for the same and in general take complete charge and responsibility for all legal requirements pertaining to this Section of the work.

C. Requirements set forth in this Section and indicated on the Drawings shall be followed when in excess of the required or minimum regulations.

D. If any work is performed and subsequent changes are necessary to conform to the regulations, such change shall be made as part of this work at no additional cost to the OWNER.

1.08 ACCEPTANCE OF INSTALLATION CONDITIONS

A. The Subcontractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be his responsibility to inspect all installation conditions and bring to the attention of the ENGINEER via the CONTRACTOR any conditions which may affect his work adversely. He shall report via the CONTRACTOR to the ENGINEER, prior to commencing any portion of this work, any conditions unsuitable for the installation of his portion of the work.

PART 2: PRODUCTS

2.01 DRAINS

A. Floor Drains

1. All floor and open ended drains as required shall be fitted with a deep seal cast iron “P” type trap.

2. All floor and open ended drain traps where exposed or accessible shall be fitted with bottom cleanouts and cleanout plugs or caps.

3. All floor drains shall have cast iron or acid resisting drainage flange, seepage control, clamping collar and inside caulk outlet.

2.02 CLEANOUTS

A. Cleanouts shall be heavy duty cast iron with square nickel bronze top adjustable to finished floor. A membrane flange shall be provided.

2.03 PLUMBING FIXTURES

A. Indoor Eye-Wash station

1. Furnish and install Bradley Model S19-220BSS Wall-Mount Eyewash Unit, or approved equal, at the locations shown on the Drawings. See 15100.

B. Electric Water Cooler (Barrier-free)

1. Furnish and install pressure type barrier-free electric water coolers for locations shown on the Drawings. The cooler shall be pushbutton operated with bubbler guard, stream height adjustment, and automatic adjustable water temperature control. The cooler shall deliver a minimum of 7.8 gallons per hour of 50 degrees Fahrenheit drinking water with inlet temperature of 80 degrees Fahrenheit and room temperature of 90 degrees Fahrenheit (ARI Standard 1010-73). The water coolers shall be rated at 115 volts, 60 hertz.

C. Water Closets

1. Furnish and install water closets for locations shown on the Drawings. Water closets shall be the water saving, siphon jet type with freestanding elongated bowl. The bowl shall be white vitreous china. All exposed metal surfaces shall be polished chromium plated.

2. Each water closet shall be equipped with bolt caps, flush valve, and seat.

F. Lavatories

1. Furnish and install lavatories for locations shown on the Drawings. Lavatories shall be which vitreous china with 20 inch by 18 inch rectangular basin, splash lip, front overflow, soap depression(s), concealed hangers and lavatory anchoring screws. All exposed metal trim and accessories shall be polished chromium plated. Drilling shall be for 4 inch lavatory faucet.

2. Each lavatory shall be equipped with a 1-1/4 inch adjustable cast brass “P” trap with cleanout and waste to wall; supply assembly consisting of 3/8 inch angle valves, wheel handles and flexible tube risers; and brass faucet and waste trim (chrome finish) consisting of valves with renewable seats on 4 inch centers, ½ inch male threaded inlets, coupling nuts, aerator, grid drain, 1-1/4 inch tail piece, chrome handles and 2-1/2 gpm flow restrictor.

3. Lavatories shall be Kohler Chesapeake Series or equal. Faucets shall be Kohler Triton Finesse with lever handles or equal.

G. Urinal

1. Furnish and install urinals for locations shown on the Drawings. The urinals shall be vitreous china wall-hung siphon jet with integral extended shields, flushing rim and trap, ¾ inch top spud, 2 inch S.P.S. female outlet connection and wall hangers. All exposed metal surfaces shall be polished chrome plated. The flush valve shall be exposed.

2. The urinal shall be Kohler, or equal.

3. The flush valve shall be of the vacuum breaker, water saving type, ¾ inch screwdriver angle stop and flush connection.

H. Electric Water Heater

1. Furnish and install a tankless electric water heater for emergency eyewash stations at the location shown on the Drawings.

2. The heater shall be equal to a Keltech CLE Series emergency eyewash heater.

I. Shower and Accessories

1. Furnish and install a shower complete with all accessories needed for a complete installation. Shower shall be equal to Kohlers K-1517, One Piece, Cape Cod Neo Angle Shower Module. Doors shall be equal to Kohlers Focal, Neo Angle. Fixtures shall be equal to Kohler Triton with lever handles.

J. Thermostatic Mixing Valve

1. Master water mixing valve for tempered water control shall be of the thermostatic type with liquid filled sensor. It shall have bronze body construction with non-corrosive parts. Valve construction shall employ poppets which are independently seated, balanced, and self-aligning. Union inlets with strainers and checkstops shall be provided.

2. Temperature adjustment control shall be tamper-resistant.

3. The valve shall be designed such that, with initial pressure differentials of 45 psi (310 kPa), the delivery temperature will hold within ± 3 degrees Fahrenheit (± 1.7 degrees Celsius) under any of the following conditions: a 50 percent drop in inlet pressure, a 25 degrees Fahrenheit (14 degrees Celsius) fluctuation in hot water temperature, or an 85 percent restriction of discharge flow. Valve will shutdown to minimum flow if either water supply or thermostatic element fails.

PART 3: EXECUTION

3.01 INSTALLATION

A. All the items specified under PART 2 PRODUCTS, shall be installed according to the applicable manufacturer's recommendations, the details shown on the Drawings and as specified under this Section.

B. Completely caulk around fixtures where fixture meets the floor or wall to provide a water tight seal.

C. Where water piping is installed as copper tubing, all valves shall be copper solder end except as noted above to be threaded ends.

D. Control valves to all equipment and fixtures shall be installed, grouped and located so they will be easily operated, through access panels, doors, or adjacent to equipment.

E. Valves shall be installed in horizontal to upright position and shall not be installed in down position from the horizontal.

F. The sanitary system shall be extended to points of termination and installed as described as shown on the Drawings.

G. Hanger rods shall be secured by passing through rough slab and/or structural pre-cast unit above and finishing with plate and nut or rods shall be made fast by means of approved type inserts which shall be set before slab is poured. Hangers shall not interfere with the finish of the floors. Rods, bolts or plates shall not extend through the floor finish.

H. Provide all temporary metal supports to secure and maintain buried piping in correct alignment and slope.

I. When pips run on a wall below a fixture or to a fixture, the supports for these pipes shall be cast pattern brass and where exposed shall be of same finish as the pipes they support.

J. All interior hot and cold water lines shall be insulated whether exposed or located in walls, pipe chases or above ceilings.

K. Insulation shall not be applied until pipes have been tested and accepted by all parties making inspection. All insulated covering shall be guaranteed for a period of one year.

L. Short exposed supply pipe at or immediately near regular plumbing fixtures shall not be insulated, but shall be finished as trim for fixtures specified in PART 2 of this Section.

M. Temperature and pressure relief valves shall be installed on the potable water heaters. Relief valves shall be ASME rated. Relief valves shall be piped to drain over floor drains or through wall to exterior of buildings as shown on the Drawings.

N. The flow switch as described above for emergency shower and eye wash units, shall be installed in the horizontal pipe line. It shall be on top of the pipe with the vane vertical. The flow switch shall be located not less than 6 diameters from any fitting that changes the direction of the flow.

O. All work shall be installed in accordance with the manufacturer's printed instructions and shall be rigid, plumb and true to line, with all parts in perfect working order. Maintain protective covers on all units until final clean-up time and at that time remove covers and clean and polish all surfaces.

P. Installation of the fixtures and accessories shall meet the applicable requirements of the American Disabilities Act, as noted on the Drawings.

Q. Interior copper pipe shall show no dents or bends and joints shall present a neat appearance. Pips shall be parallel to walls, floors and ceilings with

unions and valves near beginning all runs and branches to facilitate dismantling and shutting off. Pipe shall be secured to walls and ceiling by clamps and rod hangers manufactured for the purpose. Perforated strap hangers are not acceptable. After installation, the pipe shall be tested and all leakage stopped.

R. Wherever copper pipes pass through walls or floors, they shall have ductile or cast iron sleeves for easy removal. Pipes passing through structural beams shall be placed as near as possible to the top of the beam under the floor slab.

S. All interior steel pipe work for welded joints, as to workmanship, testing, qualifications or welders and general requirements, shall conform to the welding section of ANSI B-31-1, "Code for Pressure Piping." Use only welding type fittings and welding neck flanges. Do not make direct welded connection to valves, expansion joints, strainers, etc., which are intended to be removable. Companion flanges shall be provided at these points.

T. Where piping passes through walls, the CONTRACTOR shall install standard IPS sleeve. Floor and ceiling plates for all lines shall be chrome plated steel.

3.02 TESTING

A. Potable water supply and the entire soil and/or waste and vent system shall be tested in accordance with Article 815 KAR 20:150 of the Kentucky State Plumbing Code. The potable water line and appurtenances shall be installed and disinfected in accordance with the requirements of the Division of Water, Kentucky Natural Resources and Environmental Protection Cabinet.

B. All additional tests, methods or materials as may be required by the local ordinances and not specifically mentioned herein, shall be made as directed by the Local Inspection Authority.

C. Provide for any repeated test as necessary to make systems tight as required.

3.03 WATER FOR TESTING

A. The CONTRACTOR will provide air, steam, and water necessary for testing the piping systems. The Subcontractor shall make all connections for testing and remove all debris resulting there from. The water shall be used in an efficient and economical manner.

B. Provide all apparatus and all other supplies or materials which may be necessary for testing the systems and operating the apparatus during the period while tests of any kind are being made, or for carrying out the work of the Contract.

3.04 CLEANING

A. At the completion of the work, all fixtures, equipment, apparatus and exposed trim for same included in this Section shall be clean and, where required, polished ready for use.

3.05 PROTECTION

A. Materials, fixtures, and equipment shall be properly protected at all times and all pipe openings shall be temporarily closed so as to prevent obstruction and damage. Work damaged during construction shall be replaced at no additional cost.

3.06 DISINFECTION

A. This requirement applies to the entire potable water system including the new underground service pipe and all interior potable hot and cold service piping.

B. Thoroughly flush the potable water system with clean potable water.

C. Fill the potable water system with a water/chlorine solution of 50 parts per million (50 mg/l) of chlorine, valve off and let stand for 24 hours. A chlorine residual test is required after filling line to ensure proper chlorine concentration.

D. After the 24-hour period, open all valves and faucets and flush the system with clean, potable water until the residual chlorine content is not greater than 0.2 parts per million.

E. When final flushing is complete, samples from at least 3 points in the system shall be taken for analysis at a State Certified laboratory for certification that they are free of coliform bacteria contamination. One of the sampling points must be the furthest most fixture from the potable water service line building entry.

F. Laboratory certification that all samples are free of coliform bacteria contamination is required for system disinfection to be acceptable.

3.07 MISCELLANEOUS REQUIREMENTS

A. All final connections to mechanical equipment in all locations shall be preceded by union fitting and gate valve or globe valve.

B. Pump bases shall be drained whether shown on the Drawings or not from the tapping in the base to and over the nearest floor or open end drain.

3.08 COORDINATION SKETCHES

A. It shall be the responsibility of the Subcontractor to have in his employ a competent coordinator of mechanical systems and as such to provide all coordination of drawings or sketches as may be required or deemed necessary by the ENGINEER to obtain the required ceiling heights and eliminate conflicts with all piping, ducts, and electrical installation.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1: GENERAL

1.01 CONTRACTOR'S UNDERSTANDING

A. Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between the Basic Electrical Materials and Methods and General Requirements, the above-mentioned documents shall overrule this section. The Basic Electrical Materials and Methods are intended as a supplement to the above-mentioned documents.

B. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of proposal.

C. Each Contractor bidding on the work included in these Specifications shall view the building site and carefully examine the Contract Drawings and Specifications, so that he/she may fully understand what is to be done, and to document existing conditions.

1.02 SCOPE OF WORK

A. Work include in this section of the Specifications include the furnishing of all labor, material, tools, approvals, utility connection fees, excavation, backfill, and other equipment necessary to install the electrical system as shown on the Contract Drawings and as specified herein.

B. It also includes installation and connection of all electrical utilization equipment included in this Contract but furnished by other contractors or suppliers.

C. It is the general intent that all motors shall be furnished with the particular object of equipment it drives.

D. The Contractor shall furnish and install all conduit, wire, disconnect switches and miscellaneous material to make all electrical connections to all items of utilization equipment or wiring devices except as otherwise specified.

E. Equipment connections shall be made with flexible or rigid conduit as required. Controllers for motors, disconnect switches, and all control, protective and signal devices for motor circuits, except where such apparatus is furnished mounted and connected integrally with the motor driven equipment, shall be installed, connected and left in operating condition. The number and size of conductors between motors and control or protective apparatus shall be as required to obtain the operation described in these Specifications, and/or by the Contract Documents, and/or as shown in manufacturer furnished, Engineer reviewed Shop Drawings.

F. All devices and items of electrical equipment, including those shown on the Contract Drawings but not specifically mentioned in the Specifications or those mentioned in the Specifications but not shown on the Contract Drawings, are to be furnished under this section of the Specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar equipment and/or devices specified herein.

G. All devices and items of equipment mentioned in this section of the Specifications whether electrical or not or whether furnished under this or other Division of the Specifications, shall be installed under this Division of the Specifications, unless specifically indicated otherwise.

H. Where wiring diagrams are not shown on the Contract Drawings, they are to be provided by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.

I. The following is a list of items that may not be defined clearly on the Contract Drawings or in other parts of these Specifications. The list is meant to be an aid to the Contractor and is not necessarily a complete list of all work to be performed under this Contract:

1. Connect all motors and accessories furnished by equipment suppliers.
2. Furnish, install, and connect all motor controls.
3. Furnish, install, and connect lighting, indoor and outdoor.
4. Furnish, install, and connect power and signal lines to all instrumentation equipment, and accessories.
5. Furnish, install, and connect all electrical conduit, duct and cables.
6. Furnish, install, and connect all telephone boxes, outlets, etc.
7. Furnish, install, and connect all power distribution equipment.
8. Demolish and remove all existing wiring and materials in the existing plant.
9. Furnish and install standby power equipment.
10. Furnish and install security system equipment.
11. Furnish and install communications system equipment.

J. All raceways and wiring shall be firestopped where required by code and/or indicated in the Contract Drawings.

1.03 SHOP DRAWINGS, DESCRIPTIVE LITERATURE, INSTALLATION, OPERATION AND MAINTENANCE INFORMATION

A. Shop Drawings including descriptive literature and/or installation, operation and maintenance instructions shall be submitted in the amount of 8 copies for this Division. All Shop Drawings shall be submitted in loose-leaf three-ring cardboard reinforced vinyl binders.

B. Shop Drawings shall be submitted on the following materials specified in this Division:

1. Conduit - all types and sizes, including liquid-tight flexible.
2. Boxes - all types and sizes.
3. Paint.
4. Wiring devices.
5. Device plates.
6. Metal framing system (Strut type channel).
7. Conduit fittings, expansion joints, support hardware.
8. Motor control equipment - including individually mounted items and pole top items.
9. Power distribution equipment - including individually mounted items.
10. Adjustable speed equipment and accessories.
11. Miscellaneous spare parts and hardware.
12. Wire - all types and sizes.
13. Light fixtures - all types.
14. Wire markers, signs and labels.
15. Lightning/transient suppressors.
16. Motors.
17. Transformers.
18. Standby power equipment and accessories.
19.

C. The Engineer reserves the right to make modifications to motor control and power distribution equipment ratings after equipment Shop Drawing review, if the equipment Shop Drawings are submitted prematurely (prematurely meaning submitted before all utilization equipment has been reviewed and accepted). Cost of modifications shall be the Contractor’s responsibility.

1.04 SYMBOLS AND ABBREVIATIONS

A. The symbols and abbreviations general follow standard electrical and architectural practice, however, exceptions to this shall be as shown on the Contract Drawings.

1.05 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the electrical work with that of other trades to ensure proper final location of all electrical equipment and/or connections. The Contractor shall verify door swings to see that light switches are located properly.

1.06 CODES

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC) and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineer's design require a higher standard that the current NEC or KBC, then these laws and/or regulations and/or the design shall be followed.

B. Following is a list of other applicable Standards or Codes:

1.	Kentucky Building Code	KBC
2.	National Electrical Code	NEC
3.	National Electrical Safety Code	NESC
4.	Underwriters Laboratories, Inc.	UL
5.	Factory Mutual System	FM
6.	National Fire Protection Association	NFPA
7.	National Electrical Manufacturers Association	NEMA
8.	Occupational Safety and Health Administration	OSHA
9.	Insulated Cable Engineers Association, Inc.	ICEA
10.	Illuminating Engineering Society of North America	IES
11.	Instrument Society of America	ISA
12.	Institute of Electrical and Electronic Engineers, Inc.	IEEE
13.	Certified Ballast Manufacturers Association	CBM
14.	American National Standards Institute, Inc.	ANSI
15.	Federal Communications Commission	FCC
16.	American Society for Testing and Materials	ASTM

1.07 INSPECTIONS AND PERMITS

A. Inspection of the electrical system on all construction projects is required. If the local government has appointed a state licensed inspector, the Contractor shall be required to use that person to perform the inspections. If a locally mandated inspector does not exist, the Contractor shall select and hire a state licensed inspector, who has jurisdiction before any work is concealed. The Contractor shall notify the electrical inspector in writing, immediately upon notice to proceed, and a copy of the notice shall be submitted to the Engineer.

B. At the time of completion of the project, there shall be furnished to the Owner a certificate of compliance, from the agency having jurisdiction pursuant to all electrical work performed. The Engineer shall also receive a photostatic copy.

C. All costs incurred by the Contractor to execute the above mentioned requirements shall be paid by the Contractor at no extra cost to the Owner.

D. All permits necessary for the complete electrical system shall be obtained by the Contractor from the authorities governing such work. For further information, see Division 1.

1.08 STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

B. Sensitive electrical equipment such as light fixtures, motor starters, controls, and panelboards, delivered to the job site, shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed. Electrical equipment other than boxes and conduit shall not be installed until the structure is under roof with doors and windows installed.

C. No light fixtures or device plates shall be hung or installed until after painting is completed; however, temporary lighting shall be provided by the Contractor.

D. The Contractor shall not store submersible pump units in the wetwell. If it is absolutely necessary to do so, the open power cable ends are to be suspended above the maximum flood elevation or maximum expected water level. If not stored in this manner, the Contractor may be called upon to replace the pump motors and cables with new units to ensure that water has not penetrated the cable and entered the motor housing.

1.09 MATERIALS

A. All materials used shall be new and at least meet the minimum standards as established by the NEC and/or National Electrical Manufacturers Association (NEMA). All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.

B. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each Contractor has the right to substitute other material and equipment in lieu of that specified, other than those specifically mentioned at matching or for standardization, providing such material and equipment meets all of the requirements of those specified and is accepted, in writing by the Engineer.

C. The reuse of salvaged electrical equipment and/or wiring will not be permitted unless specified herein or indicated on the Contract Drawings.

D. All salvaged or abandoned electrical materials shall become the property of the Contractor and shall be removed from the job site upon completion of the project, unless otherwise noted on the Contract Drawings or specified herein.

E. Existing fluorescent light fixtures to be abandoned and removed this Contract, shall be assumed to be equipped with PCB filled ballasts. Light fixtures shall be disassembled and the ballast removed prior to salvage and/or disposal. Ballasts containing PCB's shall be disposed per requirements of the Toxic Substances Control Act (TSCA). Manifests shall be submitted to the Owner documenting proper transportation and disposal of PCB contaminated ballasts.

1.10 ERRORS, CORRECTIONS, AND/OR OMISSIONS

A. Should a piece of utilization equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the Contractor shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the Owner.

B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractor's failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost. Further requirements on this subject may be found in the General Requirements, Division 1.

C. Necessary changes or revisions in electrical work to meet any code or power company requirement shall be made by the Contractor without additional charge.

1.11 GUARANTEES AND WARRANTIES

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of any of the above and shall run for a period of 1 year from the date of acceptance of the work, concurrent with the one-year guarantee period designated for the general construction contract under which electrical work is performed. Date of acceptance shall be considered to be the date on which all "punch list" items are completed ("punch list" is defined to be the written listing of work that is incomplete or deficient that must be finished or replaced/repaired before the Contractor receives final payment).

B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine. (That is oiling, greasing, etc.) The Engineer shall be the judge of what shall be considered as routine maintenance.

C. Lamps shall bear the manufacturer's warranty.

1.12 TESTING

A. After the wiring system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

B. Before energizing the system, the Contractor shall check all connections and set all relays and instruments for proper operation. He shall obtain all necessary clearances, approvals, and instructions from the serving utility company and/or equipment manufacturers prior to placing power on the equipment.

C. Tests may be performed by the Engineer to determine integrity of insulation on wiring circuits selected by the Engineer at random.

D. Cost of utilities for testing done prior to beneficial occupancy by the Owner shall be borne by the Contractor.

1.13 CLEANUP

A. Cleanup shall be completed as soon as possible after the electrical installation is complete. All light fixtures, outlets, switches, starters, motor control centers, disconnect switches and other electrical equipment shall be free of shipping tags, stickers, etc. All painted equipment shall be left free of scratches or other blemishes, such as splattered or blistered

paint, etc. All light fixture diffusers shall be clean and the interior of all motor controls, etc., shall be free of dust, dirt, wire strippings, etc. Surplus material, rubbish and equipment resulting from the work shall be removed from the job site by the Contractor upon completion of the work.

B. During construction, cover all Owner equipment and furnishings subject to mechanical damage or contamination in any way.

1.14 CUTTING AND PATCHING

A. Cutting and patching shall be held to an absolute minimum and such work shall be done only under the direction of the Engineer or Owner. The Contractor shall be responsible for and shall pay for all openings that may be required in the floors or walls, and he shall be responsible for putting said surfaces back in their original condition. Every attempt shall be made to avoid cutting reinforcing steel bars when an opening is required in a reinforced concrete wall or floor slab.

B. Prior to cutting of any floors or walls, all conduits must be located prior to the cutting through the use of sounding test equipment. Such equipment is readily available through local electrical companies and other sources. If a pipe or electrical circuit is damaged during cutting/demolition the Contractor shall repair the damaged item back to original condition. Absolutely no extras will be allowed for the replacement of damaged electrical conduits, pipes, etc. in floors walls, and ceilings.

1.15 EXCAVATION AND BACKFILL

A. Excavation

1. Excavation for conduits shall be of sufficient width to allow for proper jointing and alignment of the type conduit used. Conduit shall be bedded on original ground. Where conduit is in solid rock, a 6-inch earth cushion must be provided. Conduit shall be laid in straight lines between pull boxes and/or structures unless otherwise notes on the Contract Drawings. The cost of solid rock excavation shall be included in the lump sum bid with no extra pay allowed (unclassified).

B. Backfill

1. Backfill shall be hand placed, loose granular earth for a height of 6 inches above the top of the largest conduit. This material shall be free of rocks over ½ inches in diameter. Above this, large rocks may be included but must be mixed with sufficient earth to fill all voids.

1.16 SLEEVES, CHASES AND OPENINGS

A. Sleeves shall be required at all points where exposed conduits pass through new concrete walls, slabs, or masonry walls. Sleeves that must be installed below grade or where subject to high water conditions must be installed watertight.

C. It is the Contractor's responsibility to leave openings to allow installation of the complete, operational electrical system. Openings required but not left shall be cut as outlined under cutting and patching. The Contractor shall coordinate all holes and other openings with necessary diameters for proper firestopping.

1.17 POWER COMPANY COORDINATION

A. The Contractor is responsible for coordinating all activities onsite by the power company.

B. All power company metering equipment shall be electrically located "upstream" of any manual/automatic transfer equipment on projects requiring onsite emergency power generation equipment.

C. Any special provisions required by the serving electrical utility shall be as outlined on the Contract Drawings or as advised by the utility at the time of construction, and work required by these special provisions shall be executed with no extra cost to the Owner. Contractor.

1.18 TEMPORARY ELECTRICAL POWER

A. The Contractor shall be responsible for providing temporary electrical power as required during the course of construction and shall remove the temporary service equipment when no longer required. Temporary power is also addressed in Division 1.

1.19 OVERCURRENT PROTECTION

A. Circuit breakers or fused switches shall be the size and type as written herein and shown on the Contract Drawings. Any additional overcurrent protection required to maintain an equipment listing by an authority having jurisdiction shall be installed by the Contractor at no extra cost to the Owner.

B. The Contractor shall submit to the Engineer actual nameplate data from motors shipped to the site, stating motor identification as well as characteristics. Overload relay thermal unit selection tables shall accompany the motor data. The Engineer will select thermal unit sizes from this data for use by the Contractor in ordering proper thermal units.

1.20 TRAINING

A. All manufacturers supplying equipment for this division shall provide the Owner's operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer.

B. The cost of this training shall be included in the bid price.

C. The required training shall consist of both classroom and hands-on situation. Classroom training shall include instruction on how the equipment works, its relationship to all accessories and other related units, detailed review of shop drawings, detailed presentation of written O & M instructions, troubleshooting and record-keeping recommendations. Hands-on-training shall include a review of the manufacturer's O & M instructions, check out of each operator to identifying key elements of the equipment, tear down as appropriate, calibration, adjustment, greasing and oiling points, and operating manipulations of all electrical and mechanical controls.

D. The training shall be scheduled through the Contractor with the Owner. The timing of the training shall closely coincide with startup of the equipment, but no training shall be conducted until the equipment is operational.

E. The minimum number of hours to be provided by manufacturers supplying equipment on this project is described in the individual equipment specifications.

F. At least 60 days prior to the training the manufacturer shall submit through the Contractor to the Engineer an outline of the training proposed for the Engineer's review and concurrence.

G. The Owner reserves the right to videotape all training sessions.

1.21 RECORD DRAWINGS

A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these drawings, from day to day, the actual record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

1.22 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

A. Existing service(s) continuity shall be maintained at all times. In no way shall the installation and/or alteration of the electrical work interfere with or stop the normal operation of the existing facilities, except where prior arrangements have been made.

B. When additions and taps to existing service(s) require electrical outages of duration in excess of a few minutes, arrangements shall b made in advance for such outages. All outages shall be held to an acceptable minimum with none exceeding 8 hours continuous duration. If necessary, cuts shall be performed on premium time. If performed at night, requiring a general outage, the Contractor shall furnish an auxiliary source of light and power as required. Under no circumstances shall an electrical outage of any duration be initiated until the Owner and Engineer have concurred, and as far as possible in advance.

1.23 GROUNDING AND BONDING

A. All metallic conduit, cabinets, equipment, and service shall be grounded in accordance with the latest issue of the National Electrical Code. All supporting framework and other metal or metal clad equipment or materials which are in contact with electrical conduit, cable and/or enclosures, shall be properly grounded to meet the code requirements.

1.24 RELATED SPECIFICATION DIVISIONS

A. The following divisions contain Specifications on utilization equipment, equipment accessories, and procedures related to execution of the electrical work, and are included here for the Contractor's information. Bids shall still be based on complete Contract Documents.
Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract
Division 1 - General Requirements
Division 9 - Finishes
Division 11 - Equipment
Division 15 - Mechanical

1.25 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the Contractor. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per Power Company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the Contractor's

responsibility to contact the utility prior to bidding and obtain any special requirements or costs they will be imposing. Those costs shall be included in the bid.

C. On underground service entrances, the Contractor shall be responsible for furnishing and installing all secondary, and metering conduits, as well as secondary service/metering conductors. The Contractor shall also mount the meter base furnished by the power company.

1.26 CONTRACTOR LICENSING

A. The Contractor performing the electrical work on this project shall be a licensed Electrical Contractor in the Commonwealth of Kentucky.

1.27 ANCHORING/MOUNTING

A. Electrical conduits and/or equipment shall be rigidly supported. Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type. Plastic or explosive type anchors are prohibited.

1.28 ELECTRICAL COMPONENT MOUNTING HEIGHTS

A. Unless otherwise indicated, mounting height for components shall be as defined on the Drawings.

1.29 RECEIPTS

A. Some sections of the Specifications call for equipment, materials, accessories, etc. to be provided and "turned over to the Owner" or like requirements. The Contractor shall obtain a receipt for each item turned over, signed by the Owner or his representative. A copy of this receipt shall be transmitted to the Engineer.

B. When a question arises concerning whether items have been turned over to the Owner, and there is no signed receipt, it may be assumed that the items were not provided.

1.30 DEFINITIONS

A. Furnish – Procure equipment/materials and deliver and unload at the project site.

B. Install – Enter the equipment/materials permanently into the project and make operational.

C. Provide – Furnish and Install

PART 2: PRODUCTS

Not Applicable.

PART 3: EXECUTION

Not Applicable.

END OF SECTION

SECTION 16060

SECONDARY GROUNDING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Grounding shall be done in accordance with the NEC, as described in these Specifications, and as shown on the Contract Documents.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Grounding equipment shall be Cadweld, ITT Blackburn, ITT Weaver, Copperweld Bimetallics Group, Cathodic Engineering Equipment Co., or equal.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Grounding shall utilize a supplemental driven ground rod system in a bed to achieve the design ground resistance.

B. The ground system shall be continuous with all structures on a common ground. This can be accomplished by bonding all conduits together and bonding to the ground bus at each motor control center. Bonding jumpers shall be required at all pull boxes, and at all motor casings. A separate grounding conductor shall be pulled in all conduits in addition to wire counts shown on Drawings.

C. Ground rods shall be ¾ " x 10'-0" copper clad type. Where multiple rods are driven, they shall be separated by at least 10 feet to assure maximum effect.

D. Ground resistance between ground and absolute earth shall not exceed 5 ohms.

E. All grounding and grounding electrode systems shall be as required by the NEC as for types of electrodes utilized and sizing of grounding conductor to service equipment from the electrode system. These shall include footer rebar, buried metal water pipe, buried bare copper conductor, etc.

F. All grounding electrode system connections shall be made using exothermic welds, Cadweld, or equal. No splices are allowed in the grounding electrode conductor.

G. An insulated, isolated ground shall be run from the service entrance to panels serving computers.

H. Should ground rods be impractical for use due to rocky conditions, then grounding electrode plates may be used after acceptance by the Engineer on a case by case basis.

3.02 FIELD QUALITY CONTROL

A. Testing

1. The Contractor shall be required to provide all labor, tools, instruments, and materials as necessary to perform testing of the grounding electrode system. Results shall be submitted in writing to the Engineer. The testing shall be done to determine the effectiveness of the selected grounding scheme and to see that it conforms with resistance specified (5 ohms maximum).

2. The testing should be done using a fall-of-potential method test at the point of grounding electrode conductor connection to main power distribution equipment and at each separately derived system or MCC. The test shall be performed no sooner than 48 hours after a rainfall event.

3. The written report should contain the following information:

a. Type of ground scheme used, i.e., building steel, driven rod, mat, etc.

b. Type of instrument used.

(1) Manufacturer
(2) Model Number
(3) Confirm fall-of-potential test
(4)* Serial Number
(5)* Where instrument was obtained

* These 2 items are required so that the same instrument may be utilized should reproduction of the test be necessary due to unsatisfactory readings/instrument miscalibration.

c. Ground resistance readings obtained at various test distances.

d. Ground resistance/distance curve.

e. Value of Grounding Electrode Resistance at knee of curve.

f. Sketch showing setup of instrumentation and location of grounding electrode and test probes.

g. Proposed method to achieve the specified resistance, should an unacceptable reading be obtained.

h. Ground resistance readings obtained (if applicable) after modifications incorporated.

3.03 GROUND ENHANCEMENT MATERIAL

A. Where indicated on the Drawings or as deemed necessary by the Contractor to achieve design grounding electrode system resistance, a ground enhancement material shall be utilized, in accordance with manufacturer's recommendations.

B. The ground enhancement material must be permanent and maintenance free (no recharging with salts or chemicals which may be corrosive) and maintain its earth resistance for the life of the system. It must set up firmly and not dissolve or decompose, or otherwise pollute the soil or local water table. The material shall be capable of being applied dry or in a slurry form, and shall reduce resistance by at least 40 percent.

C. Basic components of this material shall be carbon, hydraulic cements, and hydrous aluminum silicates. Minimum 4-inch diameter holes shall be used with ground rod installations, with depth 6" shorter than length of rod, completely filled with the material. Trenches for grounding electrode conductor shall also utilize this material the full length from electrode to building, in accordance with manufacturer installation recommendations, except trench depth shall allow buried conductor to be at least 2'-6" deep.

D. Ground enhancement material shall be GEM by Erico Products, Powerfill by Cathodic Engineering Equipment Company, or equal.

END OF SECTION

SECTION 16070

SUPPORTING DEVICES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. All electric equipment shall be rigidly mounted, and installed using supporting devices as indicated on the Contract Drawings, as required by the work, and described herein.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Kindorf," "Unistrut," or equal.

2.02 MATERIALS

A. All mounting brackets and strut used outside shall be aluminum or stainless steel. Fasteners used to mount equipment outside shall be stainless steel. The only exception to the above shall be anchor bolts for area lightpoles which shall be allowed to have galvanized threads and galvanized nuts.

B. All mounting brackets and strut used inside shall be aluminum or stainless steel. Fasteners used inside to mount equipment into concrete shall be stainless steel.

PART 3: EXECUTION

3.01 ANCHORING CABINETRY

A. All free standing equipment shall be anchored to its foundation using expansion bolts of the size and number recommended by the equipment manufacturer.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1: GENERAL

1.01 EQUIPMENT LABELING

A. All starters, feeder units in panelboards, disconnects, instruments, etc. shall be marked to indicate the motor, outlet, or circuit they control. Marking is to be done with engraved laminated nameplates and shall bear the designation shown on the Contract Drawings where this information is given. Nameplates shall be fastened to equipment with stainless steel screws, minimum of one each side. In no way shall the installation of mounting screws void the NEMA enclosure rating of the equipment in which they are installed. Nameplate background color shall be white, with black engraved letters, unless otherwise noted.

B. Branch circuits in lighting panels shall be typed on a card suitable for the card frame furnished with the panel. The card shall bear the panel designation listed on the Contract Drawings where this information is given, as well as indicate what each circuit controls. The Contractor shall retype new cards for all existing panelboards modified.

C. Individual wall mounted starters, panelboards, and disconnect switches shall be labeled with vinyl self-adhesive signs that warn of “High Voltage” (state the specific voltage). The type of labels to be used shall have orange as the basic color to conform with OSHA requirements, letters shall be black. The labels shall be of proper size to fit flatly on the surface of the enclosure to make for a neat appearance and not interfere with the operating function of the device it is attached to. These labels shall be as manufactured by the Brady Identification Systems Division, Safety Sign Company, Westline Products Company, or equal.

D. Submersible pumps shall be furnished with a spare nameplate which shall be installed inside the MCC or starter enclosure.

PART 2: PRODUCTS

Not applicable

PART 3: EXECUTION

Not applicable

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. All wire and cable shall conform to the latest requirements of the NEC and shall meet all ASTM/UL specifications. Wire and cable shall be new; shall have size, grade of insulation, voltage rating and manufacturer's name permanently marked on the outer covering at regular intervals. Complete descriptive literature shall be submitted to the Engineer for review and acceptance prior to installation.

B. Building wire #12 - #1 shall be applied based on a 60 degree Celsius temperature rise. Building wire larger than #1 may be applied at its 75 degree Celsius temperature rise.

1.02 DELIVERY, STORAGE AND HANDLING

A. Wire and cable shall be suitably protected from weather and damage during storage and handling and shall be in first class condition when installed.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Building Wire (types "THWN" and "THW"-cu.) - "Collyer," "Rome," "American," "Carol," or equal.

B. Flexible Cords and Cables (Types "SO" (600V) "SJO" - 300V) "Collyer," "American," "Carol," or equal.

C. Control Cables (Shielded or unshielded) 600V max. - "Belden," "Eaton-Dekoron," "Okonite," or equal.

D. Instrumentation Cables (Shielded) 600V mx. - "Eaton-Dekoron," "Manhatton," "American," "Belden," "Okonite," or equal.

2.02 MATERIALS

A. General

1. In general, all conductors shall be 98 percent conductive, annealed copper unless otherwise noted on the Contract Drawings.

2. Conductors shall be type THW or THWN insulation. Conductor size shall be AWG (American Wire Gauge) Standard. Minimum conductor size shall be AWG number 12 except branch circuits in excess of 75 feet from panel to first outlet not smaller than no. 10 AWG. Minimum voltage rating shall be 600 volts. Conductors for small power may be solid (i.e. lighting, receptacles), but conductors for control work shall be stranded.

3. Conductors with high temperature rated insulations and special construction shall be used where required in connecting to light fixtures or appliances that have special requirements.

4. Telephone cables shall be as specified in this division, Section: Telecommunications.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General

1. Conductors shall be continuous from outlet to outlet and no splices shall be made except accessible in junction or outlet boxes. Wire connectors of insulating material or solderless pressure connectors, properly taped, shall be used for all splices in wiring, wherever possible.

2. Conductors shall be color coded in accordance with the following schedule:

	480/227V 3 Phase	208/240V 3 Phase	120/240, Single Phase
Phase A	Brown	Black	Black
Phase B	Orange	Red	Red
Phase C	Yellow	Blue	
Neutral (Grounded)	White or Light Gray	White or Light Gray	White or Light Gray
3-Way Tracers			Blue
Grounding	Green	Green	Green
Remote Energized			

Conductors (Control)			Yellow
Control	Std. Code	Std. Code	

3. Conductors shall be pulled into raceways in strict accordance with manufacturer's recommendations.

4. Ample slack conductors shall be allowed at each terminal point, and pull or junction box, to permit installation with ease and without crowding.

5. All conductors terminating at terminal blocks shall be identified with numbers and/or letters identical to circuit or control identification.

6. No conductors shall be drawn into conduits until all work which may cause wire or cable damage is completed. Wire pulling shall be accomplished utilizing machinery and accessories intended for the purpose.

7. All connections and splices shall be made in accordance with conductor manufacturer's recommendations, and as written herein.

8. If the size and number of conductors in a conduit on the Drawings is not shown, then contact the Engineer at least 10 days prior to bid opening.

B. Feeders

1. All feeders are of the secondary type, below 600 volts, unless otherwise noted. Secondary feeder voltage shall be 480 volt, or 208 volt as noted in the Contract Drawings. Three phase, 4 wire for power and 208/120 volt, 3 phase, 4 wire for general lighting, unless otherwise noted. The Contractor shall furnish and install all feeders from the distribution center(s) to each of the other structures/subpanels as shown on the Contract Drawings.

2. Wire shall be factory color-coded for each phase and neutral, with green used for the ground conductor. As far as practical, all feeders shall be continuous from origin to panel termination without running splices in intermediate pull boxes.

C. Control Cable

1. Control cable shall be the size and have the number of conductors shown on the control system drawings. Control cable shall be used for motor controls and monitoring only. Color-coding shall be ICEA, Method 1. Control cables between buildings shall be underground in conduit of the size shown in the control system schematic. Cabling shall provide a minimum of 25 percent spare conductors. Voltage rating shall be 600 volts.

D. Instrument Cable

1. General

   a. All signal lines should be constructed of individually twisted pairs (6 to 10 twists per foot), including thermocouple extension leads. Cables should be made of twisted pairs, with all lays and pairs twisted in the same direction for maximum flexibility.

   b. Wire size is #16 AWG minimum for single pair runs under 5,000 feet in length. Wire size shall be #16 - #20 AWG for multi-pair cable runs under 5,000 feet in length.

   c. Stranded tinned copper conductor shall be used for all wiring other than thermocouple extension leads.

   d. Insulation resistance at 68 degrees Fahrenheit between conductors and between conductors and ground should be at least 500 megohms per 1,000 feet.

   e. Multi-pair cable should be jacketed with poly-vinyl-chloride, polyethylene or Teflon at least 0.045" thick. Voltage rating shall be 600 volts.

2. Signal Wiring

   a. Low level analog (less than 500 millivolt d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels. Foil wraps or equivalent shielding is required for each cable with the shield insulated from ground.

   b. High level analog (greater than 500 millivolts d-c). Use twisted pairs which may be cabled with other pairs carrying similar voltage levels and current levels less than 100 ma. Shielding is required.

   c. Analog outputs (normally 0-4 d-c or 4-20 ma). Same as b.

   d. Contact inputs - use twisted pairs and run in separate conduit.

   e. Contact outputs - same as d.

   f. Pulse inputs - same as d.

3. Signal and Shield Grounding

   a. All shields must be grounded at one point only as close as possible to the signal source.

   b. Analog signals, if grounded, should be grounded as near the signal source as possible.

4. Signal and Wiring Separation

a. High level analog signals may share the same conduit or run with contact or pulse signals.

b. Thermocouple and low level signals should be run in a separate conduit.

c. A minimum separation of 12 inches between analog signal leads and a-c power leads should be maintained. For a-c power leads carrying 100 amps or greater, a 24 inch separation should be maintained. Parallel runs should be limited to less than 500 feet. Perpendicular runs may be as close as 6 inches.

E. Submersible pump Power Cable

1. Power cables for submersible pumps shall be of the extra hard usage type suitable for submerged duty and able to withstand common corrosive agents found in water and wastewater. They shall be provided with high grade non-magnetic stainless steel relief cable grips installed at the pump end and high grade non-magnetic stainless steel support cable grips anchored to the wet well structure where they enter the wet well. The strain relief and support cable grips shall be as manufactured by Kellems, Slater/Flexcor, or equal. Non-metallic corrosion resistant grips may be used in lieu of stainless steel if available for the cable size.

END OF SECTION

SECTION 16130

RACEWAYS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This section of the Technical Specifications includes all raceways for accommodation of electrical conductors, communications conductors, sleeves for underground electrical installations, conduit stubs for future installations, fittings therefor and accessories.

B. All raceways shall be marked with the manufacturer's name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved. All raceways shall be furnished and installed as outlined under Part 3 of this Specification.

C. All raceways and fittings shall be painted to match existing or surrounding surfaces except in mechanical spaces.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Tubular Raceways

1. Steel, Galvanized, Rigid, Heavy-Wall, Threaded - "Wheatland Tube Co.," "Triangle," "Allied Tube & Conduit Corp.," or equal.

2. Steel, Galvanized, Thin-Wall, Electric-Metallic-Tubing (EMT) - "VAW," "Triangle," "Allied Tube & Conduit Corp," or equal.

3. Aluminum, Rigid, Heavy-Wall, Threaded - "VAW," "Alcoa," "Reynolds," or equal.

4. Plastic (PVC); Type 80 (or Schedule 80) (Heavy -Wall) - "Robin-Tech," "Carlon," or equal.

5. Liquidtight Flexible Metal Conduit - "Carol Cable Co., Inc.," "Superflex," "OZ Gedney," or equal.

6. Factory Coated Aluminum Conduit - Alumax "ALX-1", or equal.

B. Wireways

1. "Square-D," "Hoffman," or equal.

C. Raceway Fittings

1. Conduit fittings - “Crouse-Hinds,” “Appleton,” “OZ Gedney,” or equal.

2. Non-metallic conduit fittings - “Robin-Tech,” “Carlon,” “Scepter,” or equal.

2.02 MATERIALS

A. Aluminum Conduit

1. Aluminum conduit shall be extruded from alloy 6063 and shall be the rigid type, non-toxic, corrosion resistant, and non-staining. It shall be manufactured per UL standards as well as listed/labeled by same.

2. Fittings, boxes, and accessories used in conjunction with aluminum conduit shall be die cast, copper free type. They shall be resistant to both chemical and galvanic corrosion. All covers shall have neoprene gaskets.

3. Aluminum conduit proposed for concrete slab or underground applications shall be UL listed for the purpose and factory pre-coated.

B. Rigid Steel Conduit

1. Rigid steel conduit and fittings shall be of mild steel piping, galvanized inside and out, and shall conform to UL standards. The conduit and fittings hall be listed and labeled by UL as well. The galvanized coating of zinc shall be of uniform thickness applied by the hot-dipped process, and shall be applied also to the threads. It shall be further dipped in a chromic acid bath so as to chemically form a corrosion resistant protective coating of zinc chromate which has a characteristic yellow-green color. Each piece of conduit shall be straight, free from blisters and other defects, cut square, and taper reamed. It shall be delivered with plastic protectors on the threads.

C. Polyvinychloride (PVC) Conduit

1. PVC conduit and fittings shall be Schedule 80 heavy wall, as indicated in these Specifications manufactured to conform to UL standards. It shall be listed and labeled by UL. It shall have at least the same temperature rating as the conductor insulation. Expansion joints shall be used as recommended by the manufacturer in published literature. PVC systems shall be 90 degrees Celsius minimum UL rated, have a tensile strength of 7,000 psi @ 73.4 degrees Fahrenheit, flexural strength of 11,000 psi and compressive strength of 8,000 psi.

G. Conduit Fittings

1. Rigid Steel Conduit Fittings

   a. Standard threaded couplings, locknuts, bushings, and elbows made only of steel or malleable iron are acceptable.

   b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

   c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.

   d. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted or use to complete a conduit run where conduit is installed in concrete. Use set screws of case hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

   e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, installed fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.

2. Rigid Aluminum Conduit Fittings

   a. Standard threaded couplings, locknuts, bushings, and elbows: Malleable iron, steel or aluminum alloy materials. Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.

   b. Locknuts and bushings: As specified for rigid steel conduit.

   c. Set screw fittings: Not permitted for use with aluminum conduit.

4. Expansion and Deflection Couplings

   a. Accommodate 1.9 cm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

   b. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL, and the NEC code tables for ground conductors.

   c. Watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.

d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material and stainless steel jacket clamps.

PART 3: EXECUTION

3.01 PREPARATION

A. Exterior underground metallic conduits shall be degreased, pretreated, and coated with 2 coats of Carboline 888 epoxy, or equal. Other finishes may be acceptable upon the Engineer's review.

3.02 INSTALLATION

A. Conduit

1. All conduit shall be installed in a first class workmanship manner. It shall be installed in horizontal and vertical runs in such a manner as to ensure against trouble from the collection of trapped condensation and shall be arranged so as to be devoid of traps wherever possible. Special care shall be used in assuring that exposed conduit runs are parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. No open wiring is allowed.

2. Fittings or symmetrical bends shall be required wherever right angle turns are made in exposed work. Bends and offsets shall be avoided wherever possible, but where necessary, they shall be made with an approved conduit bending machine. All conduit joints shall be cut square, reamed smooth and drawn up tight, using couplings intended for the purpose.

3. Conduits shall be securely fastened to all sheet metal outlets, junction and pull boxes with double galvanized locknuts and insulating-grounding bushings as required by the NEC. Conduit crossings in insulating roof fill will require both conduits to be secured to the roof deck, and these crossings can only be made where the insulating fill is a minimum of 3 inches deep. Runs of exposed conduit shall be supported in accordance with the NEC using cast aluminum or malleable iron one hole pipe straps with spacers to provide an air space behind the conduit. Stainless steel minerallaac, one piece conduit clamps shall be acceptable where located such that building occupants are not in danger of inadvertent contact, since this type fitting has several sharp edges. In general terms, they may be considered in areas such as on or above ceilings, or high on walls. All conduit in walls and slabs shall be securely braced, capped (wooden plugs are prohibited), and fastened to the forms to prevent dislodgement during vibration and pouring of concrete.

4. During construction, all conduit work shall be protected to prevent lodgement of dirt, plaster or trash in conduits, fittings or boxes. Conduits which have been plugged shall be entirely freed of accumulations or be replaced. All conduits in floors or below

grade shall be swabbed free of debris and moisture before wires are pulled. Crushed or deformed conduit shall not be permitted.

5. All open conduit work through new walls or slabs shall be run through sleeves that shall be made watertight. These sleeves shall be PVC of suitable diameter to permit the passage of the conduit used.

6. Where GRS conduit penetrates a floor slab the conduit shall be painted with 2 coats of Koppers Bitumastic 300-M or equal to a point 6 inches above the penetration.

7. The final section of conduit connecting each motor or piece of utilization equipment subject to vibration shall be of the flexible type. Type "UA" shall be used in all process areas and in outdoor or wet locations. Flexible conduit to space heaters shall be long enough to allow swivel action.

8. All underground conduits entering a building shall be sealed against water/condensate entering around the conductors. Sealant may be silicone rubber based caulk.

9. In certain situations, conduit expansion joints shall be required to ensure against conduit and/or cable damage due to settling or thermal expansion and contraction. These expansion joints shall be required where required by the manufacturer or the Contract Drawings and shall be installed per manufacturer instructions.

10. All conduit work in the finished space of each new structure shall be concealed except for conduits to lighting fixtures in buildings with precast roof slabs, or excepted as noted on the Contract Drawings. All conduit work below ground floor level in each structure shall be exposed. Conduits entering from underground into buildings shall be watertight through the wall, both inside and outside.

11. PVC conduit installed underground for low voltage application shall be schedule 80 without encasement, except service entrance conduits shall be schedule 40 PVC, thin wall PVC, or Fibre Duct, and shall be concrete encased. Where PVC conduit is installed, transition shall be made to GRS conduit at bends where wire pulling could cut conduit.

12. Aluminum conduit shall not be used underground or placed in concrete slabs, unless it is UL listed for the purpose and factory pre-coated.

13. Conduit stubs, for future use, extended through outside walls shall be capped with threaded pipe caps and coated to prevent corrosion. Stubs shall extend 5 feet beyond the walls from which they are stubbed unless otherwise indicated on the Contract Drawings.

14. All metal raceway systems shall be grounding conductive, solidly bonded throughout and grounded in accordance with NEC requirements and/or as noted on the Contract Drawings. In addition, all raceway systems shall be provided with separate grounding conductors.

15. Minimum conduit size shall be 3/4 inch. The following table shows the minimum burial depth required for all exterior conduit or cable:

Rigid Metal Conduit	24"
Schedule 80 PVC	30"

16. Wire pulling shall be facilitated by the use of a UL approved pulling compound in pulls over 30 feet in length or where there are 2 or more 90 degree bends. Only polypropylene, nylon, or manila pulling ropes will be permitted. Standard industry recognized wire pulling equipment shall be used.

17. All conduits entering and leaving instrument enclosures shall be sealed around the wires with silicone caulk.

18. All conduits for emergency lighting systems shall be separate from other building power conduits.

19. Areas of use for each type of conduit:

Buildings - Interior	Schedule 80 PVC	GRS	Aluminum
Process Building Floors Below Grade (Exposed Only)		X	X
Process Building Floors Above Grade (Exposed)		X	X
Process Building Floors Above Grade (Concealed)	X	X	X
Non Process Building Floors Below Grade (Exposed)		X	X
Non Process Building Floors Above Grade (Exposed)			X
Non Process Building Floors Above Grade (Concealed)	X	X	X
Non Process Building Floors Below Grade (Concealed)	X	X	X
<u>Exterior Underground</u>			
Low Voltage	X	X	X**
<u>Exterior Exposed</u>			
Low Voltage			X

**Aluminum conduit for this application must be factory pre-coated and UL listed for the application.

20. Underground raceways (conduit) shall be provided with steel sleeves where they pass over or under obstructions, such as: sidewalks; roadways; piping; etc.

21. All conduit shall have an insulated ground wire pulled to all equipment and receptacles.

23. All raceway runs are shown diagrammatically to outline the general routing of the raceway. The installation shall be made to avoid interference with pipes, ducts, structural members or other equipment. Should structural or other interference prevent the installation of the raceways, or setting of boxes, cabinets, or the electrical equipment, as indicated in the Drawings, deviations must be approved by the Owner, and after approval, shall be made without additional charges and shown on the Record Drawings.

24. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

25. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

26. No conduit shall be run exposed across roofs without first obtaining permission from the Engineer.

27. Conduit may be run inside concrete slabs as long as the slab is at least 6-inches thick and conduit will have at least 1 ½-inches of cover on both sides.

28. No conduit shall be run exposed across floors.

END OF SECTION

SECTION 16131

BOXES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Outlet and junction boxes shall be furnished and installed where indicated on the Contract Drawings, and\or as required by the work in accordance with the NEC.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Boxes - “Queen,” “Wiegmann,” “Appleton,” “Raco,” “Bauers,” “Crouse-Hinds,” “Hoffman,” “Robroy Industries,” “Cloud Concrete Products,” “Spring City,” “Carlon,” “Sedco,” or equal.

2.02 GENERAL

A. All junction and/or pull boxes for dry (non-corrosive) areas shall be of code gauge sheet metal construction, of the inside dimensions as required by code, with covers.

B. Junction and/or pull boxes for wet or damp locations shall be cast metal, rust and corrosion resistant, NEMA 4X, with at least 5 ½ full threads for each (bossed) conduit opening, and shall be suitable for flush or surface mounting as required with drilled external, cast mounting extensions (bossed to provide at least 1/8" between back of box and mounting surface for drainage). Box covers shall be hinged or cap screw retained as required, of the same material as the box and provided with stainless steel (rustproof) hardware.

C. Junction boxes for out-of-doors use, not mounted in concrete may be sheet metal NEMA 4X, waterproof, rustproof, rain and sleetproof, with hinged covers and latches and provided means of locking by means of keyed locks, tamper-resistant screws or padlocking as required and with clamping cap-screws top and bottom door edges to provide firm contact with gasketing. All gaskets shall be molded (unbroken) neoprene or butyl rubber.

D. NEMA 4X junction and/or pull boxes may be stainless steel, if called for on the Contract Drawings; or non-metallic or cast aluminum.

E. Underground junction or pull boxes or handholes shall be constructed of reinforced concrete cast-in-place or pre-fabricated as detailed on the Contract Drawings. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength

established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48/A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Pullbox and handhole covers in sidewalks and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

F. Junction boxes for use in wet-wells and other hazardous areas shall be watertight, rustproof and corrosion resistant, and explosionproof with threaded conduit openings (5 ½ full threads - minimum) and provided with rustproof hardware.

G. Explosionproof sealing fittings shall be furnished and installed in accordance with NEC requirements.

PART 3: EXECUTION

3.01 INSTALLATION, APPLICATION, AND ERECTION

A. General

1. Outlets shall be installed in the locations shown on the Contract Drawings. The Contractor shall study the general building plans in relation to the space surrounding each outlet, in order that his work may fit the other work required by these Specifications. When necessary, the Contractor shall relocate outlets so that when fixtures or other fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment.

2. All supports for outlet boxes shall be furnished and installed by the electrical trades.

B. Concealed Work

1. All outlet boxes shall be standard galvanized steel type at least 1½ inches deep, single or gang type of size to accommodate devices shown. Exceptions shall be noted on the Contract Drawings.

2. Standard deep type outlet boxes (concrete rings with appropriate covers) shall be used in floor slab construction so concealed conduits entering sides of boxes can clear reinforcing rods.

3. Outlet boxes for concealed telephone and signaling systems shall be the 4-inch square type, unless otherwise noted or required by the telephone company.

4. Boxes for use in masonry construction shall be 2½ inches deep for 4-inch block and 3½ inches deep for 6- and 8-inch block. Through wall boxes are prohibited for outlets opposite each other.

C. Exposed Work

1. Outlet or junction boxes for use with exposed steel conduit shall be cast steel. In dry areas sheet steel with rounded corners, made for the purpose.

2. Outlet or junction boxes for use with exposed aluminum conduit shall be copper free, cast aluminum type.

3. Outlet or junction boxes for use with exposed PVC conduit shall be PVC.

D. Interior Pull Boxes

1. Interior pull boxes are not shown but shall be used as needed. Pull box types are as follows:

a. Interior pull boxes in dry areas shall be of code gauge steel of not less than the minimum required by the NEC and shall be provided with hinged covers.
b. In wet areas or process areas, they shall be rated watertight, of stainless steel, cast aluminum, PVC, fiberglass, or equal. Hardware shall be stainless steel.

E. Manholes, Handholes, and Pullboxes - Exterior Underground

1. General

a. Manholes, handholes, and pull boxes for exterior underground work are shown on the Contract Drawings and are the minimum number required. Others may be added at the Contractor's option, but no extra pay shall be allowed. See detail on the Contract Drawings.

b. Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of manholes that are not indicated on the drawings shall be approved by the Engineer prior to construction. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved

areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

2. Electric Manholes

   a. Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

3. Communications/Data/Instrumentation Manholes

   a. The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each manhole. Each cable rack shall be provided with 2 cable hooks.

4. Handholes

   a. Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

5. Pullboxes

   a. Pullbox tops shall be flush with sidewalks or curbs or placed 1/2 inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage," “Communications,” or “Instrumentation” as applicable and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod.

Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

6. Ground Rods

a. A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

F. Openings in Electrical Boxes

1. All openings in electrical equipment, enclosures, cabinets, outlet and junction boxes shall be by means of welded bosses, standard knockouts, or shall be sawed, drilled, or punched with tools specially made for the purpose. The use of a cutting torch is prohibited. Unused openings shall be plugged per the NEC.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Wiring devices shall be installed where indicated on the Contract Drawings.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Hubbell," "Bryant," "Eagle," "General Electric," "Wiremold," "P&S," "Leviton," "Daniel Woodhead," or equal.

2.02 EQUIPMENT

A. General

1. Ranges, sump pumps, and air conditioners shall be equipped with the proper cord and plug for receptacles.

2. Switch and receptacles for sump pump motors shall be rated at 20 amps at 125 volts and shall be equipped with a manual motor starting switch in lieu of toggle switch, as specified elsewhere this division.

B. Receptacles

1. Twin-convenience - outlet (interior) - "Hubbell" cat. no. 5362, or equal.

2. Twin-convenience - outlet (exterior) - "Hubbell" cat. no. 5362 with Taymac Corporation or Intermatic, Inc. safety outlet enclosure.

3. Single-convenience - outlet (pole mounted) - "Hubbell" cat. no. 53CM61, or equal.

4 Special purpose outlet - Per equipment requirements.

5 Isolated ground twin - convenience - outlet - "Pass & Seymour" catalog number IG6300I with Isolated Ground symbol and Ivory faceplate, or equal.

6 Single receptacle for sump pump - 20A/125 VAC - “Hubbell” cat. no. 2310, or equal.

7 Ground fault interrupting receptacles shall be required where shown on the Contract Drawings, and shall be indicated by the abbreviation “GFI” beside the circuit symbol on the Contract Drawings. They shall be rated 20 amps (125 volts) and shall be of the duplex, feed through type, capable of protecting all downstream receptacles on the same circuit. They shall be UL listed and interrupt the current between 4-6 milliamps of ground fault leakage. Appropriate plates shall be furnished and installed. The 20 ampere rating shall apply not only to device internals but to the faceplate as well.

C. Plates and Covers

1. Furnish and install plates of the appropriate type and size for all wiring and control devices, signal and telephone outlets.

2. All plates on surface mounted boxes shall be of 302 stainless steel (nonmagnetic) with rounded or beveled edges, except in pump rooms and other NEMA 4X areas, then weatherproof covers shall be installed. All device plate stainless steel with countersunk heads. Plates shall be installed vertically and with an alignment tolerance of 1/16 inch. Device plates shall be of the one-piece type, of suitable shape for the devices to be covered. Plates shall have a smooth finish with no crevices to collect dirt. Oversize plates are not acceptable.

3. Covers for boxes serving equipment where flexible conduit is to be tapped into cover plates shall be sheet metal drilled for conduit. Gaskets shall be required as well as all special adapters for mounting.

D. Wall Switches (Tumbler Type)

1. Single pole (interior) - “Hubbell” cat. no. 1221, or equal.

2. Single pole (exterior) - “Hubbell” cat. no. 1222-gray, or equal, and Bryant 7420 or equal plate.

3. 3-way switches (interior) - “Hubbell” cat. no. 1223, or equal.

4. Double-pole (interior) - “Hubbell” cat. no. 1222, or equal.

5. 4-way switches (interior) - “Hubbell” cat. no. 1224, or equal.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Wall Switches

1. Wall switches shall be mounted at a height as indicated on The Drawings, unless otherwise noted on the Contract Drawings.

B. Receptacles

1. Outlets shall be located as shown on the Contract Drawings. Where located in special interior finishes, they shall be properly centered. Boxes shall be of the type noted and accepted for the specific installation.

2. Furnish and install receptacle circuits where called for on the Contract Drawings and/or by these Specifications. Circuits shall be installed in conduit from panel to receptacle, with flush mounted boxes except as noted on the Contract Drawings.

3. Receptacles and lighting circuits shall not be combined on the same overcurrent device. For runs over 75 feet or for 30 amp receptacles, minimum wire size shall be AWG No. 10.

4. Receptacles for specific devices (i.e., air conditioner), shall be rated at the correct voltage and amperage for that unit.

5. The minimum free length of conductor at each box for the connection of a fixture, switch or receptacle shall be 8 inches. All connections shall be made mechanically and electrically secure.

6. Receptacles shall be duplex type, rated at 20 amps, 125 volts, ivory (brown) colored, unless otherwise noted. Mounting height shall be as specified for low outlets on the Contract Drawings, except in pump rooms subject to floods, where they shall be medium height. All receptacles shall be of the grounding type.

7. Receptacles over workbenches or countertops or at medium or high mountings shall be mounted so that the grounding slot is below the neutral and hot. All other receptacles shall be mounted with the grounding slot above the neutral and hot.

8. Weatherproof receptacles, shall be weatherproof while in use. This requirement shall apply on all outdoor units and on others as indicated on the Drawings. To meet this requirement, appropriate safety outlet covers as manufactured by Taymac Corporation, Intermatic Guardian Series, or equal shall be utilized in these areas.

END OF SECTION

SECTION 16150

WIRE CONNECTIONS AND CONNECTING DEVICES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Wire connection and connecting devices shall be as herein specified.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Connectors, Lugs, etc. - “T & B”, “Anderson”, “Burndy”, or equal.

B. Ties and Servings - “T & B”, “Panduit”, or equal.

C. Termination and splice connectors - “3M Scotchlok”, “Anderson”, “T & B”, “Burndy”, or equal.

2.02 MATERIALS

A. Wire Splicing and Terminations (600 Volts and Below)

1. Electrical Terminal and Splice Connectors (#22 - #4 AWG)

a. Terminals and splice connectors from #22 - #4 AWG shall be compression types with barrels to provide maximum conductor contact and tensile strength. Performance, construction, and materials shall be in conformance with UL standards for wire connectors and rated for 600 volts and 105 degrees Celsius.

b. Connectors shall be manufactured from high conductivity copper and entirely tin-plated. Terminal barrels shall be serrated on the inside surface and have a chamfered conductor entry. Terminals shall have funnel entry construction to prevent strand fold-back. All barrels shall be brazed seam or seamless construction.

c. Spade type terminals shall be sized for the appropriate stud and shall be locking type that snap firmly onto studs with a close fit for maximum retention. Spade type terminals shall be insulated with an insulation

suitable for maintaining a high dielectric strength when crimped and be made form nylon, PVC, or equal.

2. Electrical Lugs and Connectors (#6 AWG - 1000 Kcmil)

   a. Lugs and splice connectors from #6 AWG - 1000 Kcmil shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper and entirely tin plated. They shall be crimped with standard industry tooling. The lugs and connectors must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above 4/0 AWG shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

3. Twist-on Wire Connectors (#22 AWG - #10 AWG)

   a. All twist-on wire connectors must have a corrosion resistant spring that is free to expand within a steel jacket. The steel jacket must be insulated with a flexible vinyl jacket capable of withstanding 105 degrees Celsius ambient temperatures and of sufficient length to cover wires that are inadvertently overstripped.

   b. Each connector size must be listed by UL for the intended purpose and color coded to assure that the proper size is used on the wire combinations to be spliced. The connectors must be compatible with all common rubber and thermoplastic wire insulations.

4. Solderless/re-usable lugs shall be used only when furnished with equipment such as control panels, furnished by others, where specification of compression type lugs is beyond the Contractor's control. In the event their use is necessary, the Contractor shall be responsible for assuring that they are manufactured to NEMA standards, with proper number and spacing of holes and set screws.

PART 3: EXECUTION

3.01 INSTALLATION, APPLICATION, & ERECTION

A. Insulation of Splices and Connections

1. Connections/splices with a smooth even contour shall be insulated with a conformable 7 mil thick vinyl plastic insulating tape which can be applied under all weather conditions and is designed to perform in a continuous temperature

environment up to 105 degrees Celsius. The tape shall have excellent resistance to abrasion, moisture, alkalies, acids, corrosion, and varying weather conditions (including sunlight). The tape shall be equal to Scotch 33+ and shall be applied in conformance with manufacturer's recommendations. In addition, it shall be applied in successive half-lapped layers with sufficient tension to reduce its width to 5/8 of its original width. The last inch of the wrap shall not be stretched.

2. Connections/splices with irregular shapes or sharp edges protruding shall be first wrapped with 30 mil rubber tape to smooth the contour of the joint before being insulated with 33+ insulating tape specified in the previous paragraph. The rubber tape shall be high voltage (69 KV) corona-resistant based on self-fusing ethylene propylene rubber and be capable of operation at 130 degrees Celsius under emergency conditions. The tape must be capable of being applied in either the stretched or unstretched condition without any loss in either physical or electrical properties. The tape must not split, crack, slip, or flag when exposed to various environments. The tape must be compatible with all synthetic cable insulations. The tape must have a dissipation factor of less than 5 percent at 130 degrees Celsius, be non-vulcanizing, and have a shelf life of a least 5 years. The rubber tape shall be applied in successive, half-lapped wound layers and shall be highly elongated to eliminate voids. Other manufacturer's recommendations on installation shall be adhered to. The rubber tape shall be equal to Scotch 23 or 130C electrical splicing tape.

3. Splices made in wet or damp locations shall be made submersible and watertight with special kits made for the application and compatible with type of cables employed.

B. Connection Make-up

1. Connections of lugs to bus bars, etc., shall be made up with corrosion resistant steel bolts having non-magnetic properties with matching nuts, and shall utilize a Belleville spring washer (stainless steel) to maintain connection integrity. Connections shall be torqued to the proper limits. Prior to bolting up the connection, electrical joint compound shall be brushed on the contact faces of the electrical joint.

2. All motor lead connections shall be made up to match the type of lead furnished on the motor. If the lead is not lugged, then twist-on wire connectors may be used. To prevent possible vibration problems, twist-on connectors shall be taped after installation.

3. All lugged motor lead connections (excluding motors over 200 horse-power) shall be made up using ring tongue compression lugs with proper size stainless steel nuts and bolts. Belleville type spring shall be used to maintain tension on the connections. The connections shall then be insulated using the procedure described for irregular shapes, utilizing rubber tape in conjunction with vinyl electrical tape.

4. At the time of final inspection, the Engineer may request the Contractor to disassemble 3 randomly selected motor lead connections in the Engineer's presence, to assure conformance with these Specifications.

5. The Contractor shall include all necessary tools, materials, and labor in his bid for disassembly of the connections and for remaking them with new insulating materials after inspection.

END OF SECTION

SECTION 16220

MOTORS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Motors are to be furnished with driven equipment except where otherwise noted on the Contract Drawings or elsewhere in this Division of the Specifications. All motors shall conform to the following Specifications and any special requirements of the driven equipment. Special requirements of the driven equipment shall take precedence over these Specifications should a discrepancy occur. Starting torque and slip ratings shall conform to the requirements of the driven equipment. All motors 15 horsepower and larger (230 volt) or 25 horsepower and larger (480 volt) shall be started via solid state reduced voltage starters unless otherwise noted on the Contract Drawings.

B. Polyphase motors shall be of the squirrel cage induction type and single phase of the capacitor start-induction run type except as otherwise noted. Conduit boxes shall be tapped for the size conduit shown on the Contract Drawings.

C. All motors shall be manufactured and installed in accordance with applicable NEMA standards and NEC provisions, latest revisions.

1.02 DELIVERY, STORAGE, & HANDLING

A. All electrical motors shall be protected against the accumulation of moisture, dust and debris and physical damage during the course of installation of the job.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Motors - “General Electric”, “Westinghouse”, “U.S. Motors”, “Gould Century”, “Lincoln”, “Baldor”, “Marathon”, “Reliance”, “Magnatek”, “Siemens”, or equal.

2.02 EQUIPMENT

A. Motors 200 Horsepower and Under for Service Under 600 Volts

1. Ratings and Electrical Characteristics

a. Time: All motors shall be rated for continuous duty.

b. Temperature: Based on NEMA standards for a maximum ambient temperature of 40 degrees Celsius and an altitude of 3,300 feet or less, according to service factor and insulation class employed.

c. Voltage: All single phase motors shall be rated 115/208/230 volts and all polyphase motors 230/460 volts. Submersible polyphase motors to be operated at 460 volts may take exception to the dual voltage requirement. All motors shall be capable of normal operation at balanced voltages in the range of ±10 percent from rated winding voltage.

d. Frequency: All a-c motors shall be rated for 60 Hz. operation. All motors shall be capable of normal operation at frequencies 5 percent above or below the nominal rating of 60 Hz.

e. Horsepower: Horsepower of the motors shall be as given in the Specification Division on the driven equipment or as shown on the Contract Drawings. Submersible motors shall be allowed to be furnished even though the horsepower rating may not be in accordance with standard NEMA assignments. In many cases, the horsepower specified is a minimum requirement and certain alternate manufacturers may require larger horsepower motors. The larger motor shall be furnished at no extra cost to the Owner.

f. Locked Rotor Current: Locked rotor current shall be in accordance with NEMA standards.

g. Efficiency and Power Factor: Efficiency and power factor shall be given consideration during Shop Drawing review. The ratings at full, ¾, and ½ load shall be compared to similar motors manufactured by acceptable suppliers listed in these Specifications. Excessive variation shall be considered grounds for rejection.

h. Speed: Synchronous speed of motors shall correspond to standard NEMA ratings. Actual speed shall be as given in the Specification Division on the driven equipment. Slip shall not exceed 5 percent at full load.

i. Service Factor: The service factor shall be 1.0 unless requirements of the driven load necessitate a higher service factor.

j. Insulation Class: Insulation shall be NEMA Class B, except as otherwise noted. Submersible motors shall be Class F, and motors to be operated at

variable speed shall be Class F. Class F insulated motors shall operate at a Class B rise at nameplate horsepower loading.

k. Design Level: Motors shall be NEMA design B, except as otherwise noted.

l. Enclosure: Motors for process equipment 2 HP and smaller shall be totally enclosed. All motors for process equipment larger than 2 HP shall be TEFC (totally enclosed fan cooled), suitable for use indoors or outdoors, except as otherwise noted. Totally enclosed non-ventilated (or air-over) motors may be used for ventilators and other auxiliary equipment that by virtue of the load are provided with more than adequate ventilation. ODP (open dripproof) motors may be used for ventilators where the motor is outside the air stream yet still protected from the weather. Division 15 of the Specifications and the HVAC Contract Drawings will detail the type of enclosure required for ventilators. Submersible motors shall be air or oil filled and of watertight construction. Motors used in classified atmospheres shall be properly rated for that hazard. Motors for potable water wells shall be water-filled/lubricated.

m. Frame Size: Frame designations shall be in accordance with NEMA standards.

n. Winding Overtemperature Sensors: All motors 15 horsepower and over shall be provided with motor winding thermostats. The devices shall be hermetically sealed, snap-acting thermal switches, actuated by a thermally responsive bi-metallic disk. A minimum of 1 per phase is required, with switches wired into the control circuit of the starter to provide de-energization should overheating threaten. All submersible motors shall be equipped with motor winding thermostats. Also all motors operated by adjustable frequency drives shall have motor winding thermostats, regardless of size.

o. All submersible pump/motor assemblies shall be equipped to detect presence of moisture and alarm at the controller.

2. Mechanical Characteristics

a. Integral Horsepower Motor Construction

(1) Motor frames for horizontal motors shall be cast iron, heavy fabricated steel, or cast aluminum (alloy 356 or 360). A steel insert ring shall be set into the aluminum alloy endshield when cast to minimize wear of the bearing support.

(2) Motor frames for vertical motors shall be cast iron, heavy fabricated steel, or extruded aluminum (alloy 6063-T4 or 6063-T6). Endshields for vertical motors must be cast iron.

(3) If an aluminum frame is used, the endshields and/or all other steel hardware must be plated with zinc or cadmium and coated with grease before assembly to minimize the galvanic action between the steel and aluminum.

(4) Motor frames and endshields shall be of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type enclosure employed. Lifting lugs of all motors shall conform to NEMA standards.

(5) Windings shall be random or form wound, adequately insulated and securely braced to resist failure due to electrical stresses and vibration. If the windings are aluminum, there shall be a cold welded aluminum-copper transition joint at the termination of the windings to permit the use of standard copper to copper connection techniques by the electrician and to prevent galvanic action between the copper power wires and the aluminum windings.

(6) The motor shaft shall be made of high grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of that particular rating. Bearing journals shall be ground and polished.

(7) Rotors shall be made from high grade steel laminations adequately fastened together and to the shaft. Rotor cage windings may be cast aluminum of bar type construction with brazed end rings.

(8) Integral horsepower motors shall be equipped with cone, roller, or ball bearings made to AFBMA standards, Grade 1 and shall be of ample capacity for the motor ratings. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication (ten years normal operation without lubrication), but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight running fits or rotating seals to protect against the entrance of foreign matter into the bearings or leakage of lubricant out of the bearing cavity.

(9) See the specification division relating to each piece of motor driven equipment for additional motor requirements to those listed above.

b. Fractional Horsepower Motor Construction

(1) Motor and shell shall be rigid welded steel designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight, die cast aluminum. Windings shall be of varnish insulated wire with slot insulation of polyester film and baked on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses, and other hazards. Motor shafts shall be made from high grade, cold rolled, shaft steel with drive shaft extensions carefully machined to standard NEMA dimensions for shaft coupled drive connection. Bearings shall be carefully selected precision ball bearings with extra quality, long life grease and large reservoir providing 10 years normal operation without relubrication, AFBMA Grade 1.

c. Submersible Motor Construction

(1) See Equipment Specifications.

3. Tests, Nameplates, and Shop Drawings

a. Tests

(1) Tests shall be required on integral horsepower motors only. A factory certified test report of "electrically duplicate motors previously tested" shall be supplied on all motors under 200 horsepower. The test shall be certified by the factory and shall contain a statement to the effect that complete tests affirm the guaranteed characteristics published in the manufacturer's catalogs or descriptive literature.

(2) Tests will be in accordance with IEEE test procedures.

b. Nameplates

(1) Each motor shall have a permanently affixed nameplate of brass, stainless steel, or other metal of durability and corrosion resistance. The data contained on the nameplate shall be in accordance with NEMA standards.

(2) Submersible pump motors and other motors in difficult-to-access locations shall be furnished with a spare nameplate for mounting inside the MCC or starter enclosure.

c. Shop Drawings

(1) Shop Drawings shall consist of motor dimensions, nameplate data from each motor and tests as outlined above. Also included shall be efficiency and power factor at 100, 75, and 50 percent load. Operation, maintenance, and lubrication information (including bearing catalog numbers) shall be submitted with Shop Drawings for review.

4. Efficiency Requirements

a. Motors shall be energy efficient type.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Installation of motors shall comply with motor manufacturer instruction's as well as applicable NEMA recommendations and requirements of the driven equipment OEM (original equipment manufacturer).

B. Motors shall be aligned to acceptable tolerances and shall not vibrate excessively.

C. Motors shall not be energized until they have been accepted by the OEM start up personnel.

END OF SECTION

SECTION 16280

TRANSIENT VOLTAGE SURGE SUPPRESSORS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Instrumentation Transient Suppressors

1. Transient suppressors are intended for use on all instrument control loops for power and signal protection on transmitters/receivers, etc., and shall be furnished and installed as specified in Division 17.

B. Hybrid Transient Suppressors (480, 240, or 240/120 Voltage)

1. Hybrid transient suppressors shall be furnished and installed in all Power Distribution and Motor Control Centers and on all equipment supplied having solid state components as the central control/monitoring device. These shall included, but not be limited to, computer systems, level control systems, and/or variable speed equipment. They shall be shown on the Drawings where required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Air Terminal Systems are specified in Section 16670.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Hybrid Transient Suppressors

1. “Eaton,” “Atlantic Scientific Corporation,” “W.N. Phillips Company,” “Joslyn,” “MCG,” “Transtector,” “Current Technology,” “Advanced Protection Technologies,” “Square D,” or equal.

2.02 EQUIPMENT

A. Hybrid Transient Suppressors

1. This Specification describes the mechanical and electrical requirements for a transient voltage surge suppressor herein known as TVSS. The TVSS shall be suitable for application in category C3 environments as described in ANSI/IEEE C62.41. The TVSS shall be of parallel design and provide protection, line to ground, neutral to ground, and line to neutral for wye or delta distribution systems.

2. The Contractor shall submit all related TVSS specifications, electrical and mechanical drawings, maintenance manuals and UL 1449 surge suppression ratings for TVSS, in proper amount of copies.

3. Manufacturer's Qualifications: firms regularly engaged in the manufacture of TVSS products for category C3 (ANSI/IEEE C62.41) and whose products have been in satisfactory service for not less than 5 years.

4. Manufacturers may be required to submit oscillographs and/or computer generated graphs from compatible smartscopes, which demonstrate TVSS clamping voltage values when tested to category C3 (per ANSI/IEE C62.45) 6kV 1.2x50 microseconds and 10kA 8x20 microseconds test waveshapes, in all specified suppression modes if the Engineer is not familiar with the product offered.

5. UL compliance and labeling: Must be listed per UL 1449. TVSS shall have 200kA short circuit current ratings. TVSS shall have thermal disconnects to protect against overvoltage conditions.

6. ANSI/IEEE compliance: Comply with ANSI/IEEE C62.1, C62.41, and C62.45.

7. The TVSS shall be capable of surviving 1,000 sequential category C3 surges without failure following IEEE test procedures established in C62.45.

8. The TVSS shall use redundant LED indicators which provide indication of suppression failure.

9. Local support shall be available for the TVSS as required.

10. The TVSS shall be warranted for 1 year.

11. The TVSS shall be compatible with the electrical system, voltage, current and distribution configuration.

12. The TVSS maximum continuous operating voltage (MCOV) shall be capable of sustaining 110 percent of the nominal RMS voltage continuously without degradation.

13. The TVSS shall use only solid state clamping components to limit the surge voltage.

14. The service entrance TVSS shall have surge current capacity as indicated on the Contract Drawings, which is shown as the minimum per phase.

15. Distribution Panel TVSS' shall have a surge current capacity of 25,000 amps minimum per phase.

16. The TVSS shall have a response time no greater than 5 nanoseconds, for any of the individual protection modes, under laboratory conditions with optimum lead lengths.

17. The panel shall have redundant status indicating lights for the monitoring of the individual surge modules. One (1) redundant status indicating light on the panel front and one (1) status indicating light on each module.

18. The TVSS UL 1449 surge suppression rating for any suppression mode shall not exceed:

Electrical System Voltage	Phases	UL 1449 Surge Suppression Ratings
120/240	1	330V
120/240	3	330V
120/208	3	330V
208	3	700V
277/480	3	700V
480	3	1500V

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Install the TVSS with #6 AWG copper minimum conductors tapped from the electrical power distribution system. The conductors are to be as short and straight as practically possible and shall not exceed 6 feet in length. The input conductors are to be twisted together to reduce the TVSS system inductance. An appropriately sized manual safety/disconnect switch or thermal magnetic circuit breaker shall be installed before and in line with the TVSS. It shall be capable of electrically isolating the TVSS from the electrical service for repair without interrupting service to the building. The TVSS shall be installed following the TVSS manufacturer's recommended practices and in compliance with all applicable codes.

END OF SECTION

SECTION 16300

ENGINE GENERATOR/TRANSFER SWITCH

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel Fuel engine.
2. Unit-mounted cooling system.
3. Outdoor enclosure.
4. Automatic Transfer Switch

1.2 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator and accessory indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Warranty: Special warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 99 and 110

E. Comply with UL 2200.

F. EPA Certified

G. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m) .

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A.

B. Manufacturers: Subject to compliance with requirements, provide products equal to one of the following:

1. Generac Power Systems, Inc. – Basis of Design
2. Kohler Co.; Generator Division.
3. Caterpillar; Engine Div
4. Onan/Cummins Power Generation; Industrial Business Group.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Capacities and Characteristics:

1. Power Output Ratings: 400 KW with upsized 555 KW alternator , 480/277 volt, three phase, four wire
2. Output Connections: 600 amp/3pole 80% main circuit breaker
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: diesel

B. Turbocharged/aftercooled 6-cylinder 12.5 L engine.

C. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3.
    a. Carburetor.
    b. Secondary Gas Regulators: One for each fuel type.
    c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
    d. Flexible Fuel Connectors: One for each fuel source.
4. Generator shall have a 24 hour run-time without refueling.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Governor: Adjustable isochronous, with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

H. Muffler/Silencer: Residential type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 18 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 95 dBA or less.

I. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
4. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls:

1. AC voltmeter.

2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 80 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: 600 Amp/3 Pole
3. ~~Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.~~
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

2. DC lighting system for operation when remote source and generator are both unavailable.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.8 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.9 AUTOMATIC TRANSFER SWITCH

A. 480/277 volt, three phase, three pole, 600 Amp.

B. Switch shall be furnished by the Generator supplier and be of the same manufacturer of the generator.

~~C. Switch shall be UL listed and labeled for Service Entrance~~

D. Switch shall be UL1008 listed.

E. Switch shall be enclosed in a NEMA 1 enclosure and contain all necessary relays and accessories for complete generator operation and interface.

F. Switch shall have three relays for running, alarm, off, that will be used for HVAC control system interface.

G. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

H. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

I. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

J. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.

K. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.

L. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.

M. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods

are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is not available.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

E. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

F. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

G. Connect engine exhaust pipe to engine with flexible connector.

H. Connect fuel piping to engines with a gate valve and union and flexible connector.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

K. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

2. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
3. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
4. Exhaust Emissions Test: Comply with applicable government test criteria.
5. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
6. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and reinspect as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 16300

SECTION 16440

MOTOR CONTROL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Contractor shall furnish and install motor control equipment as specified herein and as shown on the Drawings.

1.02 SUBMITTALS

A. Motor control equipment shall be new and the equipment of one manufacturer. Each component is specified by a particular trade name; however, this does not relieve the Contractor of the responsibility of submitting descriptive literature and Shop Drawings for review of all components. Motor control shall be the same brand as power distribution equipment on projects with both.

B. Shop drawings, including layout drawings, complete schematic and composite wiring diagrams, control circuit wiring diagrams and descriptive literature shall be submitted to the Engineer for review. Service manuals shall be submitted on all equipment and shall be bound in 3-ring looseleaf binders. The manuals shall also include information on accessories such as timers, etc., built in the control center.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Control Equipment

1. “Eaton Cutler Hammer”, “Siemens”, “General Electric,” “Allen-Bradley”. Square D, or equal.

B. Timers

1. “Paragon”, “Tork”, “Intermatic”, or equal.

2.02 MOTOR CONTROL CENTERS (MCC)

A. General

1. Quality of built-in transformers, starters, lighting panelboards, timers, etc. shall be as written elsewhere in this Division unless otherwise noted.

2. Motor Control Center(s) shall consist of one or more enclosed vertical sections joined together to form a rigid, free standing assembly. The construction of the Motor Control Center shall meet the requirements set forth by Underwriters' Laboratories publication UL-845, NEMA publication number ICS-2-322, the National Electrical Code, and color coded.

3. The structure shall be UL listed and labeled as service equipment if applicable. All sections shall bear UL labels.

4. Enclosures shall be NEMA 1 unless otherwise indicated, and each control center suitable for connection to an available symmetrical fault current as indicated on the Drawings.

B. Construction

1. Vertical Sections

a. Vertical sections shall support the horizontal and vertical buses, combination starter units, covers and doors, and shall be designed to allow for easy rearrangement of units by the purchaser. Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Where needed, reinforcement structural parts shall be of 10-gauge steel to provide a strong rigid assembly. Each section shall be 90 inches high and shall have 7 gauge steel, 3 inch high removable lifting angle and two 1 ½ inch high base channels. Complete control center line-ups shall be divided into shipping splits no wider than approximately 60 inches. The lifting angle shall be provided on the top of each shipping split and shall extend the entire width of the shipping split. Lifting angles shall be designed to support the entire weight of the MCC section. Base channels shall be provided with holes to permit bolting the Motor Control Center(s) to the floor. The entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation.

b. Motor Control Centers shall be designed so that matching vertical sections of the same current rating and manufacture can be added later at either end of the line-up without use of transition sections and without difficulty or undue expense. Removable end closing plates shall be provided to close off openings on the end of the Motor Control Center line-up. A removable top

plate shall be provided on each vertical section and shall be of one piece construction for added convenience in cutting conduit holes. The design shall allow use of the standard conduit entrance area without significant sag or deformation of the top plate.

c. Vertical sections shall be designed to accommodate plug-on units in front-of-board or back-to-back construction as shown on Contract Drawings. Vertical sections housing plug-on units shall be 20 inches wide and shall be 20 inches deep. Wider sections will be permitted only for bolted connection type units not fitting the 20 inch wide sections. Unit mounting area shall be divided into ½ space factor divisions, each approximately 6 inches. NEMA Size 1 and 2 combination starter units shall use only 1 space factor, or 12 inches, of unit mounting space. Vertical sections shall allow for 7 space factors of unit mounting space. Removable blank plates shall cover all unused unit mounting spaces. Blank plates shall be flanged on all 4 sides and shall be mounted with captive screws. Blank space shall be equipped for future use.

d. Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireway sections contained in this document.

2. Horizontal Wireways

a. Horizontal wireways shall be provided in the top and bottom of each vertical section as indicated in the Contract Drawings and shall be arranged to provide full length continuity throughout the entire assembly. The top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11 ½ square inches. The bottom horizontal wireway shall extend through the length and depth of the vertical sections and shall also be provided with openings of not less than 11 ½ square inches to allow for full length continuity throughout the entire assembly. The bottom horizontal wireway height shall be not less than 9 1/4 inches. Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

3. Vertical Wireways

a. A vertical wire trough shall be located on the right -hand side of each vertical section and shall extend from the top horizontal wireway to the bottom of the available unit mounting space. Each vertical wire trough shall have a cross sectional area of not less than 19 square inches and shall be isolated from the bus bars to guard against accidental contact. A separately

hinged door having captive type screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing control units.

b. Reusable wire ties shall be furnished in each vertical wire trough for the purpose of grouping and securely holding wires in place for a neat and orderly installation.

4. Busbars

a. A continuous main three-conductor horizontal bus shall be provided over the full length of the control center. A half-rated horizontal neutral bus shall also be supplied over the full length of the Motor Control Center. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus wherever a split has been made. All splice connections shall be made with at least two bolts and shall employ the use of Belleville washers in the connection. Horizontal bus bars shall be mounted edgewise and supported by insulated bus supports.

b. For distribution of power from the main horizontal bus to each unit compartment, a three-phase vertical bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

c. The main horizontal and vertical buses shall be made of copper and the entire length shall be electrolytically tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

d. Bus supports shall be formed of high strength glass reinforced alkyd material. Bus supports shall have generous surface clearances in the vertical plane to shed dust and maintain dielectric integrity. Bus supports and insulators shall be red to indicate proximity of energized bus parts.

e. Horizontal and vertical buses shall have continuous current ratings adequate to handle all loads as shown on the one line diagram in the Contract Drawings. Continuous current ratings shall be in accordance with temperature rise specifications established by UL, ANSI, and NEMA standards.

f. A copper ground lug shall be provided in each incoming line vertical section capable of accepting a #8 to 250 MCM cable. A horizontal copper grounding bus shall be provided in each section of the Motor Control Center. Horizontal grounding bus shall run continuously throughout the control center except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Grounding bus shall be tin plated copper and have a cross sectional area equal to 28% of the

main horizontal bus cross sectional area. Horizontal ground bus shall be located at the bottom of the Motor Control Center.

5. Bus Barriers

   a. Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over". Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure. Unused plug-on openings in the bus shall have plastic snap-in closing plates for added safety.

6. Main Incoming Lug Compartment

   a. A front accessible main lug compartment shall be provided with suitable main lugs to accommodate the number of cables per phase as indicated on the Contract Drawings. The compartment shall be located in the top most or bottom most unit space of the section to accommodate the user's cables entering the Motor Control Center as indicated on the Contract Drawings or as required for an efficient installation. The main incoming lug compartment shall be covered by a hinged door for maintenance access. This door shall be held closed with captive type screws to discourage unauthorized access. A unit door padlock attachment shall also be provided to lock the door in the closed position with one 5/16 inch diameter shackle padlock. This attachment shall also accept a meter type seal.

7. Units

   a. Combination starter units shall consist of Size 1 minimum full voltage magnetic starters, solid-state reduced voltage starters, drives, molded case magnetic-only circuit breakers, and auxiliary control devices, as required and/or shown on the one-line and elementary diagrams. Pilot light assemblies (push-to-test) shall be LED type as noted below. All auxiliary equipment, except that which is specified for mounting on the door, shall be mounted within the compartment. All units shall be provided with unit doors, unit support pans, unit saddles and unit disconnect operators as outlined in this Specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses and wireways except for openings for conductor entrance into units. Units shall be designed and constructed so that any fault will be localized within the compartment. All units shall be

UL listed for a minimum RMS symmetrical fault withstand ability as indicated on the Drawings.

b. Plug-on combination starter units of the same NEMA size and branch feeder units of the same trip size shall be readily interchangeable with each other. It shall be possible to withdraw each plug-on unit to a de-energized position with the unit still being supported by the structure. It shall be possible to lock the unit in this position with one padlock.

c. Full voltage non-reversing combination starter units shall have the following minimum space factor requirements, shall be provided with plug-on connections and shall be provided with ample space for customer wiring room:

	Circuit Breaker Space Factor
Size 1	1
Size 2	1
Size 3	1 ½
Size 4	2

8. Unit Plug-On

a. For convenient unit connection to bus bars, unit plug-on contacts shall be provided on the following units:

(1) For circuit breaker type units; full voltage starters, size 4 and smaller; solid-state reduced voltage starters, size 4 and smaller; branch circuit units, 225 ampere and smaller.

b. The plug-on connection for each phase shall be of a high quality two point connection and shall be designed to tighten around the vertical bus bar during a heavy current surge. For trouble-free connections, the plug-on fingers shall be silver plated and coated with a compound to assure a low resistance connection. Contact fingers shall be of a floating and self-aligning design to allow solid seating onto the vertical bus bars.

c. Starters NEMA size 4 and larger shall bolt directly to the vertical bus bars, circuit breakers rated higher than 225 amps shall also bolt directly to the bus bars.

9. Unit Doors

a. Each unit shall have a door securely mounted with rugged concealed-type hinges which allow the door to swing open a minimum of 112° for unit

maintenance and withdrawal. Doors shall be fastened to the structure so that they remain in place when a unit is withdrawn and may be closed to cover the unit space when the unit has been temporarily removed. Doors shall be held closed with captive type screws which engage self-aligning cage nuts. These screws shall provide at least two threads of engagement to hold doors closed under fault conditions. Each unit door shall be interlocked with its disconnect mechanism to prevent the door from opening when the unit is energized. A defeater mechanism shall be provided for defeating this interlock by authorized personnel. Removable door panels held with captive type screws shall be provided on starter unit doors for mounting push buttons, selector switches or pilot lights. Blank door panels capable of accepting future pilot devices shall be furnished when pilot devices are not originally specified for starter units. Each starter unit door shall house an external low-profile overload reset button for resetting the overload relay in the event of tripping.

10. Unit Support Pan

    a. Each plug-on unit shall be supported and guided by a tilt and lift-out removable pan so that unit rearrangement can be easily accomplished. For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished with ease after the control unit and door have been removed.

11. Unit Saddles

    a. Each plug-on unit shall have a saddle of 14 gauge hot rolled steel designed and constructed to physically isolate the unit from the bus compartment and adjacent units. Saddlers shall be equipped with captive, self-aligning mounting screws which shall hold the unit securely in place during shipment. Flanged edges shall be provided on each saddle to facilitate unit removal.

12. Disconnect Operators

    a. An external operator handle shall be supplied for each switch or breaker. This mechanism shall be engaged with the switch or breaker at all times regardless of unit door position to prevent false circuit indication. The operator handle shall be color coded to display red in the “ON” position and black in the “OFF” position. The operator handle shall have a conventional up-down motion and shall be designed so that the down position will indicate the unit is “OFF”. For added safety it shall be possible to lock this handle in the “OFF” position with up to three padlocks. The operator handle shall be interlocked with the unit door to prevent switching the unit to “ON” while the unit door is open. A defeater mechanism shall be provided for the purpose of defeating this interlock by a deliberate act of an

electrician should he desire to observe the operation of the operator handle assembly or the unit components. Operators shall not be higher than 6'-6" above finished floor elevation, as installed.

13. Wiring

    a. The motor control center wiring shall be NEMA Class II, Type B.

    b. All wiring to the terminal strips from outside the MCC shall be made with spade type terminals of the proper size and rating for the wire used. Pull apart terminal blocks shall be provided in unit spaces of motor starters that contain field wiring energized from a remote source to comply with NEC Article 430-74.

14. Finish

    a. The finish shall be manufacturer's standard gray enamel applied over a rust inhibiting phosphate primer.

15. Optional Modifications and Accessories

    a. Additional modifications and accessories shall be as listed and specified on the Contract Drawings.

16. Identification

    a. A control center identification nameplate describing section catalog numbers and characteristics shall be fastened on the vertical wire trough door of every section. Each control center unit shall have its own identification nameplate fastened to the unit saddle. These nameplates shall have suitable references to factory records for efficient communication with supplier. Each control center unit shall also have an engraved Bakelite nameplate fastened to the outside of each unit door inscribed as written on the Contract Drawings for ease in identification and for making changes when regrouping units. An overall structure nameplate is also required.

17. Metering

    a. All power monitors, current transformers, and potential transformers shall be furnished as shown on the Contract Drawings. Solid state metering shall be as specified this section.

C. Starters and Overcurrent Protective Devices

1. Magnetic Starters

a. Magnetic starters shall be furnished in all combination starter units unless otherwise indicated on Contract Drawings. Starter Sizes 1 through 4 shall employ the use of a bell-crank lever design to transform vertical action of the armature into horizontal action of the contact carriers and thus minimize contact bounce and produce extra long contact life. Thermal overload relays on starters shall be ambient temperature compensated bimetallic type with selector for either auto or manual reset. Overload heater units shall be provided in each starter unit. Overload relay heater schedules shall be provided on each starter unit.

2. Circuit Breakers

a. Type FA, KA, LA, MA and PA molded case circuit breakers shall be furnished in all starter and branch feeder units using circuit breakers as a disconnect means. All circuit breakers will have a push-to-trip test feature for testing and exercising the circuit breaker trip mechanism.

3. Starters shall conform to requirements listed under individually mounted Motor Control Devices, hereinafter.

D. Lighting Panelboards

1. Lighting panelboards shall be as specified in other section of this Division. Lighting panelboard unit doors shall be held closed with captive latches that may easily be operated without the use of tools, i.e., wing nuts, handle, etc.

E. Transformers

1. 480 volt primary, 120/240 volt or 120/208 volt secondary transformers shall be as specified in other sections of this Division.

F. Electronic Circuit (Power) Monitors

1. Circuit Monitor Installation

a. Electronic circuit monitors shall be installed by the equipment manufacturer for all circuits as indicated on the Contract Drawings.

b. All control power, CT, PT, and communications wire shall be factory installed and harnessed within the lineup.

c. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's shop drawings must clearly identify the interconnection requirements, including wire type, to be used.

d. This equipment shall be Eaton IQ DP 4000, General Electric, or equal.

2. Circuit Monitor Characteristics

a. The electronic circuit monitors shall accept inputs from industry standard instrument transformers (1 20 VAC secondary PTs and 5A secondary CTs).

b. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate rms sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental of 60 Hz).

c. All setup parameters required by the circuit monitors shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.

d. The circuit monitor shall also maintain, in nonvolatile memory, a maximum and minimum value for each of the instantaneous values reported, as well as the time and date of the highest peak for all of the peak demand readings.

e. The circuit monitors shall be equipped with an integral LED display to provide local access to metered quantities.

f. The following instantaneous readings shall be reported by the circuit monitor:

(1) Frequency
(2) Temperature
(3) Current, per phase rms
(4) Current, 3-phase average rms
(5) Current, apparent rms
(6) Voltage, phase-to-phase & phase-to-neutral
(7) Power factor, per phase

(8) Power factor, 3-phase total
(9) Real power, 3-phase total
(10) Reactive power, 3-phase total
(11) Apparent power, 3-phase total
(12) Total Harmonic Distortion

g. The following demand readings shall be reported by the circuit monitor:

(1) Average demand current, per phase
(2) Peak demand current, per phase
(3) Average demand, real power
(4) Predicted demand, real power
(5) Peak demand, real power

h. The following energy readings shall be reported by the circuit monitor:

(1) Accumulated energy
(2) Accumulated reactive energy

3. Waveform Capture Capability

a. All electronic circuit monitors shall include waveform capture capability.

b. Upon a user-initiated command, the circuit monitor shall capture and store, in nonvolatile memory, 3-phase voltage and current samples consisting of 256 data points each.

c. These data points shall represent at least four cycles of each current or voltage waveform.

d. These samples shall be evenly gathered from three voltage and three current phases such that the original power signals with proper magnitude and phase relationships may be reconstructed.

e. It shall be possible to recreate the original power signal from the stored data with sufficient accuracy such that steady-state power harmonic analysis will provide valid information on harmonic content for up to the 30th harmonic of the fundamental power frequency.

4. Connecting and Networking Circuit Monitors

a. All data and calculated values stored in the circuit monitor shall be accessible to external devices by means of an Ethernet communications port built into the circuit monitor.

5. System Display

a. The circuit monitor shall include an LED readout which will allow local display of the following electrical parameters:

(1) Current, per phase rms
(2) Voltage, phase-to-phase & phase-to-neutral
(3) Real power, 3-phase total
(4) Reactive power, 3-phase total
(5) Apparent power, 3-phase total
(6) Power factor, 3-phase total & per phase
(7) Frequency
(8) Peak demand current, per phase
(9) Peak demand, real power
(10) Accumulated Energy, (MWH and MVARH)
(11) Total Harmonic Distortion

b. Reset of the following electrical parameters shall also be allowed from the front of the circuit monitor:

(1) Peak demand current
(2) Peak demand power
(3) Energy (MWH)
(4) Reactive energy (MVARH)

c. Circuit monitor setup for system requirements shall be allowed from the front of the circuit monitor. Setup provisions shall include:

(1) CT rating (xxxx:5)
(2) PT rating (xxxx:120)
(3) System type (3-wire and 4-wire)
(4) Demand interval (5-60 min.)

d. All reset and setup functions shall be keyswitch-protected to prevent unauthorized/accidental changes.

e. System display units shall be installed by the manufacturer in the equipment.

f. The system display units shall be flush mounted on door panels.

g. The system display unit shall utilize a 4-line by 20-character, high contrast LCD technology display with backlighting to provide high reliability and superior readability in all light conditions.

2.03 INDIVIDUALLY MOUNTED MOTOR CONTROL DEVICES (480, 240, OR 120 VOLT)

A. General

1. All motor control equipment shall be new and the product of 1 manufacturer. All individually mounted disconnects, push-button stations, starters, etc., shall be mounted on a 1 inch strut to provide an air space at rear.

B. Starters

1. General

a. All starters shall be of the voltage rating, type, and sized for the motor size shown in these Specifications and/or on the Contract Drawings. For enclosure type see the system operation description and/or the Contract Drawings. All starters shall be of the magnetic type. Should a piece of electrically driven equipment be furnished with a larger motor than shown on the Contract Drawings, the proper size combination starter shall be provided for the equipment supplied, at no extra cost to the Owner.

b. See the Contract Drawings for the auxiliary equipment to be furnished. Maximum control voltage shall be 120 volts, a-c. Minimum starter size shall be NEMA Size 1.

2. Overloads

a. Each starter shall have a thermal overload device in each ungrounded leg. The overload shall be of the “Ambient compensated Bi-metallic”, thermal element type. All overloads shall be of the manual reset type and shall be reset without opening the starter enclosure. Heaters will be sized for the proper temperature rise of the motor that it is being used on. Heaters for general service shall be of the standard trip type. Adjustable Overload Relay Thermal Units are not allowed. All integral horsepower motors, 15 horsepower and over, require thermal elements embedded in the windings. See Motor Specifications, this division. Siemens-Allis overload relays shall be provided with a meter-sealed cover over relay adjustment controls.

3. Contactors

a. All contactors for motor starters shall be of the a-c magnetic type with “undervoltage” protection when used in conjunction with momentary contact push-button control and “undervoltage” release when used with maintained contact push-button control.

b. Contactor size shall be in accordance with NEMA Standards for the motor controlled and shall be horsepower rated.

c. Contacts shall be of the heavy duty silver-to-silver type and shall be totally enclosed in individual arc quenching chambers. Contacts shall be easily accessible for replacement.

d. The contactor coil shall be of the vacuum impregnated or epoxy resin type, moisture resistant and corrosion proof.

4. Solid State Reduced Voltage Soft Starter – See Section 16444.

5. Variable Frequency Drives – See Section 16483.

C. Control Stations

1. General

a. Control stations shall be heavy duty, maintained or momentary contact type, as noted on the Contract Drawings. Contacts shall be silver alloy, double break type. The number and marking of controls shall be as shown on the Contract Drawings. Enclosures shall be NEMA 4X for indoor and outdoor mounting, unless otherwise noted on the Contract Drawings. All control stations shall operate on 120 volt, a-c maximum, unless otherwise designated on the Contract Drawings.

2. Maintained Contact

a. Maintained contact control switches shall be marked "On" and "Off". The button pushed shall remain in and push the other button out until the other button is pushed. In general, they are to be used for hand control of motors which have to operate continuously and restart whenever power is off then resumed, without any manual operator. This is needed for motors which have to operate continuously in the absence of an operator.

3. Momentary Contact

a. Momentary contact control push-button switches shall be marked "start" and "stop". Pushbuttons shall spring out whenever pushed. If the circuit is dropped for any reason, operation cannot be resumed until a "start" push-button is pushed. In general, they are to be used for hand control of motors which are desired to operate intermittently in the presence of the operator and stop and start independently from more than one parallel control location.

D. Circuit Breakers

1. Circuit breakers shall be molded case type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any one pole shall open all poles simultaneously.

2. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

3. Breakers not used with motor starters shall be of the thermal magnetic type with a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

4. The breaker shall be trip indicating with the trip position midway between the "On" and "Off" positions.

5. Breakers for combination starters shall be 100 amp frame or larger. All breakers for combination starters shall be magnetic-only type and have an adjustable magnetic trip element of the motor circuit protector type.

6. Breakers for combination starters shall be F frame or larger. All breakers shall have adjustable magnetic trip elements. Circuit breakers K frame and larger shall have interchangeable thermal-magnetic trip elements.

E. Safety Switches

1. Safety switches shall be of the heavy duty industrial, quick make, quick-break type. Ratings shall correspond to that of the equipment in which circuit it is used, fuses sized as shown on the Contract Drawings. All safety switches at motor locations are of the nonfused type unless otherwise noted.

2. Safety switches shall have a mechanical door interlock to prevent the door from being opened with the switch in the on position and facilities for locking it in the closed or open position. Enclosures shall be NEMA 4X unless otherwise indicated on the Contract Drawings.

3. Safety switches shall be UL listed and shall conform to NEMA Standards. NEMA 4X enclosed safety switches where called for shall be stainless steel, or fiberglass.

4. Double throw fused/nonfused safety switches, where required, shall be as specified on the Contract Drawings.

F. Selector Switches

1. Hand-off-automatic type selector switches shall be of oil-tight construction and shall have 3 positions. The switch must not have a spring loaded return. It shall be of the "quick-make", "quick-break" type.
2. Selector switches for corrosive areas and water/wastewater plants shall be 30mm, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.

G. Pilot Lights and Pushbuttons

1. Pilot lights for corrosive areas and water/wastewater plants shall be 30mm, push-to-test, LED-style, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.
2. Pushbuttons for corrosive areas and water/wastewater plants shall be 30mm, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.

H. Manual Motor Starting Switches

Manual motor starting switches for the control of fractional horsepower motors shall be single pole, and shall be provided with a thermal heater of the correct size for the load controlled. Each starting switch shall be mounted where shown on the Contract Drawings. Where they are used for rotating equipment such as grinders, they shall be equipped with low voltage protection, and required manual reset after power failure. As an alternate to low voltage protection built-in, a "Safety Restart Plug" may be utilized, available from Mitchell Instrument Company.

I. Alarm Horns and Lights

Alarm horns and lights, where called for on the Contract Drawings, shall be NEMA 4X weatherproof, suitable for surface mounting and horns shall be provided with a silence button. Alarm horn shall be Edwards with 103dB at 10 feet, Federal Signal, or equal.

J. Timing Relays

Time delay relays shall have an adjustable timing range as shown on the Contract Drawings. The time delay shall be after energizing timer coil. Timing relays shall be Agastat, Square D, or equal.

K. Control Relays

Control relays shall be magnetic, general purpose, "ice cube" type with 3-pole (minimum), double throw contacts rated at 5 amperes (minimum), 120 volts (minimum). Coils shall be rated to operate at the indicated control voltage. Provide proper bases, mounting track, etc. for a complete installation. All relays shall be have a retainer clip, manual operator, and pilot light. Coils connected to solid-state digital outputs shall have transient surge protection.

2.04 TIMERS

A. Timers for various services required in the motor control equipment shall be Paragon, Tork or equal as indicated in control circuits shown on the Drawings.

B. Timers requiring tripping pins shall be supplied with enough pins to completely fill all locations on the dial face.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Motor Control Centers

1. Ends of MCC(s) shall be closed with 1/4" mesh hardware cloth and galvanized or aluminized insect screen or sill covers to prevent the entrance of rodents and large insects into the MCC housing(s).

2. Each MCC shall be provided with a 3.5" high concrete pad.

3. One inch air space (min.) shall be allowed between back of MCC(s) and wall surface.

4. Lifting-eyes in tops of MCC(s) section shall be removed (and retained) and the threaded openings closed with stainless cap screws and plastic washers or plastic seals provided for that purpose by the MCC(s) manufacturer.

5. In installations where conduit runs to electrical equipment emanate from the top of MCC(s) there shall be provided additional wiring space in the form of metal trough(s) of the same metal housing(s) dimensions and details. Trough(s) shall be provided by the manufacturer of the MCC(s).

B. Individually Mounted Motor Control Devices (480, 240, or 120 Volt)

1. Each motor disconnect shall be located as near as possible to its respective motor.

2. Remote control station at or near motor shall be mounted near its respective motor, adjacent to the motor disconnect.

3.02 EXTRA STOCK/SPARE PARTS

A. Provide the following spare parts:

10 fuses of each type/amperage used

1 pilot light lamp for each pilot light socket assembly provided

1 control transformer for each size utilized

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This section of the Technical Specifications includes furnishing all labor, materials, equipment, and incidentals required for the installation of all lighting and distribution panelboards as hereinafter specified and as shown on the Contract Drawings.

B. The panelboards for installation under this Contract shall be selected from the following types with the panel voltage and main sizes the determining factors. All panelboards shall be by the same manufacturer.

C. Circuit breakers of size and type shown on Contract Drawings and described herein shall be provided with the panelboards. Circuit assignments noted on the drawings must match circuit assignments in all panelboards, and must be shown in shop drawings.

1.02 SUBMITTALS

A. Shop Drawings, including Layout Drawings and complete over current protection devices descriptive literature shall be submitted to the Engineer for review.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. “Square D”, “Siemens”, “General Electric,” “Eaton.” , or equal

2.02 EQUIPMENT

A. Rating

1. Panelboard ratings shall be as shown on the Contract Drawings. All panelboards shall be rated for the intended voltage.

B. Standards

1. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. “Standard for Panelboards” and “Standard for Cabinets and Boxes” and shall be so

labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

C. Panelboard Construction

1. Interiors

a. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.

b. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

c. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

d. A nameplate shall be provided listing panel type, number of circuit-breakers and ratings.

2. Bussing

a. Bus-bars for the mains shall be of copper. Full size neutral bars shall be included. Bus-bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

b. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

c. Spaces for future circuit-breakers shall be bussed for the maximum device that can be fitted into them.

d. Separate neutral and ground bus shall be provided, insulated and isolated from each other.

3. Boxes

a. Recessed boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Surface mounted boxes shall

be painted to match the trim. Boxes shall be of sufficient size to provide a minimum gutter space of 4 inches on all sides.

b. Surface mounted boxes shall have an internal and external finish as hereinafter specified. Surface mounted boxes shall be field punched for conduit entrances.

c. At least 4 interior mounting studs shall be provided.

d. Where noted on the drawings, provide NEMA 4X or NEMA 3R boxes.

4. Trims

a. Hinged doors covering all circuit-breaker handles shall be included in all panel trims.

b. Doors shall have semi flush type cylinder lock and catch, except that doors over 43 inches in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

c. The trims shall be fabricated from code gauge sheet steel.

d. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with manufacturer's standard gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere without cracking or peeling.

e. Trims for flush panels shall overlap the box by at least 3/4 inch all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

D. Overcurrent Protective Devices (Circuit Breakers)

1. Panelboards shall be equipped with circuit-breakers with frame size and trip settings as shown on the Contract Drawings.

2. Circuit-breakers shall be molded case, bolt-in, thermal-magnetic trip.

3. Single Pole Circuit Breakers shall not be tied together to fabricate double or triple pole circuit breakers.

4. Circuit-breakers used in 120/208 volt panelboards shall have an interrupting capacity of not less than 10,000 amperes, RMS symmetrical.

5. Circuit-breakers used in 480 volt panelboards shall have an interrupting capacity of not less than 14,000 amperes, RMS symmetrical.

6. GFCI (ground fault circuit interrupter) shall be provided for circuits where indicated on the Contract Drawings. GFCI units shall be 1-pole, 120 volt, molded case, bolt-on circuit-breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the circuit-breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time), and an interrupting capacity of 10,000 amperes RMS.

7. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any pole shall open all poles simultaneously.

8. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

9. Breakers shall have a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

10. The breaker shall be trip indicating with the trip position midway between the “On” and “Off” positions.

11. Breakers for power distribution panels shall be F frame or larger. All breakers rated above 225 amps shall have interchangeable magnetic trip elements.

12. All breakers shall be UL listed, and conform to requirements of NEMA Standards.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Boxes for surface mounted panelboards shall be mounted so there is at least ½ inch air space between the box and the mounting surface.

B. Circuit directories shall be typed giving location and nature of load served.

C. Provide a minimum of three 1" spare conduits stubbed out into the ceiling grid cavity from each flush mounted panelboard.

D. Each panelboard shall be nameplated with plastic engraved nameplates stating the panel's name, voltage, and the name of panel serving the panel. Nameplates shall be secured by use of stainless steel screws.

END OF SECTION

SECTION 16460

TRANSFORMERS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Transformer locations and size shall be as shown on the Contract Drawings, as specified herein.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. "Square D", "General Electric", "Siemens," "Eaton," or equal.

2.02 FABRICATION

A. General Purpose Dry-Type Transformers

1. Single phase transformers shall be 480 or 600 volt primary and 120/240 volt secondary. Three phase transformers shall be 480 or 600 volts delta primary and 208 Y/120 or 240 volt delta secondary. Transformers 25 KVA and larger shall have a minimum of 4 (2 above, 2 below) 2 ½ percent full capacity primary taps.

2. Transformers shall be 150 degrees Celsius temperature rise above a 40 degrees Celsius ambient. All insulating materials are to be in accordance with the latest NEMA Standards for a 220 degrees Celsius UL recognized insulation system.

3. Transformer coils shall be of the continuous wire wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish. The coils shall also have a final wrap of electrical insulating material to prevent mechanical injury to the wire as well as increasing the electrical breakdown strength.

4. All cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with steel angles. The completed core and coil shall then be bolted to the base of the enclosure but isolated from the base by means of rubber, vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil to the enclosure. On transformers 500 KVA and smaller, the vibration isolation system shall be designed to provide a permanent fastening of the core and coil to the enclosure. To further facilitate vibration and noise isolation,

the final section of conduit to the transformer shall be flexible.

5. Transformers 25 KVA and larger shall be in heavy gauge, sheet steel, ventilated enclosures. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code Standards for ventilated enclosures. Transformers 25 KVA through 75 KVA shall be designed so they can either be floor or wall mounted. Above 75 KVA they shall be of the floor mounted design.

6. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished in the same color as the motor control equipment. For more details see Division 9 of these Specifications. Where indicated, transformers shall have a NEMA 4X or NEMA 3R rating.

7. The maximum temperature of the top of the enclosure shall not exceed 50 degrees Celsius rise above a 40 degrees Celsius ambient.

8. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with NEMA and NEC Standards.

9. The transformer shall be marked “DANGER HIGH VOLTAGE” with labels specified in the section on marking, this Division.

10. The transformers shall be manufactured to requirements of applicable standards, especially as they apply to noise level and surface temperatures.

PART 3: EXECUTION

3.01 INSTALLATION / APPLICATION / ERECTION

A. Transformers shall be rigidly mounted to the structure or the foundation in the case of freestanding units.

B. Transformers shall be megger tested prior to energization.

C. Transformers with taps shall be adjusted to supply the nominal service voltage required on the secondary.

D. Transformers shall be installed in accordance with NEC requirements and manufacturer recommendations.

END OF SECTION

SECTION 16483
ADJUSTABLE FREQUENCY DRIVE

PART 1: GENERAL

1.01 SCOPE

A. This specification describes the electrical, mechanical, environmental, agency and reliability requirements for three-phase, Adjustable Frequency Drives (AFD) as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

A. Section 11215 – Submersible Pump Stations

B. Section 16440 – Motor control centers

C. Section 16900 – Controls and Control Panels

1.03 REFERENCES

A. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
   1. Institute of Electrical and Electronic Engineers (IEEE)
      a. IEEE 519-1992: Guide for harmonic content and control
   2. Underwriters Laboratories (UL508C: Power Conversion Equipment)
      a. UL
      b. CUL
   3. National Electrical Manufacturer's Association (NEMA)
      a. ICS 7.0: Industrial Controls & Systems for AFD.
   4. IEC 61800-2 and –3. EN 50082-1 and –2
      a. Fulfill all EMC immunity requirements

B. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1.04 SUBMITTALS - FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer.
   1. Dimensioned outline drawing
   2. Schematic diagram
   3. Power and control connection diagram(s)

B. Submit four (4) copies of the above information.

1.05 SUBMITTALS-FOR INFORMATION

A. When requested by the Engineer the following product information shall be submitted:
   1. Descriptive bulletins

      Product sheets

1.06 SUBMITTALS-FOR CLOSEOUT

A. The following information shall be submitted for record purposes prior to final payment.

1. Final as-built drawings and information for items listed section in 1.04.
2. Installation information.

1.07 QUALIFICATIONS

A. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors when specified.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 certified.

C. The supplier of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Three (3) copies of the equipment operation and maintenance manuals shall be provided.

B. Operation and maintenance manuals shall include the following information:

1. Instruction books
2. Recommended renewal parts list
3. Drawings and information required by Section 1.06.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Eaton / Cutler-Hammer products

B. General Electric

C. Allen-Bradley

D. Siemens

E. Or equal

2.02 ADJUSTABLE FREQUENCY DRIVES (AFD)

A. Where shown on the drawings, adjustable frequency drives shall be Variable Torque (VT), shall have the following features:

1. The AFD shall be rated for 480 VAC. The AFD shall provide microprocessor-based control for three-phase induction motors. The controller’s full load output current rating shall be based on 40° C ambient and 10 kHz switching frequency

below 50-HP and 3.6 kHz switching frequency 50-HP and above to reduce motor noise and avoid increased motor losses.

2. The AFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source AFD are not acceptable. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable. The AFD shall run at the above listed switching frequencies.
3. The AFD shall have efficiency at full load and speed that exceeds 95% for AFD below 15-HP and 97% for drives 15-HP and above. The efficiency shall exceed 90% at 50% speed and load.
4. The AFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
5. AFD shall have a one (1) minute overload current rating of 110% for variable torque drives.
6. The AFD shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
7. The AFD shall have an integral EMI/RFI filter as standard.
8. The AFD shall limit harmonic distortion reflected onto the utility system by utilizing the standard 3% nominal impedance integral AC three-phase line reactor.
9. The AFD shall be able to start into a spinning motor. The AFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
10. Standard operating conditions shall be:
    a. Incoming Power: Three-phase, 480 Vac (+10% to -15%) and 60 Hz.
    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
    c. Speed regulation of +/- 0.5% of base speed.
    d. Load inertia dependant carryover (ride-through) during utility loss.
    e. Insensitive to input line rotation.
    f. Humidity: 0 to 95% (non-condensing and non-corrosive).
    g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
    h. Ambient Temperature: -10 to 50 °C, -10 to 40 °C (VT).
    i. Storage Temperature: -40 to 60 °C.
11. Control Functions
    a. Frequently accessed AFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the AFD. The AFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
    b. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.

c. The keypad shall have copy / paste capability.

d. Upon initial power up of the AFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.

e. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the AFD RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through section 18.

f. The operator shall be able to scroll through the keypad menu to choose between the following:

1. Monitor
2. Operate
3. Parameter setup
4. Actual parameter values
5. Active faults
6. Fault history
7. LCD contrast adjustment
8. Information to indicate the standard software and optional features software loaded.

g. The following setups and adjustments, at a minimum, are to be available:

1. Start command from keypad, remote or communications port
2. Speed command from keypad, remote or communications port
3. Motor direction selection
4. Maximum and minimum speed limits
5. Acceleration and deceleration times, two settable ranges
6. Critical (skip) frequency avoidance
7. Torque limit
8. Multiple attempt restart function
9. Multiple preset speeds adjustment
10. Catch a spinning motor start or normal start selection
11. Programmable analog output
12. DC brake current magnitude and time
13. PID process controller

12. The AFD shall have the following system interfaces:

a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:

1. Remote manual/auto
2. Remote start/stop
3. Remote forward/reverse
4. Remote preset speeds
5. Remote external trip
6. Remote fault reset
7. Process control speed reference interface, 4-20mA DC
8. Potentiometer and 1-10VDC speed reference interface

9. RS-232 programming and operation interface port
10. Serial communications port

B. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
   1. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
      a. Fault
      b. Run
      c. Ready
      d. Reversed
      e. Jogging
      f. At speed
      g. Torque Limit Supervision
      h. Motor rotation direction opposite of commanded
      i. Over-temperature
   2. Programmable open collector output with available 24VDC power supply and selectable with the following available at minimum:
      a. Fault
      b. Run
      c. Ready
      d. Reversed
      e. Jogging
      f. At speed
      g. Torque Limit Supervision
      h. Motor rotation direction opposite of commanded
      i. Over-temperature
   3. Programmable analog output signal, selectable with the following available at minimum:
      a. Motor current
      b. Output frequency
      c. Frequency reference
      d. Motor speed
      e. Motor torque
      f. Motor power
      g. Motor voltage
      h. DC-bus voltage
      i. AI1 (Analog Input 1)
      j. AI2 (Analog Input 2)
      k. PT100 temperature
      l. FB digital input 4 (Field Bus Input)
   4. Monitoring and Displays
      a. The AFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
         1. Run
         2. Forward
         3. Reverse

4. Stop
5. Ready
6. Alarm
7. Fault
8. Input/Output (I/O) terminal
9. Keypad
10. Bus/Communication
11. Local (LED)
12. Remote (LED)
13. Fault (LED)

5. The AFD keypad shall be capable of displaying the following monitoring functions at a minimum:
   a. Output frequency
   b. Frequency reference
   c. Motor speed
   d. Motor current
   e. Motor torque
   f. Motor power
   g. Motor voltage
   h. DC-bus voltage
   i. Unit temperature
   j. Calculated motor temperature
   k. Voltage level of analog input
   l. Current level of analog input
   m. Digital inputs status
   n. Digital and relay outputs status
   o. Analog Input
6. Protective Functions
   a. The AFD shall include the following protective features at minimum:
      1. Over-current
      2. Over-voltage
      3. Inverter fault
      4. Under-voltage
      5. Input phase loss
      6. Output phase loss
      7. Under-temperature
      8. Over-temperature
      9. Motor stalled
      10. Motor over-temperature
      11. Motor under-load
      12. Logic voltage failure
      13. Microprocessor failure
   b. The AFD shall provide ground fault protection during power-up, starting, and running. AFD with no ground fault protection during running are not acceptable.
7. Diagnostic Features

a. Fault History
1. Record and log faults
2. Indicate the most recent first, and store up to 30 faults

8. Additional features to be included in the AFD:
   a. 120 VAC control to allow AFD to interface with remote dry contacts.
   b. Motor filter for use on motor cable runs exceeding 100 feet for motors with a peak voltage insulation rating less than 1600 Vac.
      1. A properly sized line reactor shall be installed at the AFD output to reduce dv/dt levels and the resultant peak voltage overshoots at the motor terminals.
   c. Communication card for interface with DeviceNet control system.
9. Enclosure
   a. The AFD enclosure shall be NEMA 1. The AFD shall have complete front accessibility with easily removable assemblies.
10. Spare Parts
    a. The main logic board, keypad and power supply board shall be supplied as spares, one for each different part number supplied.
11. The AFD manufacturer shall maintain, as part of a national network, engineering service facilities within 200 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
   1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
   2. After all tests have been performed, each AFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
   3. After the burn-in cycle is complete, each AFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.03 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of AFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer’s installation instructions, wiring, application dependant adjustments, and verification of proper AFD operation.

B. The Contractor under the technical direction of the manufacturer’s service representative shall perform the following minimum work.
   1. Inspection and final adjustments.

2. Operational and functional checks of AFD and spare parts.
3. The contractor shall certify that he has read the drive manufacturer’s installation instructions and has installed the AFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.04 MAINTENANCE / WARRANTY SERVICE

A. Warranty shall include all parts, labor, and travel time.

3.05 TRAINING

A. Shall be included with the MCC training.

END OF SECTION

SECTION 16495

SWITCHBOARD MATTING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Switchboard matting shall be furnished by the Contractor and placed in front of all power distribution and control equipment as indicated on the Contract Drawings.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Switchboard matting shall be W.H. Salisbury & Company, Safety Line, Inc., Tepromark, Wearwell, Erico, or equal.

2.02 MATERIALS

A. Switchboard matting shall be nonconductive with a minimum of 40,000 volts dielectric strength. The mat shall have a corrugated, non-slip surface and shall be a minimum of 1/4 inch thick. Width shall be 36 inches and length shall be as required at each location. The mat shall be black in color, ozone and oil resistant, and manufactured to meet all applicable ANSI/ASTM standards.

PART 3: EXECUTION

A. Install per manufacturer's instructions.

END OF SECTION

SECTION 16500

LIGHTING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The specific characteristics of the light fixtures to be furnished and installed shall be as detailed in the light fixture schedule on the Contract Drawings.

B. All Luminaires shall be quiet. If a Luminaire develops a noticeable hum within the warranty period, the Luminaire shall be replaced without cost to the Owner.

1.02 RELATED WORK SPECIFIED ELESEWHERE

A. Related Sections: The following sections contain requirements that related to this section.

1. Division 1 – General Requirements

2. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. General: Submit the following in accordance with Section 16010 General Electrical Requirements and the General and Special Conditions:

1. The lighting submittal shall be complete with all fixtures listed utilizing the same tagging convention as listed in the Light Fixture Schedule on the Drawing.

2. The submittal shall be bound in a three ring binder.

3. The minimum data for each light fixture shall include complete photometrics, electrical characteristics, construction characteristics, and options clearly listed.

4. If requested by the Engineer, the Contractor shall be prepared to submit sample equipment for appraisal when requested, and shall assume all transportation costs involved in the shipment and return of samples. All sample fixtures submitted shall be provided with lamps and shall be wired with cord and plug, connectable at 120 volts, single phase.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers of design and other acceptable manufacturers are listed in the Light Fixture Schedule located on the drawings.

2.02 BALLASTS

A. Where shown on the Contract Drawings, electronic ballasts with 10% THD (Total Harmonic Distortion) shall be provided with luminaires.

2.03 LUMINAIRES

A. All fixtures shall be delivered complete with suspension and mounting accessories, ballasts, diffusers, reflectors, etc., all wired and assembled. All accessory wiring shall be furnished and installed as shown on the Contract Drawings.

B. All steel supports required for luminaires in addition to that furnished under the general building construction shall be furnished and installed by the Contractor.

C. Luminaire wire shall be of non-asbestos construction.

2.04 LAMPS

A. Incandescent lamps shall be for 130-volt operation, unless otherwise specified.

B. LED lamps shall have color characteristics and a minimum Color Rendering Index (CRI) as indicated in the Light Fixture Schedule.

PART 3: EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General:

1. The Contractor shall furnish all light fixtures, lighting equipment, components, hangers, etc., as shown on the Contract Drawings and shall install them at the locations shown on the Contract Drawings.

2. Deliver lighting fixture in individually wrapped in factory containers. Stack and store in accordance with manufacturer’s instructions.

3. All fixture wiring shall be in conformance with the latest revision of the NEC and UL standards. All fixtures must be UL labeled and listed.

4. Lamps of the proper type, wattage and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project, with spare lamps as listed on the Contract Drawings.

5. Locations of fixtures shall be coordinated with reflected ceiling plans where they exist. Any conflicts between electrical plans and Engineer's reflected ceiling plans, the reflected plans shall override.

B. Luminaires:

1. Mounting heights specified as indicated shall be to bottom of fixture. Coordinate exact mounting of lighting fixture with type, style and pattern of ceiling being installed.

2. Clean interior lighting fixtures of dirt and debris upon completion of installation. Protect installed fixtures from damage during remainder of construction period.

3. Flexible fixture hangers shall be used for all pendant-mounted fixtures.

4. No light fixtures shall be hung or installed until after painting is completed, however, the Contractor shall provide temporary lighting.

5. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

C. Light Poles:

1. A concrete foundation shall be provided for each pole as detailed on the Contract Drawing. The poles will be mounted utilizing anchor bolts set in the concrete. The anchor bolts should have galvanized or plated threads and should be furnished with the pole by the manufacturer.

2. When anchor bolts are positioned prior to pouring concrete, spacing and projection must be verified with pole manufacturer's recommendations. A plastic or plywood template should be fabricated from the manufacturer's instructions to use when setting the anchor bolts. Anchor bolts that are not installed plumb and in the correct locations shall be removed and replaced. The Contractor shall not be allowed to bend the anchor bolts back to plumb after concrete is set.

3. Leveling nuts shall be utilized for the mounting of poles to foundations. A nut should be screwed down on each bolt until it meets the concrete, then the nuts must be adjusted until they are level.

4. The pole should be carefully lowered onto the anchor bolts and allowed to rest on

the leveling nuts. Flat washers followed by lockwashers should be placed on the anchor bolts and the top nut installed. Minor adjustments on the leveling nuts may be necessary to plumb the pole before the top nuts are tightened down. Special care should be taken to tighten the top nuts to the torque level recommended by the pole manufacturer. All nuts and washers shall be galvanized or plated.

5. Concrete grout of the nonshrink type must be installed between the base of the pole and the concrete foundation. The grout should be puddled around the edge of the pole base and firmly packed in the space between the pole and foundation. A short piece of small diameter pipe must be installed to make a drain hole through the grout to the pole interior.

6. Aluminum poles must have the bottom of the base painted with Koppers bitumastic No. 50 or equal substitute product before grouting so that the aluminum does not come in contact with the concrete.

7. Poles shall not be modified or drilled on the job site.

8. Under no circumstances should a ground wire be wrapped around an anchor bolt underneath an anchor bolt nut.

9. Do not set poles without light fixtures installed, as poles are more likely to vibrate and become damaged.

10. Manufacturer’s installation instructions should be followed as well as those instructions contained herein. Should a discrepancy exist, promptly contact the Engineer for clarification.

11. Bases shall have 1" chamfer all around and rubbed smooth to a point below grade.

12. Anchor bolt covers shall also be provided and installed.

END OF SECTION

SECTION 16900

CONTROLS AND CONTROL PANELS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Equipment controls and control panels shall be as specified herein and as shown on the Contract Drawings.

B. Certain equipment starters contain nonresettable elapsed time meters as shown in the Contract Drawings. Also, certain motor starters have remote control devices and require connections to operate these control devices as shown on starter schematics (control circuits).

C. All starters contain red “on” lights, control transformers, and auxiliary contacts to operate as defined on the control circuits of the Contract Drawings. Reset pushbuttons shall also be provided for overloads built into the starters.

1.02 REFERENCES

A. NFPA 79 – All control panels shall comply with NFPA 79.

B. NEC – All control panels shall comply with NEC article 409.

C. UL508 – All control panels shall be listed to UL508 and shall bear the UL label.

D. UL698 – All control panels with circuit extensions into hazardous areas shall be listed to UL698 and shall bear the UL label.

1.03 RELATED WORK

A. Drawings and General and Supplementary Conditions of the Contract and Division 1 Specifications sections apply to this Section.

B. All motor controls, starters, pushbuttons, pilot lights, and other miscellaneous devices shall comply with Section 16440 – MOTOR CONTROL.

1.04 SUBMITTALS

A. Panel and enclosure plan and elevation drawings depicting all components and wiring duct

B. Complete wiring diagrams

C. Catalog cut-sheets on all components, with options clearly indicated and non-applicable items clearly excluded

D. Enclosure heat gain calculation – Shall indicate the maximum temperature inside the enclosure on a 100°F day taking into account heat losses and inefficiencies of all panel components. Heat gain shall include the effects of radiation (if located outside) and air-conditioners or ventilation fans. The maximum operating temperature of all major equipment and panel components shall be listed. The heat transfer calculation shall be based on the enclosure manufacturer's published heat transfer data. This manufacturer's data or curve shall be submitted with the calculation for review.

E. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature. For example: Device boxes – Styles shall be listed as: For masonry walls, for electrical devices, for ceiling mounted light fixtures, etc

F. O&M manuals shall be submitted in accordance with Section 16010. They shall include all field modifications made such that the wiring diagrams exactly match the field-installed equipment and control panels. They shall also include complete cut-sheets, product data, operation, and maintenance information.

1.05 CUSTOM CONTROL PANELS

A. All control panels furnished under this Contract shall be manufactured in accordance with industry standards and as herein specified. Some control panels are specified to be furnished with the equipment controlled and others are to be furnished by the Contractor, as written elsewhere.

B. Control panels shall be as manufactured by ControlWorks, Inc., Control Interface, Inc., Sewell Electronics, or other panel vendor.

C. Control panels to be furnished on this project shall be wired to function according to schematics shown on the Contract Drawings. All Control Panels shall be manufactured using "relay logic", or PLC'S (Programmable Logic Controllers) as shown on schematics (control circuits) located in the Contract Drawings. In addition to the requirements shown on the Contract Drawings, the panels shall adhere to additional requirements as written herein, and in the utilization equipment specifications.

D. All relays, timers, terminal strips, etc., shall be mounted to a subpanel inside the enclosure. All wiring must be stranded and sized to be protected by a 20 A/IP circuit breaker. Supplemental overcurrent protection may be used in lieu of oversized wiring. All panels mounted outside shall have operators devices mounted on an inner door with an outdoor door that is blank. All panels mounted inside shall have operators devices mounted on the

outer door.

E. All terminal strips and lugs shall be of a type UL listed to terminate the size and quantity of wires encountered. Where conduits enter the boxes, if they are NEMA 4 or 3R, sealing locknuts or hubs must be used to maintain the box rating. The exterior of steel panels shall be painted ANSI 49 light gray, lacquer or enamel.

F. Enclosures shall be provided with a locking hasp and any exterior hardware shall be stainless steel or other corrosion resistant material. Enclosures for interior use in dry areas shall be of the NEMA rating indicated on the Drawings. Wet location or outdoor mounted enclosures shall comply with Article 1.04 below.

G. Elementary control schematics and connection diagrams showing the spatial relationship of components and wiring shall be submitted for review. Also, a bill of materials, drawing of device arrangement on front, and enclosure fabrication drawings shall be submitted. Further, descriptive literature is required on all components. A copy of the as-built drawings shall be furnished and stored in a pocket inside the enclosure.

H. Sleeve type wire markers or other "permanent" type marker shall be installed on all wires, keynoted back to the elementary schematic or the connection diagram, and all terminals identified.

1.06 SYSTEM DESCRIPTION

A. General

1. The systems description section of these Specifications is supplementary to the descriptions in other Divisions of the Specifications and to the Contract Drawings. Refer also to the equipment specifications and controls shown on the Contract Drawings.

B. Systems Common to All Structures/Basins

1. Single Phase Ventilators and Motor Operated Dampers

a. The ventilators and motor operated dampers shall be served by molded case circuit breaker subfeeds from the single phase panels. All ventilators and motor operated dampers shall have a manual resettable thermal overload device in each ungrounded leg of its power circuit for overcurrent protection. The ventilators and/or dampers shall be controlled by switches, remote contacts or thermostats as shown on the Contract Drawings. Supply type ventilators with motor operated dampers shall be wired through damper switches so that the ventilator will not start until the damper is fully open. Ventilators, dampers with motors and contacts and thermostats shall be provided under Division 15 of these Specifications. Starters, conduit and

wiring shall be furnished and installed under this Division.

2. Monitoring and Instrumentation

   a. The instruments that require power shall be served by molded case circuit breaker subfeeds from the single phase panel. Voltages shall be as shown on the Contract Drawings. The instrumentation shall be provided under Division 17 of these Specifications. The conduit and all power, control and signal wiring shall be furnished and installed under this Division to operate as described in Division 17 of these Specifications and as shown on the Contract Drawings.

3. Emergency Lighting Fixtures

   a. The emergency lights shall be wall or ceiling mounted as indicated on the Contract Drawings and shall be wired into the load side of the power circuit to normal room lighting.

4. Corrosion Resistant Electric Heaters

   a. The electric heaters shall be served by molded case circuit breaker subfeeds from building power distribution equipment, voltage and phase as shown. Heater, mounting bracketing, and thermostat shall be provided under Division 15.

   b. The heater may require the use of a separate contactor which shall be NEMA 4X enclosed, furnished under division 15, depending on brand heater supplied. All conduit and wiring shall be furnished and installed under this Division.

   c. Corrosion resistant unit heaters in smaller sizes sometimes require a separate control power feed from a lighting panelboard. Consult manufacturer provided, Engineer reviewed shop drawings.

PART 2: PRODUCTS

2.01 ENCLOSURES – NEMA 4X

A. Control panel enclosure shall be wall-mount type where sized at 30” width x 42” height or less. Otherwise, it shall be floor-mount type. All panels indicated on the Drawings to be floor-mounted shall be floor-mounted regardless of size. Enclosures shall be single or double-door as required. Enclosures shall be manufactured by Hoffman, or equal.

B. Enclosure material shall be stainless steel type 304. The enclosure shall be sized to provide 25% spare panel space. Seams shall be continuously welded and ground smooth.

C. Enclosure door shall have a 3-point latch. Screw clamps are not acceptable. The latch handle shall have a padlock hasp.

D. Enclosures for installation outside shall have an interior dead-front swing out panel for panel-mounting of all pilot devices and displays. Enclosures for installation inside shall have pilot devices mounted on the outer door. Enclosures shall also have an interior pocket for holding wiring diagrams, and an interior sub-panel for mounting control equipment.

2.02 WIRING REQUIREMENTS

A. Wire and cable shall comply with Section 16120 except Type MTW conductors shall be used inside the control panel for control circuits. Control circuit wiring shall be 18 gauge or larger.

B. Control wiring shall be terminated using crimp-type ferrule, fork, or ring terminals. Power wiring shall utilize compression lugs.

C. Wiring shall extend to terminal blocks for connection to external equipment.

2.03 TEMPERATURE CONTROL DEVICES

A. Electric Heater for Control Panels

1. Provide an electric heater for exterior control panels
2. Heater shall be sized as indicated on the Contract Drawings, or shall be sized and submitted in the Enclosure Heat Gain calculation
3. The heater shall include an integral thermostat, adjustable from 0°F to 100°F, and a fan
4. Heater housing shall be anodized aluminum
5. Fan shall have ball bearings and shall be designed for continuous operation
6. Terminal strip shall accept both solid and stranded wire
7. The heater shall be UL Recognized and CSA listed
8. The heater shall be Hoffman’s thermostatically controlled fan-driven heater, or equal.

B. Air Conditioners for Control Panels

1. Provide an air conditioner (AC) for control panels where indicated, or where necessary as determined by the Enclosure Heat Gain calculation. All control panels with VFDs are required to have air conditioners.
2. The AC size shall be as indicated, or as determined by the Enclosure Heat Gain calculation
3. The AC shall include thermostat control and EMI/RFI noise suppression
4. The AC shall have a hinged front cover for quick access to all components
5. The AC shall have mounting flanges for installation on the side of the enclosure

6. The AC shall dehumidify the enclosure when operating
7. The AC shall use a CFC-free or environmentally safe refrigerant
8. The AC shall be rated NEMA 4X, and shall be constructed of aluminum or stainless steel. When mounted to the enclosure, it shall maintain the 4X rating of the enclosure.
9. A special coating shall be applied to coils and copper lines exposed to the ambient air to prevent corrosion. The thermostat shall be tin-plated.
10. The AC shall be UL listed or recognized for the application it is used in.
11. The AC shall be Hoffman's CR series, or equal.

2.04 POWER SUPPLIES

A. DC Power Supplies

1. DC power supplies shall be switched mode and Din-rail mountable.
2. Input power range shall be from 85-264 VAC.
3. Output voltage range shall be as needed with a tolerance of 1%. Output voltage shall be adjustable up and down at least 10% from the nominal value.
4. The power supply shall include an internal input fuse.
5. Power supply shall have a "DC Ok" signaling LED.
6. Operating temperature rating shall be –25 C to +70 C and up to 95% relative humidity.
7. Output power shall be buffered for full output power ridethrough for 20 milliseconds in the event of a power outage.
8. The power supply shall be able to supply 150% of its continuous capacity for short periods of time.
9. The power supply shall have internal short circuit protection with automatic recovery.
10. The power supply shall be Phoenix Contact, Sola, Allen-Bradley, or equal.

2.05 OVERCURRENT PROTECTION

A. Main 3-Phase Breakers – Shall be thermal-magnetic, molded-case, Type FA or KA as needed, Square D or equal. Provide service entrance rating where indicated on the Drawings as being used in a service entrance application. Interrupting rating shall be 14000 amps minimum.

B. Main Single-Phase Breakers – Shall be Din-rail mountable with clear "on," "off," and "tripped" positions, Square D QOU or equal. Where a substantial number of breakers are used, provide a panelboard mounting base.

C. Combination Starters – Circuit breakers for use with combination starters shall be magnetic-only, Square D MagGuard, or equal, with adjustable trip settings.

D. Supplementary Protectors – Shall be Din-rail mountable UL489 listed. Trip rating shall match load served.

E. Power Fuses – Utilize Class J fuses and fuse blocks. Fuse blocks must have protective cover. Fuses may only be used where indicated on the Drawings. Otherwise, use circuit breakers.

2.06 MISCELLANEOUS PANEL COMPONENTS

A. Terminal Blocks, #10 conductor size and smaller.

1. Terminal blocks shall be Din-rail mountable IEC style with minimum width of 6.2 mm. They shall be rated for conductors from #10 to #24 AWG. Current rating shall be 30A, minimum. Terminal blocks shall be finger-safe. Double level terminal blocks may be utilized where necessary to conserve space.
2. Screw clamp terminal blocks are required. Terminal blocks that rely upon spring pressure only for conductor termination are not acceptable.
3. Provide cross connection bridges, partition plates, end anchors, zack strip labels, and all other components necessary for a complete installation. Each block shall be labeled with a machine-printed label. No more than 2 conductors may be landed under on single terminal block terminal screw.
4. Utilize the following terminal block colors:
    a. 120V Power – Black
    b. 120V Control – Red
    c. 120V Neutral – White
    d. Equipment Grounding – Green or Green/Yellow
    e. DC Positive – Blue
    f. DC Negative/Grounded – Gray
    g. Conductor energized from remote source: Yellow
5. Terminal blocks shall be manufactured by Phoenix Contact, Allen-Bradley, or equal.

B. Fuse blocks (control circuits) – Fuse blocks shall be finger safe and shall have LED indication when the fuse is blown. Fuses may be used only where indicated on the Drawings; otherwise use circuit breakers.

C. Conductor Labels – Shall be the heat-shrink type, machine printed. Brady, or equal.

D. Component nameplates – Shall be engraved, rigid, laminated plastic with adhesive back and letter height of 3/16” minimum. Nameplates shall be white with black letters.

E. Intrinsic Safety Barriers – Provide UL listed intrinsic safety barriers for circuit extensions into hazardous areas. The barriers shall be Phoenix Contact, or equal.

F. Transient/Surge protectors shall comply with Section 17200.

G. Control transformers shall be machine tool type transformers with epoxy encapsulated coils

or resin impregnated coils, high quality silicon steel laminations, copper magnet wire, molded-in terminals, and 55°C rise insulation system.

H. Voltage/Phase Monitor – Shall continually measure the voltage of all phases of incoming power and provide protection for any motors or other equipment that could be damaged. The phase monitor shall sense under and overvoltage, voltage unbalance, phase loss, and phase reversal.

PART 3: EXECUTION

3.01 LABELING

A. Provide labels for all conductors and components.

B. Legends for starter nameplates shall be taken from the one line diagram in the Contract Drawings. Wire and miscellaneous component labels shall match the O&M manual wiring diagrams.

3.02 GROUNDING

A. Enclosures shall be grounded in accordance with the NEC.

B. Each analog signal loop shall be grounded at a single point for the loop at the location of the DC power supply for the loop.

3.03 PROTECTION

A. All electrical and electronic components of the Control Panel shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and surges in nearby electrical systems. The TVSS alarm contact shall be connected to the SCADA system.

B. All control panels shall be equipped with a voltage/phase monitor. The monitor shall have an alarm contact connected to the SCADA system.

3.04 INSTALLATION/ERECTION

A. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, manufacturer Shop Drawings, and manufacturer installation instructions.

END OF SECTION

SECTION 17100

PROCESS INSTRUMENTATION

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide instrumentation as indicated on the Contract drawings. Provide all materials, labor, spare parts, start-up services, as shown and specified and as required to install a complete, functional, calibrated instrumentation system.

B. Provide surge protection on instrumentation loops and power supplies as specified herein.

C. Provide instrumentation training services.

1.02 RELATED WORK

A. Installation of all electrical equipment, conductors, and related items shall be in accordance with all applicable sections of Division 16 of these specifications.

B. General Requirements are included in Division 1.

C. Division 11 – Equipment

1.03 SUBMITTALS

A. Shop drawing approval is required before the Contractor purchases or installs any equipment. Submit in accordance with Section 17010.

B. Operation and Maintenance Manuals shall be submitted in accordance with Section 17010.

1.04 QUALITY ASSURANCE

A. The Contractor shall be a factory authorized representative capable of start-up services of the equipment or shall provide the services of a factory-authorized representative.

B. The instrumentation/Scada system shall be furnished as an “open” system that can be modified and updated by the Owner or by any of the Owner’s designated representatives. Proprietary systems will not be considered. The Owner reserves the right to cancel any post-construction service contract at any time due to quality of service or any other reason as determined by the Owner.

1.05 WARRANTY AND SERVICE

A. The Contractor shall guarantee all work including equipment, materials, programming, calibrations, and workmanship. This guarantee shall be against all defects of any of the above and shall run for a period of 1 year from the date of acceptance of the work, concurrent with the one-year guarantee period designated for the general construction contract under which the work is performed. Date of acceptance shall be considered to be the date on which all "punch list" items are completed ("punch list" is defined to be the written listing of work that is incomplete or deficient that must be finished or replaced/repaired before the Contractor receives final payment).

B. Return visits – the Contractor shall provide a minimum of two one-day return visits after final completion to implement additional software items as requested by the Owner. The costs for these return visits shall be included in the bid price.

C. Equipment manufacturers shall provide a minimum of one-year of free technical support dating from final acceptance. Certification of this shall be provided to the Owner with the O&M manuals.

1.06 SPARE PARTS

A. Furnish a one-year supply of any expendable parts for each device.

B. Ten fuses of each size/type in the system.

1.07 TRAINING

A. The instrumentation training program shall be a minimum of one 8 hour day on-site.

1.08 DELIVERY AND STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

PART 2: PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers/suppliers for the instrumentation equipment shall be Rosemount, , Endress-Hauser, ABB, or equal. Manufacturers of small peripheral equipment are listed with each piece of equipment.

B. All equipment shall be UL listed where a listing exists.

C. All electronic instrumentation equipment shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA dc. No zero based signals will be allowed for remote transmission.

D. All instrumentation supplied shall be of the manufacturer's latest design and be compatible for the industry it is being applied.

E. All scales and readouts shall be direct reading in process units. Conversions are not acceptable.

F. All transmitters shall be provided with indicators, either integral or remote mounted, but must be within site of the transmitter unless specifically indicated otherwise on the Contract drawings.

G. All equipment must be able to reset after a power outage without having to be manually reset.

H. All circuit boards in instruments mounted outdoors, or in damp locations, shall be fungus proofed.

I. All equipment mounted outdoors shall be protected from the sunlight, and extreme temperatures between –20 degrees and 140 degrees Fahrenheit. Provide all necessary shielding, heaters, or air conditioners as required. All externally mounted panels shall have self-sacrificing corrosion inhibitors installed.

2.02 INSTRUMENTATION EQUIPMENT

A. Pressure Gauges

1. All indicating gauges shall be pipe mounted with male and brass threaded pipe connections. Gauges shall be liquid filled for maximum vibration and corrosion protection. Gauges shall have phosphor bronze Bourdon tubes, white laminated phenol dials, micrometer pointer and be enclosed in painted aluminum enclosure. All gauges shall be 4 ½" with 0.5% of scale accuracy. Gauges shall be manufactured by Helicoid Gauge Division, James P. Marsh Corporation, Ashcroft, U.S. Gauge, or equal. Gauges shall have diaphragm seals with non-magnetic stainless steel bolts.

2. Piping valves and fittings for gauges, and the fittings for gauges on the discharge side of the high service pumps, shall be rated for 300 psi.

B. Float (Level) Switches

1. The float switch shall be oval-shaped, direct-acting, with a single pole mercury switch which activates when the liquid level is slightly above horizontal and de-actuates when the liquid level falls below horizontal. Electrical rating shall be 4.5A minimum at 120V; 2.25A minimum at 230V (resistive). The float body shall have polypropylene casing that is impact and chemical resistant. It shall be a suspended-style unit with built-in counterweight.

2. The switch shall have a cable which is oil-resistant, 18 gauge, 2 conductor, extra hard usage STOOW-type and is rated for 600V. The cable shall be furnished of a length sufficient to terminate as shown on the Contract drawings. The switch and cable assembly shall be UL listed.

3. The float switch shall be Roto-Float Signal-Duty Internally Weighted Float Switch, or equal.

C. Electromagnetic Flowmeter and Transmitter

1. The electromagnetic flow meter shall consist of a flow sensor based on Faraday's Law of Electromagnetic Induction and microprocessor-based signal converter & transmitter.
2. The sensor flow tube shall be 304 stainless steel surrounded by two coils. Liner material shall be Neoprene. Measurement and grounding electrodes shall be 316 stainless steel. Connecting flanges shall be carbon steel with corrosion resistant two component coating. Size shall be as indicated on the Contract drawings.
3. Assembly shall be FM approved for a Class 1 Division 2 area, and shall be rated NEMA 6P with 3 foot submersion capability for up to 30 minutes.
4. Operating temp: Operating Temp: -5 to +120° F minimum acceptable band
5. Display: Background illumination with alphanumeric 3-line, 20-character display to indicate flow rate, totalized values, settings, and faults
6. Power supply: 115/230 VAC or 24VDC as indicated on Contract Drawings.
7. Outputs: 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1A. Provide Digital pulse for external display of flow rate or totalizer.
8. Flow Range: 1.5 fps to 33 fps for accuracies stated below.
9. Accuracy: 0.5% of actual flow.
10. Separation: Allowable distance of 900 feet between signal converter and sensor without the use of any additional equipment
11. Provide Bi-directional flow capabilities
12. Totalizer: Two eight-digit counters for forward, net, or reverse flow
13. The electromagnetic flow meter shall be a Siemens Model MAG 3100W flow sensor with a Siemens Model MAG 5000 signal converter, or equal. Insertion type flow meters will not be accepted.

F. Instrument Valves (1/4" through ¾")

1. Shutoff valves shall be provided on each pressure line to an instrument and accessory item, and shall be bronze ¼ turn ball valves with Teflon seats as manufactured by Whitey Co., Gould, Hoke, Apollo, or equal. Valves shall have a corrosion resistant handle.
2. Throttling valves where required and/or shown on the Contract Drawings shall be bronze globe valves, NUPRO "J" Series, Hoke 3700-3800 Series, or equal. Valves shall have a corrosion resistant handle.

G. Tubing

1. Tubing for pressure lines to transmitters shall be hard drawn copper or 316 stainless steel. Bulkhead fittings, bushings, etc., shall be those especially designed for the tubing and used at all terminations. Tubing shall be Type "L" copper bent with bending tools, o as to have a minimum number of joints. Solder joint fittings are not allowed; compression type shall be utilized, Swagelok or equal.

2. All runs of tubing shall be straight, parallel to walls with a slope to a drip leg at each connection to a transmitter, where the transmitter is below the primary element. Horizontal liquid-filled lines shall slope at least 1 inch per foot downward toward the measuring element to ensure that air or gas bubbles return to the main flow line or tank.

2.03 SURGE PROTECTION FOR INSTRUMENTATION

A. Local Surge Protection Device for Analog 4-20mA loops.

1. The local surge protection device shall be installed at the location of the instrument it is protecting.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for "fine" voltage clamping and "coarse" surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 10 ohms.

3. The device shall be Class 1, Div. 2 certified under UL1604 if it is located in a hazardous area as indicated on the Contract drawings.

4. The device shall be housed in a stainless steel pipe stub or similar for installation on a field-mounted conduit body. Temperature range shall be –40°C to 80°C.

5. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 270mA continuous current.

6. The device shall be a Phoenix Contact "Pipetrab" surge protection device, or equal.

B. Din-Rail-Mounted Surge Protection Device for Analog 4-20mA loops & Power Supply

1. The Din-Rail-Mounted surge protection device shall be installed at the termination end of the instrumentation loop where it enters the I/O cabinet.

2. The device shall have a surge handling capacity of 20kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 2.2 ohms.

3. The device shall be suitable for din-rail mounting, and shall be no more than 17.5 mm thick. Temperature range shall be –40°C to 80°C.

4. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 450mA continuous current.

5. Where the instrument being protected has a separate 24VDC power supply in addition to the analog current loop, the 24VDC supply circuit shall also be protected with a total surge current rating of 700A (8/20microsecond), clamping voltage less than or equal to 180V (conductor to conductor) or 550V (conductor to ground. Response time shall be 25nanoseconds (conductor to conductor) or 100 nanoseconds (conductor to ground).

5. The device shall be a Phoenix Contact “MCR-Plugtrab PT” surge protection device, or equal.

PART 3: EXECUTION

3.01 EQUIPMENT INSTALLATION

A. General

1. All piping to and from field instrumentation shall be provided with necessary unions, tees, adapters, and shut-off valves.

2. Install all equipment in accordance with the manufacturer’s installation and maintenance information.

3. Provide and install all necessary mounting equipment, brackets, required for mounting of equipment.

4. Instrument cables shall be pulled without undo stress that may aggravate the number of twists per foot. Shields shall be continuous and shall be only grounded at one end.

5. Place silicone caulk around the wires in each conduit entering every instrument enclosure for the project.

6. All instruments and equipment shall be left free from shipping burrs, paint overspray, grease, etc. All scratches shall be touched up with manufacturer's matching paint.

7. Provide a local surge protection device at each instrument in the 4-20 mA loop if it is located more than 50 feet from the I/O cabinet. Provide a local surge protection device at the instrument for all underground STIC installations.

8. Provide a Din-rail-mounted surge protection device at the I/O cabinet termination on each 4-20mA loop and 24VDC instrumentation power supply circuit.

8. Install on each instrument, transmitter, recorder, indicator, etc., a plastic engraved white with black letters nameplate secured to the panel. Nameplates shall be permanently secured with stainless steel screws if it does not interfere with the NEMA rating of the box. Two wire transmitters shall be supplied with a metal tag if no room exists for a nameplate.

9. Locate instruments as shown on the electrical drawings and primary elements as shown on the electrical or plant process drawings.

10. Transmitters or indicators shall not be mounted from process piping or hangers, only the building structure.

11. Remove all shipping tags, lifting rings, from enclosures. Plug all non-used holds in enclosures.

12. The system supplier shall coordinate the installation through the Contractor.

13. The placing and location of system components, their connections to the process equipment panels, cabinets and devices, shall be coordinated with the Engineer's acceptance.

3.02 STARTUP SERVICES

A. After equipment and materials have been shipped to the job site, the Contractor shall furnish the services of a factory-trained service technician or engineer to assist and advise the Contractor during installation and to provide calibration/adjustment at initial startup.

B. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the Contractor shall schedule a performance test in the

presence of the Engineer on all equipment. The Contractor shall furnish the services of servicemen, all special tools, calibration equipment, and labor to perform the tests.

C. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked. Testing shall be done from the signal source to the final element or device including all field wiring.

D. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, the Contractor shall make such adjustments or alterations as are necessary to bring equipment up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

END OF SECTION