SECTION 43 11 33
POSITIVE DISPLACEMENT BLOWERS AND ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope of Work: Furnish all labor, materials, equipment, and incidentals required and install, place in operation, and field test two (2) electric motor driven, rotary lobe positive displacement blowers for filter backwash. Blowers shall be of the type and size specified herein and include all appurtenances to provide complete systems ready for operation. Blowers shall be installed at the locations shown on the Drawings. Each blower shall include the following:

1. Inlet air filter.
2. Intake silencer.
3. Blower and motor, base mounted.
4. Discharge silencer.
5. Pressure relief valve.
6. Check valve.
7. Isolation valve.
8. Sound attenuating enclosure.
9. Instrumentation
10. Spare parts for each blower.
11. Miscellaneous appurtenances.

B. Related Work Described Elsewhere:

1. Submittal Procedures: Section 01 33 00
2. Operation and Maintenance Data: Section 01 78 23
3. Warranties and Bonds: Section 01 74 00
4. Concrete: Division 3

5. Metals: Division 5

6. Painting: Section 09 91 00.

7. Electrical: Division 26

C. These Specifications are intended to give a general description of what is required but do not cover all details, which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, complete installation, and field testing of all materials, equipment, and appurtenances for the complete blower units as herein specified.

D. For all units, furnish and install all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. This installation shall incorporate the highest standards for the type of service shown on the Drawings including field testing of the entire installation and instruction of the regular operating personnel in the care, operation, and maintenance of all equipment.

1.02 QUALIFICATIONS

A. To assure unity of responsibility, the blowers and motors shall be furnished and coordinated by the blower manufacturer. The Contractor and manufacturer shall assume responsibility for the satisfactory installation and operation of the blowers.

B. The blowers covered by these Specifications are intended to be standard equipment of proven ability as manufactured by a reputable and qualified manufacturer having experience in the production of such blowers. The blowers furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

C. All equipment furnished under these Specifications shall be new and unused, shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years. The manufacturer shall have at least ten (10) installations of similar equipment in Alabama operating for five (5) years.

D. Blowers shall be manufactured by Universal Blower Pac, Incorporated, Aerzen or General Electric - Roots.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of Section 01 33 00. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions, and anchor bolt locations, and stating what items will be shipped to the job site assembled and those shipped loose for field assembly.

2. Descriptive literature, bulletins, and/or catalogs of the equipment including standards of design, materials of construction, and prime/paint coating systems.

3. Data regarding the characteristics and performance of each blower. Data shall include factory guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for capacity in SCFM, discharge pressure in psig, blower rpm, efficiency, and brake horsepower required at the design conditions, as well as discharge temperature at ambient temperature and normal system operating conditions. Curves shall be submitted on 8 1/2-inch by 11 inch sheets, at as large a scale as is practical. Catalog sheets showing a family of curves will not be acceptable.

4. L10 bearing life calculations for each bearing.

5. The total weight of the equipment, including the weight of the single largest item.

6. A complete total bill of materials of all equipment.

7. A list of the manufacturer's recommended spare parts to be supplied in addition to those specified in Paragraph 1.05, with the manufacturer's current price for each item. Include gaskets, bearings, seals, etc., on the list. List bearings by the bearing manufacturer's numbers only.

8. Motor data including 1/2, 3/4, full load efficiencies and power factors and as required herein.

9. An attenuation performance curve for each type of silencer.

10. Set pressure for the pressure relief valve.

11. Coupling drive calculations.

12. Copies of all factory test results, as specified herein.

13. Warranty statement.

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

1.04 OPERATING INSTRUCTIONS

A. Operating and maintenance manuals shall be furnished as specified in Section 01 78 23. The manuals shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The number of manuals to be submitted and special requirements shall be as specified in Section 01 78 23.

B. A factory representative who has complete knowledge of proper operation and maintenance shall be provided for two (2) days to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and test run as provided herein with the Owner's permission. If there are difficulties in operation of the equipment due to manufacturer's design or fabrication, additional services shall be provided at no cost to the Owner.

1.05 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided for the blowers. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.

B. The manufacturer shall furnish a complete set of recommended spare parts necessary for the first one (1) year operation of the blower system, which shall include at least the following:

1. Two (2) sets of drive belts for each blower supplied, if applicable.

2. Two (2) filter elements for each inlet filter/silencer supplied.

3. One (1) year's supply of each type of lubricant required.

C. Spare parts shall be properly packaged and labeled for identification without opening the packaging and shall be suitably protected for long-term storage.

1.06 PRODUCT HANDLING

A. All items shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Care must be taken during unloading and handling of equipment to ensure against undue strain to the blower and motor. DO NOT use lifting straps or chains under the blower or motor. Lift from under the main frame, base or use base mounted lifting lugs (if provided).

C. In storage blowers must be kept clean, free of moisture and rotated a minimum of 20 revolutions each week. For storage in excess of four (4) months, or in a damp or corrosive environment see the manufacturer's operation and maintenance manual.

1.07 WARRANTY

A. The manufacturer shall provide a warranty stating that the blower system is warranted to be in accordance with the product specifications and to be free from defects in workmanship and materials. The blower system manufacturer's product warranty will extend to all packaged products supplied by the blower system manufacturer whether or not manufactured by the blower system manufacturer.

B. Refer to Section 01 74 00 for specific warranty requirements.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The blower units required under this Section of these Specifications shall be complete with proper alignment and balancing of the individual units. All parts shall be designed and proportioned to have liberal strength, stability, and stiffness, and to be especially adapted for the intended service. Ample room shall be provided for inspection, repairs, and adjustment.

B. The support system for blowers and drives shall be rigidly and accurately anchored into position. All foundation bolts, plates, nuts, and washers shall be furnished by the Contractor. All anchoring hardware shall be Type 316 stainless steel.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, discharge pressure, speed, brake horsepower, efficiency, and all other pertinent data shall be attached to each blower and motor. Stainless steel nameplates shall be attached to the blower with stainless steel screws or pins.

2.02 BLOWERS

A. General:

1. Furnish each blower complete with electric motor, steel base, drive system and appurtenances.

2. The blowers shall be of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

3. The blowers shall be furnished with a common base or skid for blower, motor and drive unit. Base shall be fabricated of carbon steel with all necessary auxiliary equipment.

4. The blower packages shall be as manufactured by Universal Blower Pac, Incorporated, General Electric - Roots, or an approved equal.

B. Performance:

1. The blowers shall be capable of meeting the conditions described in the table below.

Table A
GENERAL BLOWER PERFORMANCE SUMMARY

Parameter	Requirement
Number of Units	2
Capacity (Each)	4,200 SCFM
Discharge Pressure*	6.0 psig
Altitude, MSL	600 ft.
Minimum Inlet Temperature	20°F at 36% R.H.
Maximum Inlet Temperature	100° F at 36% R.H.
Maximum Relative Humidity	85%
Maximum Blower Speed	1,785 rpm
Maximum Motor Horsepower	150 HP
Basis of Design	Universal Blower Pac

*Note: Discharge pressure is specified at the discharge of packaged unit.
The blower system supplier must take into account filter, silencer, and internal piping losses.

C. Blower Construction:

1. Blowers shall be the tri-lobe (three-impeller) rotary positive displacement type.

2. Each blower casing shall be of one-piece construction with separate headplates at the gear end and drive end. Casings and headplates shall be made of close-grained cast iron suitably ribbed externally to prevent distortion under the specified operating conditions. Casings shall be provided with inspection ports to permit internal inspection and clearance checks. Inlet and outlet connections shall be flanged with standard ANSI 150 pound flanged drilling. The casing shall meet ASTM A48 Class 30A and have a 30,000 psi tensile strength.

3. The impellers shall be of the straight, tri-lobe involute type and shall operate without rubbing, liquid seals or lubrication. Impellers shall be constructed of ductile iron or close-grained cast iron. All impellers shall be statically and dynamically balanced, and machined on all exterior surfaces for operating at close tolerances. The impellers shall be attached to forged, machined alloy steel shafts by flanges integral with the impellers or impellers shall be cast integral with shafts. Shafts shall be of one-piece straight through design or two-piece design with stub shaft cast integrally with the impellers and designed to withstand all operating loads imposed.

4. The impellers shall be positively timed by a matched pair of timing gears. Timing gears shall be designed and manufactured for continuous service in accordance with AGMA Standards. Timing gears shall be fully machined from heat-treated alloy steel and adjustable for field retiming.

5. Each impeller and shaft assembly shall be supported by a minimum of two, double-row, antifriction, spherical, self-aligning bearings. All bearings shall have a B_{10} bearing life of 20 years in continuous operation, as defined by AFBMA Standards. The bearings shall be replaceable without the necessity of disconnecting the piping or disassembly of the unit housing. The bearing housing shall be of totally closed, gas tight construction.

   a. Lubrication to the gears of each blower shall be maintained by an oil bath relying on gears to splash lubricate all moving parts. The oil system shall have sufficient capacity and cooling provisions to provide adequate oil to the gears and bearings with a continuous service interval between oil changes of not less than 2,000 hours. Bearings shall be provided with seals that will prevent lubricant from entering the air stream. Air vents shall be located between the

seals and the impeller chamber to relieve excessive pressure on the seals.

b. Sight glasses shall be provided for oil level observation. Each sight glass shall be able to indicate that a safe oil level exists during blower operation and accurately indicate the amount of oil present when the blower is off. The system shall be arranged so that should a sight glass break during operation, the oil loss will be limited so as to prevent damage to the blower under continued operation.

6. Each unit shall be either belt driven or directly connected to the drive motor:

   a. The unit may be V-belt driven with matched belts and sheaves designed at the proper speed ratio to meet the specified conditions. A belt guard of solid metal construction shall be provided which meets all OSHA requirements.
   b. Motor may be direct connected to the blower with a grid-flex type coupling having at least 2.0 service factor above the motor nameplate horsepower. A drive guard with top, sides and bottom made of 14 gauge sheet steel with expanded metal front and back shall be provided. The system shall be designed to allow ample ventilation for the drive, have an easy access cover, and conform to applicable safety codes.

7. The blower unit shall be a packaged base mounted unit including blower, motor, inlet filter, inlet silencer, discharge silencer, drive, drive guard, pressure relief valve, interconnecting pipe, supports, and appurtenances and shall be shipped assembled on the base to the extent allowable by trucking.

8. The base design shall be as specified in either of the following options:

   a. The baseplate shall be of welded carbon steel construction to provide adequate support of the blower unit, drive motor, drive components and accessories. Each motor mounting base shall include all necessary provisions to permit proper blower/motor alignment. The motor mounting base shall be of the adjustable two-rail type with each rail having a corresponding threaded rod to facilitate alignment and drive belt replacement/tensioning. The baseplate shall be sufficiently reinforced and braced to withstand all shock loads and resist all wearing and buckling during blower operation.
   b. A steel angle or channel skeleton-frame base, elevated on legs, with continuous welded joints shall be supplied. Base shall be constructed of carbon steel.

9. The base unit shall be provided with 1/2-inch thick neoprene rubber base pads for vibration isolation of the unit. Neoprene pads shall be of ribbed construction with a Durometer hardness of 40± 5 Shore A. Neoprene pads shall be sized to limit loading to 60 psi maximum.

10. Blower and motor combination units shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level without the sound attenuating enclosure not to exceed 98 dBA as measured 5 feet from any surface.

2.03 ELECTRIC MOTORS

A. General:

1. The motors for the blowers shall be of the horizontal, open drip-proof design.

2. All motors shall be built in accordance with latest NEMA, IEEE, ANSI, and AFBMA standards where applicable.

3. Motors shall be as manufactured by U.S. Electric Motors, General Electric Company, Reliance, Toshiba, or approved equal.

B. Performance Requirements:

1. Motors shall be rated for operation on a 460-volt 3-phase, 60 Hertz power supply.

2. Each motor shall have a 1.15 service factor.

3. Motors shall be rated at a minimum horsepower as listed in Table A.

4. Motors shall be premium efficiency.

5. Maximum motor speed shall be 1,800 rpm.

6. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 98 dBA as measured 5 feet from any surface.

7. Maximum temperature rise of motor windings shall not exceed 80 degrees C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air temperature of 40 degrees C.

C. Each motor shall be provided with a 120-volt single phase strip heater to maintain a motor temperature of at least 40 degrees C or 10 degrees C above ambient, whichever is greater.

2.04 SOUND ATTENUATING ENCLOSURES

A. Provide a sound attenuating enclosure for each blower and motor combination. The enclosure shall ensure that the sound level for the entire unit to be no greater than 75 dBA at 3 feet from the operating equipment in a free field environment. Enclosures shall be designed, assembled and inspected by the blower system supplier at the manufacturing site with documentation provided to verify the noise reduction required in these documents. All readings shall be taken by personnel experienced in the field of sound attenuation.

B. The sound attenuating enclosure shall be fabricated of welded 14 gauge galvanized steel, lined with a special acoustical liner.

C. Each enclosure will be fitted with a weather hood covered acoustical intake vent rated for the blower capacity specified herein and discharge pipe openings with a sound seal.

D. A cooling fan with acoustical vent shall be supplied installed on the enclosure to provide adequate cooling of the blower and motor.

E. Oil fills and drain extensions, and weather/sound seals shall be fitted on all enclosure penetrations as needed.

F. Each enclosure shall have service doors, covering at least 80 percent of each side. Hinges for the doors shall be full length and designed for the weight of the door provided. Door shall have a minimum 180 degree swing. All surfaces and edges shall be free of burs and sharp edges. The doors shall lock closed using ½ turn telescoping "T" handles.

G. Any access plates installed on enclosure for venting or screening shall be installed with self-starting, self-locking zinc plated screws to promote tightness. Rivets or loose fitting panels which can loosen during operation will not be accepted. Slide-in panels showing a loose fit shall provide grounds for rejection. Panels shall be constructed as to compress media on installation providing tightness and maximum sound absorption.

H. The enclosure shall be ATTENUPAC by Universal Blower Pac, Inc. or an approved equal.

I. The enclosure herein specified shall be designed and manufactured by the blower system manufacturer specifically for the equipment supplied. Units shall be designed to be picked up by a fork truck. Each acoustical enclosure shall be

shipped completely assembled. Each enclosure shall ship installed on the blower system when feasible. No field assembly shall be permitted.

2.05 APPURTENANCES

A. Inlet Filter: The manufacturer shall provide one (1) inlet filter for each blower. The piping connection for the inlet filter shall be flanged with standard ANSI 150 lb. flange drilling. Filter elements shall be of the radial fin cartridge design and shall be replaceable and cleanable. The filter medium shall be paper filter media capable of filtering 2-micron solids with a 99.5 percent solids retention efficiency with a pressure drop across the clean element and housing of less than 2 inches of water column. The inlet filter shall be manufactured by Stoddard Silencers, Inc., Universal Silencer, or an approved equal.

B. Inlet Silencer: The manufacturer shall provide one (1) inlet silencer for each blower. The silencer shall be of the straight through, multi-chambered type, containing a special arrangement of volumes and air passageways to effectively reduce pulsations through the conversion of noise energy into heat. Pressure drop through the silencer shall be minimal. Silencer shall be constructed with an all welded heavy gauge sheet and plate steel shell. Inlet and outlet connections shall be sized by the manufacturer, with standard ANSI 150 pound flanged drilling. Noise attenuation for the silencer shall be from 30 to 33 decibels depending on the frequency. The inlet silencer shall be manufactured by Stoddard or an approved equal.

C. Discharge Silencer: The manufacturer shall provide one (1) discharge silencer for each blower. The discharge silencer shall be installed in the discharge piping below the unit. The silencer shall have a side inlet, end outlet, and be multi-chambered containing a special arrangement of volumes and air passageways to effectively reduce pulsation through the conversion of noise energy into heat. Pressure drop through the silencer shall be minimal. Silencer shall be constructed with an all welded heavy gauge sheet and plate steel shell. Inlet and outlet connections shall be flanged, with standard ANSI 150 lb. flange drilling. Noise attenuation for the silencer shall be from 25 to 30 decibels depending on the frequency. The discharge silencer shall be manufactured by Stoddard or an approved equal.

D. Pressure Relief Valve: A properly sized pressure relief valve shall be provided for the discharge of each blower. The relief valve shall open at a setting of 10 percent above the specified discharge pressure. Relief valve shall be the weight loaded-type pressure safety valve with removable weights. If the valve malfunctions it shall do so in the open condition to prevent blower damage. Pressure safety valve shall be as manufactured by Sutorbilt or an approved equal.

E. Check Valve: A spring wafer type check valve shall be installed in the blower discharge piping, downstream of the silencer and pressure relief valve. The wafer type check valve shall be for air service with a pressure rating of a minimum of 25 psig. The check valve shall have a cast iron body, stainless steel pin and spring, and two semi-circular cast iron plates. The seat material shall be suitable for an operating discharge temperature of 250 degrees Fahrenheit (°F). The valves shall be shipped loose for field installation.

F. Flexible Connectors: Flexible connectors shall be provided at the inlet and discharge of the blower. The joints shall be of the single arch style and designed for the maximum temperature, pressure, and vibration conditions that may result from operation of the system. The joints shall be provided with Type 316 stainless steel control rods. The joint shall be sized to match the blower connections.

G. Isolation Valve: Each blower shall have a discharge isolation valve. Isolation valves shall be cast-iron wafer-body, aluminum-bronze, disc butterfly type with a locking handle. The temperature rating of the seat shall exceed the maximum anticipated discharge temperature. The valves shall be shipped loose for field installation.

H. Instruments

1. Pressure Gauge: One (1) 2-1/2-inch diameter air pressure gauge with 1/4 NPT connection and a range from 0 to 15 psig shall be provided on the discharge side of each blower. Gauge and fittings shall be of Type 316 stainless steel. Gauge shall have a 1/4" brass snubber and isolation valve.

2. Temperature Gauge: One (1) 3-inch dial bimetal type air temperature gauge with a range from 0 to 400°F shall be provided on the discharge side of each blower.

3. Filter Restriction Gauge: Each inlet filter shall have a filter restriction gauge that progressively measures vacuum in the filter element. A visual indicator, with a manual reset, shall lock at the current vacuum when the blower is shut off.

2.06 BLOWER SHOP COATING

A. All external parts of the blower, motor, drive unit, base, sound attenuating enclosure and accessories shall be primed and finish painted at the factory prior to shipping. Surface preparation, priming and finish coating shall be an alkyd coating system in accordance with Section 09 90 00, Painting and Coating. All coatings used for shop painting shall be the products of the same manufacturer as the coating to be used for field painting to assure coating compatibility. Color of

finish coating shall be medium gray for the blower/motor and enclosure unit and OSHA orange for the belt guard.

PART 3 EXECUTION

3.01 EXECUTION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations. Blower and motor baseplate shall be set on vibration isolation pads.

B. Align blower and motor in accordance with the manufacturer's instructions. No more than two shims of proper thickness shall be used to secure proper alignment. Prior to placing the blower in operation, recheck the alignment after piping and other external connections have been made up to the blower. Adjust and realign as required if alignment has changed. All alignments and adjustments made to the blower shall be completed by technicians with prior experience and training in making such alignments and adjustments for the specific equipment provided.

3.02 FIELD PAINTING

A. All equipment furnished shall be provided with finished coating system in the field. Field painting shall be specified under Section 09 90 00, Painting and Coating.

B. All nameplates shall be properly protected during painting.

3.03 INSPECTION AND TESTING

A. General:

1. Materials and equipment shall be tested or inspected as required by the Engineer, and the cost of such work shall be included in the cost of the equipment.

2. Furnish the services of a factory representative for two (2) days who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test run of the equipment. These services may be combined with those provided under Paragraph 1.04.

3. The duties of the factory service representative shall be as follows: After the equipment has been installed but before it is operated by others, the

representative shall inspect the completed installation. The service representative shall start-up the equipment and instruct the Owner's personnel in proper operation and maintenance procedures. The responsibility of the Contractor with regards to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly and it has been accepted by the Owner.

4. Field tests shall not be conducted until the entire installation is complete and ready for testing.

5. The Contractor shall submit to the Engineer, six (6) copies of a certified report from the factory service representative of the results of the representative's inspections, adjustments, testing and start-up. The report shall include a statement that the equipment is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void. Final payment shall not be made to the Contractor until this report has been submitted to and approved by the Engineer.

B. Blowers:

1. After all blowers have been completely installed and working under the direction of the manufacturer, conduct in the presence of the Engineer tests necessary to indicate that blower operation, efficiency, blower rpm and discharge pressure and capacity conform to these Specifications. Field tests shall include all blowers under this Section.

2. If the blower performance does not meet these Specifications, corrective measures shall be taken or blowers shall be removed and replaced with blowers which satisfy the conditions specified. A 24 hour operating period of the blowers will be required before acceptance.

C. The Contractor's attention is directed to the fact that the services specified represent an absolute minimum acceptable level of service, and are not intended to limit the responsibilities of the Contractor to comply with all requirements of the Contract Documents. The Contractor shall procure, at no additional cost to the Owner, all services required, including additional or extended trips to the jobsite by manufacturer's representatives to comply with said requirements.

END OF SECTION

SECTION 43 13 02
RECIPROCATING AIR COMPRESSORS AND RELATED EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. The extent of compressed air system work is indicated on Drawings and by requirements of this Section. All accessories specified in this Section shall be included as a part of the air supply system. It is the intent of this Specification for the Contractor to furnish compressors, receivers, dryers, filters, drains, valves, piping, electrical components, and all other items necessary for a complete function system.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01 33 00, Submittal Procedures, covering the items included under this Section

1. Submit manufacturer's technical product data and installation instructions for compressed air systems materials and products.

2. Submit performance curves for each set of compressors furnished. The curves shall indicate compressor speed, air flow, and horsepower requirements versus discharge pressure. Compressor motor nameplate horsepower shall be sufficient for non-overloading operation at all points on the performance curve.

3. Submit manufacturer's electrical requirements for power supply wiring to compressed air equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 78 23, Operation and Maintenance Data for items included under this Section.

C. Test and Inspection Report: Submit a written report to Engineer documenting testing and/or inspection results. The report shall be prepared as noted under Section 01 91 14, Equipment Testing and Facility Startup.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of compressed air systems products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. After the equipment has been installed, performance tests shall be conducted. The purpose of these tests is to demonstrate that the units have been properly installed, will operate satisfactorily, and meet the specified conditions. These tests shall be conducted in the presence of Engineer with the cooperation of the manufacturer's representative. The equipment will not be accepted until a satisfactory test has been run.

C. Codes and Standards:

1. ASME Compliance: Fabricate and install compressed air piping system in accordance with ASME B31.9 "Building Services Piping."
2. CAGI Compliance: Provide compressed air auxiliary piping equipment in accordance with CAGI Standards (Compressed Air and Gas Institute).
3. ASME Compliance: Provide compressed air receivers, and compressed air safety valves in accordance with ASME "Boiler and Pressure Vessel Code"; provide ASME Code Symbol Stamp.
4. UL Compliance: Provide electrical components of compressed air system which have been listed and labeled by UL. Provide listing/approval stamp, label, or other marking on equipment and accessories that are listed and labeled. The terms “Listed” and “Labeled” shall be as defined in National Electrical Code, Article 100. The Listing and Labeling Agency shall be a “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.
5. Comply with ASME B19.1 “Safety Standards for Air Compressor Systems”.
6. Comply with NFPA 70, "National Electrical Code" and SAE HS-1738, "Electrical Standard for Industrial Machinery – Supplement to NFPA 79".

1.04 WARRANTY

A. The equipment manufacturer shall warrant the equipment against defects in design, material, and workmanship as specified in Section 01 74 00.

B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit restored to service at no expense to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The compressors, dryers, filters, drains and related equipment shall be manufactured by Quincy, Ingersill Rand, Atlas Copco, or an approved equal.

2.02 MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections. Provide fittings of materials which match pipe materials used in compressed air systems. Where several types of materials or products are indicated, selection is installer's option.

B. Compressed Air Distribution: Unless otherwise noted, materials for the compressed air distribution system shall conform to the following specifications.

1. Section 40 27 00, Process Piping, General
2. Section 40 27 02, Process Valves and Operators

2.03 AIR-COOLED RECIPROCATING AIR COMPRESSOR

A. The work shall include the furnishing and installation of a tank mounted, duplex, reciprocating (piston type) air compressor system, complete with factory mounted accessories for each compressor as specified herein.

B. Each compressor shall be rated for 56 acfm at 175 psig. System shall be mounted on and above a National Board approved ASME U-stamp and CRN 200 gallon air receiver tank. Compressors and motors shall be mounted and aligned on a heavy-duty welded steel base as shown on the Drawings. The receiver tank shall include a pressure gauge, manual tank drain, automatic tank drain, manual shut-off valve at the outlet and ASME/CRN pressure relief valve sized to handle the full capacity of both compressors operating simultaneously.

C. Each compressor shall be a two-stage, pressure oil lubricated, air-cooled, motor-driven compressor complete with controls. Drive shall be V-belt type with means for easy adjustment of belt tension. A pressure relief valve shall be provided on the discharge of each compressor.

D. Each compressor shall be complete with hydraulic or magnetic unloader, 10 micron filter-silencer and dual control regulation. The unloader shall provide loadless starting and unload the compressor in the event of oil pressure failure.

E. In the duplex, tank mounted system, each compressor shall be capable of being isolated with valving while allowing the remaining compressor to continue operating.

F. An integral finned intercooler shall included between the first and second compression cylinders.

G. Provide positive displacement oil pumps with oil filters and gauges.

H. Valves shall be stainless steel, easily removable and inspected without special tools.

I. The compressor flywheel, motor pulley, and v-belts shall be totally enclosed within a metal belt guard which shall provide protection on all sides in accordance with OSHA requirements.

J. Each compressor shall be provided with an aftercooler. The aftercooler shall be air-cooled, capable of cooling the discharge temperature of each air compressor to within 15 degrees Fahrenheit of room ambient temperature. The air-cooled aftercooler shall consist of finned triple-pass tubes mounted in an expanded metal housing which shall also serve as the belt guard for the compressor. A moisture separator shall follow each aftercooler which shall consist of a separating chamber, collecting chamber, and a float actuated discharge valve. The separator shall be rated for 200 psig.

K. Provide a 15 HP, 460 volt, 3 phase, 60 Hertz, open drip-proof, premium efficiency motor with a 1.15 service factor for each air compressor. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for additional requirements.

L. Controls: A single control panel shall be provided for the air compressor system. The control panel shall include magnetic motor starters, alternator, fusible disconnect switches, pressure switches and wiring as required for a complete operating system. The panel shall be provided as a packaged unit with dual control regulation for constant speed or for automatic start-stop operation.

1. The system is to be provided with:
    a. Low oil level switch to shut down compressor at low oil level.
    b. Low oil pressure switch.
    c. Air temperature and pressure gauges.
    d. Air pressure switch for compressor control.
    e. NEMA 4 enclosure provided with:
        1) Two (2) I.E.C. magnetic starters.
        2) 120 VAC control circuit.
        3) Remote monitoring capability.

4) On/Off switch for each compressor.
5) Automatic alternation with lead/lag.
6) Continuous Run or Auto Start/Stop mode selection.
7) Lead/Lag/Auto designation.
8) Operating lights.
9) Fault indications.
10) Run time meters.
11) Thermal motor overload protection.
12) Dual power source.

2. Automatic restart after power failure shall be included.

3. Provide unit mounted control panel with vibration isolation.

4. Under Continuous Run, the compressor shall run continuously, loading and unloading as required to maintain a constant pressure.

5. Under Auto, the compressor shall start only when the air receiver pressure drops below a preset level. The start and stop setpoint pressure shall be field adjustable..

M. Spare Parts and Oil Supply: A minimum of one (1) year's supply of filter-silencer elements shall be provided for each unit as well as sufficient oil for two (2) complete oil changes for each unit in addition to the initial filling prior to starting the compressors.

2.04 STANDARD ACCESSORIES

A. Provide the following accessory items for the compressed air system: particulate filter, air dryers (2 units), coalescing filter, receiver tank, condensate drains/traps, and pressure relief valve. The size and capacity of each accessory item shall be sufficient to handle the total capacity of the compressor system specified.

B. Particulate Filter: The particulate air filter capacity shall be equal the capacity of one (1) compressor in the duplex system. The particulate filter shall pass a maximum solid particle of five microns. An automatic condensate drain shall be a part of the filter. Provide a differential pressure gauge for the filter. Provide six (6) spare filter elements.

C. Air Dryer: Provide two (2) air-cooled refrigerated dryers capable of supplying air at plus 38 degrees Fahrenheit dew point at 100 psig. Each dryer shall be sized to accommodate the air flow from one (1) compressor.

1. The air dryer shall be of the non-cycling, refrigerated, air-cooled, direct expansion, flooded evaporator type and shall consist of a combination air

to air heat and air to refrigerant heat exchanger, individual moisture separator, automatic adjustable drain, and a refrigerant system. The dryer shall be capable of operating at 200 psig.

a. The heat exchanger shall be of a brazed plate design consisting of both the air to air and air to refrigerant heat exchanger. Hot humid air entering the air to air heat exchanger shall be pre-cooled by the cold outgoing air (re-heat). The air shall then be cooled in the air to refrigerant heat exchanger to the dew point temperature.

b. The system shall be completely assembled and factory tested for automatic operation. The air dryer shall include a hermetic type refrigerant cooled compressor sized for total dryer capacity, completely wired and piped. The refrigerant system shall also include an air-cooled condenser, thermally protected fan motor, hot gas bypass valve, thermostatic expansion valve, and filter driers for both liquid and suction line.

c. Compressor motor shall be 1 HP.

d. Fan motor shall be a maximum of ¼ HP.

e. A low velocity, centrifugal-type moisture separator shall be provided, complete with an automatic condensate drain valve rated for 200 psig.

f. An automatic adjustable drain valve in each dryer shall be supplied to eject condensate as needed. The automatic drain shall be programmed to operate at 1 to 60 minute intervals and for 1 to 30 second cycle times. This unit shall ensure clog-free, unattended operation. Drain shall be installed in the dryer enclosure.

g. A control panel shall be included in the dryer cabinet containing the following minimum instrumentation:
   1) On/off switch with power-on light.
   2) High temperature light.
   3) Compressor-on light.
   4) Refrigerant suction pressure gauge to monitor system operation.

D. Coalescing Air Filter: The coalescing air filter capacity shall be equal to the capacity of one (1) compressor in the duplex system and be rated for 200 psig. The coalescing filter shall pass a maximum solid particle of 0.01 micron. The filter shall deliver clean air, free of oil, condensed water or other entrained impurities. Provide internal automatic condensate drain and a differential pressure gauge on the filter housing. Housing shall be metal bowl construction. Provide one dozen spare filter elements.

E. Oil and Water Separator: The oil and water separator shall remove all compressor lubricants, including polyglycol emulsions from the compressor condensate. The unit shall be a floor-mounted unit specifically sized for this installation.

F. Provide a 1,000 gallon vertical receiver. The tank shall be ASME pressure rated at 200 psig working pressure and include support and anchors suitable for installation as shown on the Drawings. The following accessories shall be mounted on the receiver.

1. 200 psig pressure gauge (4-1/2-inch dial).

2. ASME safety relief valve.

3. Drain connection with manual valve.

4. Inlet and outlet connections.

5. Pressure regulator (automatic).

6. Three (3) adjustable pressure switches for compressor control and low pressure alarm. Switches shall be 120-volt 2-two pole and 1-one pole in NEMA 4 enclosure.

2.05 VIBRATION ISOLATION

A. Vibration Isolators: Provide sandwich type elastomer mounts for the tank-mounter compressor system which are properly sized for weight loading. The mounts shall consist of a high-grade cork plate bonded between layers of oil resistant synthetic rubber.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions where the compressed air systems and equipment will be be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF COMPRESSED AIR PIPING

A. Install compressed air piping in accordance with Section 40 27 00, Process Piping, General.

B. Install piping with 1/8-inch per foot (1 percent) downward slope in direction of air flow.

C. Install reducers where required.

D. Connect branch piping to mains from top of main. Provide drain leg and drain trap at end of each main, each branch, and each low point in piping system.

3.03 INSTALLATION OF SUPPORTS AND ANCHORS

A. Install supports and anchors in accordance with Section 40 05 15, Piping Support Systems.

B. Spacing: Do not exceed 5'-0" spacing between pipe supports for any size pipe.

3.04 INSTALLATION OF AIR COMPRESSOR/RECEIVER ASSEMBLY

A. Install air compressor/receiver assembly in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install units on 4-inch-high reinforced concrete pad, 4 inches larger on each side than compressor base.

C. Mount units on vibration isolators in accordance with manufacturer's instructions.

D. Electrical Wiring:

1. Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

2. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.05 ADJUSTING AND CLEANING

A. Clean, flush, and inspect compressed air systems in accordance with requirements of Section 40 27 00, Process Piping, General.

B. Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section and to train the Owner's personel on proper operation and maintenance. The services shall be for at least one (1) day and be as required in Section 01 43 33, Manufacturer's Field Services.

END OF SECTION

SECTION 43 21 13.01
VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test vertical turbine pumps, variable frequency drives and motors as hereinafter specified, and/or as shown on the Drawings. In general, the following equipment shall be furnished:

   a. Two (2) raw water pumps with 250 horsepower motors rated for 4,200 gpm at 140 feet TDH.

   b. One (1) raw water pump with a 450 horsepower motor rated for 8,400 gpm at 140 feet TDH.

   c. One (1) backwash supply pump with a 150 horsepower motor rated for 3,000 gpm at 117 feet TDH.

   d. Two (2) finished water pumps with 450 horsepower motors rated for 4,200 gpm at 285 feet TDH.

   e. One (1) finished water pump with a 1,000 horsepower motor rated for 8,400 gpm at 285 feet TDH.

2. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment application. It is, however, intended to cover the furnishing, the shop testing the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

4. The pump manufacturer shall provide performance data and application requirements to the supplier of the VFDs in order to allow the VFD

supplier to properly select equipment appropriate for the intended application.

B. General Design

1. All pumps will be of the above base discharge, vertical turbine type. Pumps shall be constant speed or variable speed as specified herein. The pumping units shall be located and arranged as shown in the Drawings.

2. All working parts of identical pumps and motors, such as bearings, wearing rings, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the operation and maintenance manuals furnished.

3. All equipment, coatings, and materials that come in contact with raw or finished water shall comply with ANSI-NSF Standard 61.

4. The pumping systems shall be controlled by the control panels as depicted on the Instrumentation and Electrical Drawings and as specified.

1.02 QUALITY ASSURANCE

A. Qualifications

1. The equipment covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having a minimum 10-years experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

2. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years.

3. The manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit to ensure that neither harmful nor damaging vibrations occur

at any speed within the specified operating range. Design shall include all supporting sole plates and fabricated steel base plate for mounting the units.

B. Pre-Construction Analyses: The pump manufacturer shall perform computer-based analyses to determine the potential for a reed critical frequency or torsional critical frequency occurring near or below the design operating speed of the pumping unit. The first critical frequency of either type must occur above the maximum operating speed of the pumping unit, taken as the pump design speed (PDS). If the manufacturer determines that a critical frequency could occur at any pump speed below PDS + 20 percent, the pump discharge head design shall be altered so as to raise the first critical speed above that threshold. At a minimum the manufacturer shall:

1. Perform a finite element analysis (FEA) of the drive motor mounted on the pump discharge head to determine the first reed critical frequency of the combined motor/discharge head structure in two (2) perpendicular directions. The column mode frequency shall be + 20 percent above the PDS. The discharge head shall be modeled in shell elements or solids. The motor shall be modeled using elements that duplicate the motor reed critical frequency data supplied by the motor manufacturer. All analyses shall be performed using commercially available FEA programs.

2. The pump discharge head shall be considered as being mounted to a rigid foundation. The discharge nozzle shall be considered to move if the first reed critical frequency is above the PDS; this will provide a lower bound to the natural frequency. Under normal circumstances the discharge nozzle shall be considered as fixed if the first reed critical frequency were below PDS; this would provide an upper bound to the natural frequency.

3. If it is not practical to design the pump discharge head such that the combined motor/discharge head first reed critical frequency is 20 percent above PDS, the manufacturer may attempt to design for a first reed critical frequency equivalent to a pump speed of 30 percent of PDS. If the second reed critical frequency is more than 20 percent above PDS, the design may be acceptable.

4. The manufacturer shall also perform a torsional critical speed analysis to identify and ensure that the first torsional critical speed is at least 20 percent above the PDS.

C. Manufacturers

1. The naming or reference to a specific manufacturer does not indicate that the manufacturer's standard equipment is acceptable in lieu of the specified component features. This reference is only an indication that the named manufacturers may have the capability of supplying the equipment as specified.

2. The pumps shall be manufactured by:

   a. Layne
   b. FlowServe.
   c. Peerless
   d. FloWay.
   e. Goulds

3. The motors shall be manufactured by:

   a. U.S. Motor.
   b. Reliance.
   c. General Electric.
   d. Or approved equal.

1.03 SUBMITTALS

A. Materials and Shop Drawings

Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of Section 01 33 00: Submittal Procedures of these Specifications. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations and long-term storage requirements.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of the actual units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR, and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to pump capacity at minimum specified total head. Catalog sheets showing a family of curves will not be acceptable.

4. Data including principle dimensions, materials of construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

5. A complete total bill of materials of all equipment including the weights of equipment furnished.

6. A list of the manufacturer's recommended spare parts in addition to those specified in Paragraph 1.05, with the manufacturer's current price for each item. Include gaskets, packing, etc., on the list. List bearings by the bearing manufacturer's numbers only.

7. Complete motor data.

8. Copies of all factory test results, as specified in PART 2 - PRODUCTS of this Section of the Specifications.

9. Complete master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices such as the pump control system and suitable outline drawings shall be furnished for approval before proceeding with manufacture. Provide suitable outline drawings showing such details as are necessary to locate conduit stub-ups and field wiring. Due to the complexity of the system, it is imperative the above drawings be clear and carefully prepared to facilitate interconnection with other equipment. Standard pre-printed sheets or drawings simply marked to indicate applicability to this Contract will not be acceptable. Refer to the Electrical and Instrumentation Drawings for the control wiring diagrams for the pump motors.

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

1. The pump supplier shall provide an analysis of each vertical variable speed pump system to ensure that no damaging critical or resonant frequencies or multiplies of resonant frequencies occur from 15% above to 20% below the proposed speed range necessary for the pump to meet the specified operating conditions.

2. A computer program shall be used to generate the pump structural natural frequencies based on a comprehensive procedure. This procedure shall be applicable for vertical pumps.

3. The frequency analysis shall include but not be limited to:

   a. The combined rotational stiffness of the discharge head flange, discharge head flange bolting, base plate/sole plate, and anchor bolting of a vertical pump.
   b. The rotational dynamics of the motor.

4. The analysis shall be performed and certified by a registered professional engineer and calculations shall be provided to the Engineer with submittal data. The registered professional engineer shall certify the pump when operating from 70% full speed to 100% full speed does not come within 20% of the first or second critical harmonic speed.

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

1.04 OPERATION AND MAINTENANCE DATA

A. Operating and Maintenance Instructions

1. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01 78 23: Operating and Maintenance Data.

2. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 TOOLS AND SPARE PARTS

A. Furnish to the Owner one (1) complete set of all special tools, including lubricating devices, required for normal operation, adjustment and maintenance of the equipment supplied. All such tools shall be furnished with a heavy duty, thermoplastic tool chest complete with a padlock and duplicate keys.

B. The manufacturer shall furnish one (1) complete set of recommended spare parts necessary for the pumping system. Furnish for each size and type of pump the recommended spare parts, which shall include, as a minimum, the following:

1. Two (2) sets of gaskets and O-rings, for each pump model.

2. One (1) set of packing for each pump model.

3. One (1) year's supply of each type of lubricant required.

4. One (1) set of impeller shaft keys, dowels and pins.

5. One (1) spare set of bowl bearings.

C. All spare parts shall be furnished in containers properly labeled and identified with indelible markings as to their contents without opening the packaging. Containers shall be suitably protected for long-term storage.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY AND GUARANTEES

A. Warranty period shall commence as outlined in the General Conditions and Division 01.

B. The equipment shall be warranted to be free from defects in workmanship, design, materials, and to perform in accordance with the Specifications and in the application in this contract. If any part of the equipment should fail during the warranty period, it shall be replaced in the machines and the units restored to service at no expense to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping units required under this Section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. The discharge head for each pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts and washers shall be as recommended by the pump manufacturer, and provided and installed by the Contractor. Anchor bolts, nuts and washers shall be Type 316 stainless steel.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump, drive, control panel and motor.

2.02 MATERIAL AND EQUIPMENT

A. General

1. The raw water pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump raw water from the raw water intake. The finished water pumps shall be variable speed, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the clearwell into a pressurized distribution network. The backwash supply pump shall be constant speed, water lubricated, open line shaft, vertical turbine type suitable to pump finished water from the clearwell to an elevated washwater storage tank.

2. The pumps shall be of standard dimensions such that parts will be interchangeable between like units and all units shall be supplied by the same manufacturer.

B. Performance Requirements

1. When operating at the design output speed of its squirrel cage induction motor each pump shall have a characteristic performance curve which meets all the minimum conditions listed in Table 43 21 13-B. The pumps and drive motors shall be capable of operating satisfactorily under the full range of conditions as defined by Table 43 21 13-B. Pump selections to meet TDH requirements shall address all losses from the pump intake suction bell to the pump discharge flange.

2. The nameplate ratings of the motors shall not be exceeded, nor shall be design service factor be reduced when the pump is operating at any point on its characteristic curve at maximum speed. The term "at any point on its operating curve" shall mean all points from no flow at shut-off head to maximum flow at minimum TDH. All rotating parts of the specified equipment shall be mechanically and hydraulically balanced so as to operate throughout the required range without excessive end thrust, vibration, and noise. The maximum allowable vibration measured at the top motor bearing for vertical pumps shall not exceed the maximum peak to peak amplitude as set forth in the Hydraulic Institute Standards, latest edition. Failure to meet this criterion shall be sufficient cause to reject the equipment.

3. Maximum motor speeds shall not exceed those listed in Table 43 21 13-B to satisfy the specified hydraulic duty requirements.

4. With the pumping units operating at full motor speed, the maximum brake horsepower required by the pumps at any point of the pump operating curve shall not exceed the horsepower listed in Table 43 21 13-B. If the pumping units require more than the horsepower listed in the table at the motor output shaft at any full motor speed operation point, they will be rejected.

5. Each inverter duty pump shall be capable of continuous adjustable speed operation over the speed range from 70 percent to 100 percent of pump design speed. There shall be no significant change in vibration and noise level over the entire listed range of speed and flow of the pumping system.

6. Certified Factory Tests: The pumps shall be given a complete non-witnessed performance test to include head/capacity, horsepower, and efficiency to prove that the pumps supplied conform to the requirements of

this Specification. The test data shall be submitted on 8-1/2-inch by 11-inch sheets at as large a scale as is practical. Four (4) copies of the approved pump test curves laminated in plastic shall be provided to the Owner. The curves shall be plotted from no flow at shut off head to maximum flow at minimum head. No shipment of the pumps is to be made until after the Engineer's approval of the testing is obtained.

C. Discharge Heads

1. The discharge head shall have bolted register or rabbet-fit connections for the motor. Discharge head shall have connections for the pump column and discharge piping and shall support the weight of the various items as well as hydrostatic and hydrodynamic loads. Discharge head shall be fabricated in either 3-piece mitered elbow or long radius elbow configuration.

2. The discharge head shall be of the above base type of fabricated steel construction, in accordance with ASTM A36 or ASTM A53. The discharge head and discharge connection shall be not less than the diameter as shown on the Drawings and as specified on Table 43 21 13-1. Discharge heads shall be fitted with a 150-lb. flat face flange discharge connection to match the barrel flange.

3. OSHA guards shall be supplied for all rotating assemblies and shall be fabricated of Type 316 stainless steel.

4. The fabricated discharge head shall incorporate a two (2) piece flanged precision balanced coupling. The assembly shall be joined together by a minimum of four (4) bolts complete with lock washers. The assembly shall be manufactured of Type 416 stainless steel.

5. The discharge head shall be fitted with a bleed-off type stuffing box having as ASTM A584, Alloy 392 bronze stuffing box bearing, two nylon split or bronze split cage rings, ASTM A584, Alloy 836 packing gland and not less than 4 rings of packing.

D. Column and Lineshafting

1. The pump head shaft shall be constructed of ASTM A582-88a 416 stainless steel alloy. Shaft diameter shall be determined by the AWWA Standard for Vertical Turbine Pumps – Line Shaft and Submersible Types, ASNI/AWWA E101 (latest), Section A4.1.5.

2. The pump column shall be constructed of flanged steel pipe in accordance with ASTM A53. Bolts, nuts, and washers for flanges shall be of Type 316

stainless steel or a similar grade of stainless steel recommended by the pump manufacturer.

3. The pump line shaft shall be constructed of ASTM A582-88a 416 stainless steel alloy and its diameter determined as described in 2.02 D.1 above. The spacing of line shaft bearings shall not exceed 10 feet.

4. The weight of the column shall be no less than that stated in ANSI Specification B58.1. Friction loss through the columns shall not exceed 5 feet per 100 feet.

    a. Head shafting or an adjustable spacer coupling shall be provided to allow the removal of the packing seal and stuffing box without disturbing the driver.

    b. Shafting shall be polished over its full length.

    c. Total lateral deflection of the shaft above the packing box shall not exceed 0.007-inch total indicator reading. Shaft couplings for shaft diameters two (2) inches or larger shall be of the key and thrust-ring types or other non-threaded design of Type 416 stainless steel.

    d. Lineshafting shall not exceed 10 feet in length and shall have butting faces machined square to the axis of the shaft with angular misalignment of thread and shaft axis not exceeding 0.002 inches in 6 inches.

    e. Threaded couplings may be used for shaft diameters smaller than two (2) inches.

    f. Pumps shall have open self-lubricated lineshafts.

E. Bowl Assembly

1. Each bowl assembly shall consist of the discharge bowl, impeller and impeller shafting, and bearings. Bearings shall be located above and below the impeller.

2. The pump bowls shall be constructed of ASTM A48 Class 30 or 50 cast iron. The pump bowls shall be of sufficient thickness to withstand stresses and strains at full operating pressure. The bowls shall be subjected to a hydrostatic test 140 percent of that specified at the minimum pump shut-off head condition in Table 43 21 13. The bowls shall be designed and manufactured with open and smooth water passages to assure efficient,

reliable operation. Each bowl shall have a replaceable wear ring. Bowl to bowl fits shall be rabbet fit.

3. Bowls shall be flanged with male and female rabbet or threaded for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps and dips.

4. The bowls shall be fitted with ASTM B505-91 alloy 954 wear rings.

F. Suction Bell:

1. The suction bell shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The outer suction bell entrance shall be at least the size of the maximum pump bowl dimension and as large as is practical. Maximum entrance velocity shall not exceed six (6) fps. The contour between the outer edge and the impeller suction eye shall be smooth, continuous and bell shaped.

2. The suction bell of the raw water supply pumps shall be equipped with a Type 316 stainless steel basket strainer.

G. Impellers:

1. Pump impellers shall be of the closed or semi-enclosed type. Impellers shall be of ASTM B148-89a Alloy 952 aluminum bronze. Impellers shall be cast in one piece and machined to fit the contour of the bowl. Impellers shall be equipped with replaceable wear rings or with wearing ring hubs for mounting wear rings during future repair or with a bronze bowl liner.

2. Attach impellers to the shaft with tapered collets or with a Type 316 stainless steel split ring and key.

H. Motors

1. The motors for the raw and finished water pumps shall be of the vertical solid shaft squirrel cage induction type rated 4,160 volts, 3-phase, 60 Hertz. The motor for the backwash supply pump shall be of the vertical solid shaft squirrel cage induction type rated 460 volts, 3-phase, 60 Hertz. Motor frames shall be of the open drip-proof (ODP) design. All motors shall be provided with 120 volt space heaters.

2. Motors must be designed to accept all upthrust and downthrust loads imposed by pump during starting and running.

3. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.

4. Motors shall conform to all requirements stipulated in PART 1 GENERAL of this Section of the Specifications unless modified in this paragraph.

5. The motors supplied for the raw and finished water pumps shall be specifically designed for inverter duty on a PWM type power source and conform to NEMA MG1, 1993, Rev. 1, Part 31. Such motors shall be compatible with the pumps and variable frequency drives.

6. Each motor shall have a 1.15 service factor.

7. Motors shall have horsepower as listed in Table 43 21 13.01-B.

8. Motors shall be of the open drip-pan design.

9. Motors shall be furnished with a non-reverse ratchet coupling assembly.

10. Other specific motor requirements are set forth in Section 26 19 00 and Section 26 20 00.

2.03 ACCESSORIES

A. Gauges

1. Provide pressure gauges where shown on the Drawings.

2. Gauges for the pumps shall be as specified in Division 40.

3. Gauges shall be equipped with a surge suppression snubber. Each gauge shall be equipped with a lever handle gauge cock and union.

4. Connection of the gauges to the pressure taps in the pump discharge shall be with screwed brass pipe neatly installed with straight runs and right angle bends.

5. Gauges may be provided by the Contractor or the pump supplier.

B. Basket Strainer: The bell mouth suction case shall be fitted with a 0.5 inch mesh stainless steel basket type strainer. The strainer shall have a net inlet opening area of not less than four times the area of the column pipe size.

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

2.04 SHOP PAINTING

A. The interior and exterior of the pump columns, the interior and exterior of the pump bowls, the interior of the discharge heads, and any other ferrous metal surface that may come into contact with raw or potable water shall be coated with a high build modified epoxy meeting the requirements of the National Sanitation Foundation Standard 61. The coating shall have a dry film thickness of at least 10 mils. Vitreous enamel may be used in lieu of epoxy for the interior of the pump bowls.

B. The exterior of the pump discharge head and motor shall be coated in accordance with Section 09 90 00, Painting and Coating.

2.05 QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test compete assemblies for correct rotation, proper alignment and connection, and quiet operation.

2. Flow Output: Measured by plant instrumentation and storage volumes.

B. Performance Test: In accordance with Hydraulic Institute Standards.

C. Perform manufacturer and supplier product quality control specifics as required for this project.

PART 3 - EXECUTION

3.01 PREPARATION

A. Shop Painting

1. Before exposure to weather and prior to shop painting all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.

2. All exposed portions of the pumps and motors shall be shop primed, with primer compatible with field painting as specified in Section 09 90 00, Painting and Coating.

3. All nameplates shall be properly protected during painting.

4. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

5. Finish coat may be applied at the factory.

6. Certify coatings in contact with raw or potable water meet NSF Standard 61.

B. Field Painting

1. Field painting is specified under Section 09 90 00: Painting & Coating. The primer and paint used in the shop shall be products of the same manufacturer as the field paint to assure compatibility.

2. All nameplates shall be properly protected during painting.

3.02 INSTALLATION

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

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 INSPECTION AND TESTING

A. General:

1. The Engineer shall have the right to inspect, test or witness tests of all materials or equipment to be furnished under these specifications, prior to their shipment from the point of manufacture.

2. The Engineer shall be notified in writing prior to initial shipment, in ample time so that arrangements can be made for inspection by the Engineer.

3. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

B. Factory Pump Tests:

1. Factory testing in accordance with the standards of the Hydraulic Institute shall be required for all pumps. All pumps shall be subjected to a non-witnessed factory performance test.

2. Certified pump performance curves shall be submitted, including head, capacity, brake horsepower, and pump efficiency for each pump supplied. Certified data shall be provided to indicate the NPSH required by the pumps will not exceed the amount of NPSH available at any point on the operating curves.

3. Prior to conducting a pump test, notification of such test and a list of test equipment and test procedures shall be forwarded to the Engineer at least ten (10) working days before the scheduled test date. All electronic transducers, meters, gauges, and other test instruments shall have been calibrated in accordance with the requirements of the Hydraulic Institute Standards. Copies of calibration data shall be provided. Differential pressure type flow meters, such as venturis shall have been calibrated within 5 years. Mechanical variation of the meter throat diameter will be accepted as verification of calibration validity.

4. In lieu of testing with all job equipment, job pump bowls may be tested with a laboratory column pipe and discharge head similar in size to that furnished for final installation. The length of column pipe shall be the same as will be required to set the bowl in the field.

5. All pumps shall be tested at full speed and complete staging through the specified range of flow, and head/capacity/efficiency curves shall be plotted at maximum output speed. During each test, the pump shall be run at each head condition for sufficient time to accurately determine discharge, head, power input, and efficiency.

6. The pumps shall be tested with a suction lift/suction pressure or submergence (including vapor pressure, velocity head, friction loss and static suction lift) as required to demonstrate that at maximum speed the NPSH and submergence required by the pump any point on the operating curve will be satisfied by the pump setting furnished.

7. If any pump tested fails to meet any specification requirement it shall be modified until it meets all specification requirements. If any pump tested fails to meet the efficiency requirements at any of the listed flow or head conditions listed in Table 43 21 13.01 and all reasonable attempts to

correct the inefficiency are unsuccessful, the pumps shall be replaced with units which meet the specified requirements.

8. The pumps shall be tested in regards to the VFDs to verify operation at the specified speed range of 70 to 100 percent.

C. Field Inspection and Owner Instruction:

1. The Contractor shall furnish the services of the manufacturer's field service technician, who has complete knowledge of proper operation and maintenance of the equipment, for a period of not less than two (2) days per group of pumps to inspect and adjust the installed equipment, supervise the initial test run, and to provide instruction to the plant personnel. The first visit shall be for checking and inspecting the equipment after it is installed. The second visit shall be to operate and supervise the initial field test.

2. At least one (1) of the two (2) days shall be allocated solely to instruction of plant personnel in operation and maintenance of the equipment. The instruction period shall be scheduled at least 10 days in advance with the Owner and shall take place prior to start up and acceptance by Owner. The final copies of operation and maintenance manuals specified in Section 01 78 23 must be delivered to the Engineer prior to scheduling the instruction period with the Owner.

D. Field Pump Tests:

1. In the presence of the Engineer such tests as necessary to indicate that the pumps, motors, and control system conform to the operating conditions specified shall be performed by the Contractor. A 30-day operating period of the pumps will be required before acceptance. If a pump performance does not meet the specified requirements, corrective measures shall be taken. All test procedures shall be in accordance with factory test procedures specified above and certified results of tests shall be submitted. Provide, calibrate and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.

2. After installation of the pumps and as soon as conditions permit operation, retain the services of a qualified independent mechanical testing firm to perform a detailed vibration signature analysis of each unit, including both "Bump Tests" and X-Y vibration profiles, to (a) prove compliance with the specified vibration limitations and (b) prove there are no field installed resonant conditions due to misalignment, the foundation, or the connecting

piping and its supports, when operating at any speed within the specified operating range. A written report shall be submitted including a sketch of the unit indicating on where and in which direction the vibration readings were taken and recorded showing (a) peak-to-peak displacement, in mils, (b) frequency, and (c) peak velocity level, in inches per second. The report shall contain a complete analysis of their findings, describing any problems encountered, if any, probable cause and specific recommendations for any required corrective action.

3. Noise and vibration tests shall be conducted in conformance with the Hydraulics Institute Test Codes and OSHA Standards for Occupational Noise Exposure. Maximum allowable noise level, corrected for background sound, shall not exceed 85 dBA when measured at a horizontal distance of 1.5 meters from the equipment being tested, at a height of 1.5 meters above floor level. Maximum allowable vibration, as measured by an IRD Model 330 Vibration Analyzer or equal, shall not exceed the maximum recommended limits established by the Hydraulic Institute. The actual natural frequency of the installed pumping units shall be verified using industry accepted procedures.

4. All pump operating settings, alarms, controls, and shutdown devices shall be calibrated and tested during the field tests.

5. The Contractor shall furnish all facilities, labor, materials, supplies, and test instruments required to conduct field tests.

6. Deliver to the Engineer, upon completion of satisfactory testing of the equipment, reports as specified in Part 1.

E. Field Electric Control System Tests:

1. The variable frequency drives and control system shall be test operated for proper functioning prior to the pump mechanical test. The control system shall be checked out using simulated operating signals as per VFD manufacturer's recommendations.

2. The Contractor shall check all drives for correct clearances, alignment and lubrication, prior to start up, in accordance with the respective manufacturer's instructions.

F. Field Motor Tests:

1. The Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low shall notify the Engineer and shall not energize the motor.

2. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

TABLE 43 21 13-A

MATERIALS OF CONSTRUCTION

Component	Material
Pump Shafts, Shaft Couplings, and Sleeves	ASTM A582-88a 416 Stainless Steel. Type 410 Stainless Steel may be used for shaft couplings.
Bowl Wear Rings or Seal Rings for Bowls 24" Diameter and Larger	ASTM B505-91 Alloy 954.
Bearing Retainers (fabricated integral)	Carbon Steel, A 283, Grade B
Bearing Retainers (insert type)	Cast Iron ASTM B 584, Alloy C 93700, or C-83600
Impellers	Aluminum Bronze, ASTM B148-89a, Alloy 954
Lantern Ring	Bronze, B 584, Alloy C 83600 or ASTM B 62
Pump Bowls and Suction Intake	Cast Iron, A 48, Class 30 or 50
Bowl Bearings	Bronze, B 584, Alloy C 93700; SAE 660 Bronze, Alloy 932.00
Lineshaft bearings	Neoprene
All parts made of fabricated steel including discharge heads or motor stands, unless specified otherwise	Carbon Steel, ASTM A 283, Grade B or C, or ASTM A 53, Grade B
Column Pipe	Carbon Steel, ASTM A 283, Grade B or C, or ASTM A 53, Grade B
Flanges	ASTM A 105, A 181, or A 182
Bolts and Nuts for Discharge Head and Column Pipe Flanges, Basket Strainer, Coupling Guard	Bolts shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M. Nuts shall be Type 316 stainless steel conforming to ASTM A 194, Grade 8M
Stuffing Box Gland Parts	Bronze, ASTM B 584, Alloy 836, or ASTM B 62 or 416 Stainless Steel, or ASTM A226, Type 316
Gland Nuts and Bolts	Stainless Steel, ASTM A 276, Type 316 Bolts with Bronze Nuts

Notes:

1. Materials of construction for components not listed shall conform to AWWA E101, Part A, Table 1, except that the materials shall be considered required, not typical.
2. Do not construct the impeller and bowl liner of the same material.

TABLE 43 21 13-B

PUMPING UNIT DESIGN REQUIREMENTS

Item/Design Conditions	Raw Water Pumps No. 1A & No. 3B	Raw Water Pump No. 2A	Backwash Supply Pump	Finished Water Pumps No. 1 & No. 2	Finished Water Pump No. 3
Pump Type	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine
Motor to be Supplied (HP)	250	450	150	450	1,000
Nominal Pump Design Speed (rpm)	1,200	1,200	1,200	1,200	1,200
Column Diameter (inches)	16	20	12	16	20
Discharge Size (inches)	16	20	12	16	20
Minimum Pump Shut-Off Head (feet)	260	210	180	500	500
Design Capacity (gpm)	4,200	8,400	3,000	4,200	8,400
TDH at Design Capacity (feet)	140	140	115	285	285
Minimum Efficiency at Design Point	82	80	80	82	82
Pressure Gauge Range (psi)	0-100	0-100	0-100	0-200	0-200

Notes:

1) Pump shall not exceed motor rating over the entire pump curve.

2) System curve points under minimum TDH conditions for the Raw Water Pumps are presented below. Pump operation shall not result in cavitation, excessive vibration, or other undesirable conditions at the minimum TDH conditions specified below. The minimum TDH conditions will occur when there is 11 feet of liquid in the pump chamber.

Minimum TDH System Curve Data for Raw Water Pump	
Flow (gpm)	TDH (ft.)
0	46
3,000	48
6,000	52
9,000	59
12,000	69
15,000	81
18,000	96

3) System curve points under minimum TDH conditions for the Backwash Supply Pump are presented below. Pump operation shall not result in cavitation, excessive vibration, or other undesirable conditions at the minimum TDH conditions specified below. The minimum TDH conditions will occur when there is 6 feet of liquid in the pump chamber.

Minimum TDH System Curve Data for Backwash Supply Pump	
Flow (gpm)	TDH (ft.)
0	74
2,000	75
4,000	77
6,000	82
8,000	89

4) The finished water pumps shall be capable of satisfactorily operation at a TDH of 230 feet. Pump operation shall not result in cavitation, excessive vibration or other undesirable condition at the reduced TDH condition. The water level in the pump chamber will be 6 feet above the sump floor under the reduced TDH condition.

END OF SECTION

SECTION 43 21 13.02
HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials, equipment and incidentals required and install three (3) horizontal, self-priming centrifugal pumps and all appurtenances as specified. The pumps shall be specifically designed to handle raw, unscreened, domestic sanitary sewage and shall also function satisfactorily when handling water treatment plant sludge with a solids content of 3.0%. The pumps shall be designed to retain adequate liquid in the casing to insure repriming without suction and discharge check valves and with a dry suction pipe.

B. These Specifications are intended to give a general description of what is required but do not cover all details, which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, shop testing, delivery, and testing of all materials, equipment, and appurtenances for the complete pumping units as herein specified.

C. Furnish all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not.

D. General Performance Criteria: The pumps specified in this section will pump storm water from Lake Lapanocia using the following performance criteria:

1. Thickened Sludge Pumps

a. Two (2) thickened sludge pumps must be designed to handle raw, unscreened, domestic sanitary sewage as well as thickened sludge having a solids content of 3.0% by weight. Pumps shall have a 6" suction connection, and a 6" discharge connection. Each pump shall be selected to perform under following operating conditions:

Capacity (GPM)	350
Total Dynamic Head (Feet)	42
Minimum Pump Efficiency (Percent)	50
Motor Horsepower	15

2. Sludge Recycle Pump

a. One (1) sludge recycle pump must be designed to handle raw, unscreened, domestic sanitary sewage. Pump shall have a 6" suction connection, and a 6" discharge connection. The pump shall be selected to perform under following operating conditions:

Capacity (GPM)	350
Total Dynamic Head (Feet)	42
Minimum Allowable Total Dynamic Suction Lift @ Design Condition (feet)	25
Minimum Pump Efficiency (Percent)	50
Motor Horsepower	15

3. The pumps shall not overload the nameplate horsepower rating of the drive motors at any point on the operating curves.

E. Pump Performance Certifications

1. Solids Handling Capability: All internal passages, impeller vanes, and recirculation ports shall pass a 3" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the Engineer, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

2. Reprime Performance

a. Consideration shall be given to the service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

b. 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.

c. Pump must reprime 15 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-

half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:

1) A check valve shall be installed downstream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.

2) A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.

3) The pump suction check valve shall be removed. No restrictions in the pump or suction piping shall prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2-foot minimum horizontal run, a 90° elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.

4) Impeller clearances shall be set as recommended in the pump service manual.

5) Repeatability of performance shall be demonstrated by testing five (5) consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.

6) Liquid to be used for reprime test shall be water.

7) Upon request from the Engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

1.02 QUALITY ASSURANCE

A. To assure unity of responsibility, the motors and drive equipment shall be furnished and coordinated by the pump supplier. The Contractor and manufacturer shall assume responsibility for the satisfactory installation and operation of the pumps and base as specified.

B. The pumps covered by these Specifications are intended to be standard pumping equipment of proven ability as manufactured by a reputable manufacturer having experience in the production of such pumps. Each pump shall be capable of handling solids without clogging. The pumps furnished shall be designed and manufactured in accordance with the best practices and methods, and shall operate satisfactorily when installed.

C. All equipment furnished under these Specifications shall be new and unused, shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein. The pump manufacturer shall have a minimum of 10 years of experience manufacturing and marketing self-priming centrifugal pumps.

D. Units specified shall be furnished by a single manufacturer. The equipment furnished shall be designed, constructed and installed to operate satisfactorily when installed as shown on the Drawings.

E. The rated horsepower of the drive unit shall be such that the unit will not be overloaded or the service factor reduced when the pump is operated at any point on the pump's maximum speed performance curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than that specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc., required by such change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

F. Standards:

1. ANSI
2. ASTM
3. Hydraulic Institute Standards.
4. NEC.
5. NEMA.

G. Approved Manufacturers:

1. Pumps shall be manufactured by the Gorman Rupp, Hydromatic or Crown.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with these Specifications shall be submitted and shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction. Shop drawing submittals shall include all materials of construction, descriptive data, performance characteristics, drawings, piping diagrams, anchor bolt locations, wiring schematics, and shall indicate complete compliance with these Specifications.

2. Descriptive literature, bulletins and/or catalog cut sheets of the equipment.

3. Data regarding the characteristics and performance of the pumps. Data shall include factory guaranteed performance curves, based on actual shop tests of similar units, which show that the pump meets the specified requirements for head, capacity, efficiency, NPSHR and horsepower. Curves shall be submitted on 8 1/2-inch by 11 inch sheets, at as large a scale as is practical. Catalog sheets showing a family of curves will not be acceptable.

4. The total weight of the equipment including the weight of the single largest item.

5. A complete total bill of materials of all equipment.

6. A list of the manufacturer's recommended spare parts to be supplied in addition to those specified in Paragraph 1.06, with the manufacturer's current price for each item. Include gaskets, seals, etc., on the list. List bearings by the bearing manufacturer's numbers only.

7. Motor data as required herein.

8. Copies of all factory test results, as specified herein.

1.05 OPERATING INSTRUCTIONS

A. Six (6) copies of an operating and maintenance manual (O&M) shall be furnished. The O&M manual shall be prepared specifically for this installation and shall include all required catalog cut sheets, drawings, equipment lists, descriptions, and necessary information required to instruct operating and maintenance personnel unfamiliar with such equipment. A complete, corrected and approved copy of the shop drawing submittal shall be included with each manual provided.

B. A factory representative, of all major component manufacturers, who has complete knowledge of proper operation and maintenance shall be provided for one (1) day to instruct representatives of the Owner and the Engineer on proper operation and maintenance, following installation by Contractor. This work may be conducted in conjunction with the inspection of the installation and test run as

provided herein with the Owner's permission. If there are difficulties in operation of the equipment due to manufacturer's design or fabrication, additional services shall be provided at no cost to the Owner.

1.06 SPARE PARTS AND TOOLS

A. The following spare parts shall be furnished:

1. One (1) set of gaskets for each type of pump.

2. One (1) set of lip seals for each type of pump.

3. One (1) set of bearings for each type of pump.

4. One (1) shaft sleeve for each type of pump.

5. One (1) set of wear rings for each type of pump.

6. One (1) mechanical seal for each type of pump.

B. All special tools required for normal operation and maintenance shall be furnished with the equipment.

C. Additional spare parts shall be provided in accordance with manufacturer's recommendations.

D. Spare parts shall be properly bound and labeled for easy identification without opening packaging and suitably protected for long-term storage.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is complete and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site as specified.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

H Handle during delivery, storage and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved instructions.

1.08 WARRANTY AND GUARANTEES

A. 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 as specified in Section 01 74 00, excepting only those items that are normally consumed in service, such as oils, grease, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified, 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.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The equipment covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown on the Drawings.

B. All parts shall be so designed and proportioned as to have liberal strength and stiffness, and to be especially adapted from the work to be done. Ample room and facilities shall be provided for inspection, repairs, and adjustment.

C. Pump bases shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. All necessary foundation bolts, plates, nuts and washers shall be furnished and installed by the Contractor and shall conform to the recommendations and instructions of the equipment manufacturer. Anchor bolts, nuts, and washers shall be of Type 316 stainless steel.

D. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed, impeller diameter, and any other pertinent data shall be attached to each pump.

E. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes and all other pertinent data shall be attached to each motor.

F. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

G. All pumps shall be designed and built for 24 hour per day continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain. All pumps shall be designed for indoor service.

H. Pumps and pump bases shall have suitable provisions such that leakage may be collected and drained away.

I. Each pump and motor shall be designed to withstand the maximum turbine run away speed of the pump due to backflow through the pump.

2.02 MATERIALS AND EQUIPMENT

A. Pump casing shall be cast iron conforming to ASTM A48 Class 30 with integral volute scroll. Casing shall incorporate following features:

1. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

2. Fill port cover plate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, a clamp bar screw 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.

3. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

4. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this Section.

5. Each pump shall be designed to retain adequate liquid in the pump casing to insure unattended automatic repriming.

B. Suction head shall be Class 30 cast iron. Its design must incorporate following maintenance features:

1. The suction head shall be secured to the pump casing by using hex head cap screws and lock washers. Access to the impeller and mechanical seal shall be accomplished by removing the suction head.

2. Removal of any blockages in the impeller shall be accomplished by removing the suction head, or through a cleanout cover on the suction head. In consideration of safety, two clamp bar screws must provide slow release of pressure on two clamp bars securing the cleanout cover. A Teflon gasket shall prevent adhesion of the cleanout cover to the suction head casing.

3. Removal of the suction check valve shall be accomplished through the removable cleanout cover on the suction head.

4. In consideration for safety, a pressure relief valve shall be supplied in the suction head. The relief valve shall open at 75-200 PSI.

5. A replaceable ductile iron wear plate shall be secured up against the pump casing by the suction head. Measurement of the clearance between this wearplate and impeller shall be accomplished through the cleanout cover plate.

C. 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:

1. Seal plate and bearing housing shall be Class 30 cast iron. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and

bearings. Cavities must be cooled by the liquid pumped. Three (3) lip seals shall prevent leakage of oil.

a. 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.

b. 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.

c. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

2. 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 lock screw and conical washer.

3. Impeller shaft shall be AISI 17-4 pH stainless steel.

4. 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.

5. Shaft seal shall be cartridge oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium 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 shall secure the stationary seat to the seal plate and an internal O-ring shall hold 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 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this Section.

6. Pusher bolt capability shall be provided to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same cap screws as used for retaining rotating assembly.

D. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means.

1. Clearances shall be maintained by using external shims between the casing ring of the rotating assembly and the pump casing itself. Shims shall be of various sizes to allow precise adjustment of this clearance. The clearance shall be measured by removing the cleanout cover on the suction head.

2. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

E. 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 cleanout cover on the suction head 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 shall not be acceptable.

F. Removal of the rotating assembly shall be accomplished through the front or the back of the pump casing.

G. Continuous Vane Impeller with Self-Cleaning Wear Plate

1. The nature of the conveyed medium poses significant challenges to the continuous operation of the pump. Of particular concern is the clogging of the impeller by debris in the pumped medium including but not limited to long rags, fibers, and like debris which are able to wrap around the impeller vanes, stick to the center of the vanes or hub, or lodge within the spaces between the impeller and the housing.

2. The pump impeller shall be a continuous vane extending from one edge of the impeller through the central portion of the impeller to the other edge. The impeller height shall increase continuously from the outer radius of to the central region of the impeller.

3. The matching wear plate shall have one or more notches and/or recesses provided along a common diameter of the wear plate to disturb and dislodge any solids which might otherwise remain on the impeller in

dynamic operation. Clusters of notches and/or recesses may also be provided.

2.03 ELECTRIC MOTORS

A. General:

1. The motors for the pumps shall be of the open drip-proof design.

2. All motors shall be built in accordance with latest NEMA, IEEE, ANSI, and AFBMA standards where applicable.

3. Motors shall be as manufactured by Reliance Electric, U.S. Electrical Motors, General Electric Company or Baldor Electric Company.

4. The motor shall be non-overloading, without use of the service factor, at any point on the driven pump's performance curve at the name plate speed of the motor.

B. Performance Requirements:

1. Motors shall be rated for operation on 460-volt, 3 phase, 60 Hertz power supply.

2. Each motor shall have a 1.15 service factor.

3. Motors shall be rated at a maximum horsepower of 15 HP.

4. Motors shall have a premium duty efficiency.

5. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 85 dBA as measured 5 feet from any surface.

6. Maximum temperature rise of motor windings shall not exceed 80 degrees C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air temperature of 40 degrees C.

C. Motor Construction:

1. Motor shall be of all cast iron construction for frame, end brackets, conduit box and fan shroud. Motor shall be of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.

2. The motors shall be of open drip-proof construction.

3. Motor windings for stator and rotor leads shall be manufactured using solid copper wire. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.

4. Neoprene shaft slinger shall be provided and lead wires shall be nonbraided and nonwicking to prevent entrance of moisture and contaminants.

5. All leads shall be brought out to a separate terminal box and shall be marked and identified. The terminal box shall be split construction, double gasketed, containing provisions for grounding the motor and shall comply with NEMA standards for minimum volume.

6. Motors shall have stainless steel breather drains at both ends to allow proper drainage of condensation.

7. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.

8. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.

9. Motors shall be equipped with shielded, regreasable, vacuum degassed steel ball bearings made to AFBMA Standards, and be of ample capacity for the motor rating. Bearings shall have a minimum B-10 bearing life of 100,000 hours.

10. Nameplates shall be stainless steel fastened with stainless steel pins or screws. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screening and shall be protected from corrosion, fungus and insects.

11. All grease plugs, fittings, bolts, nuts, and screws shall be stainless steel. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.

12. A grounding lug shall be provided in the conduit box.

2.04 STRUCTURAL STEEL SKID

A. As shown on the Drawings, each complete equipment assembly shall be rigidly mounted to a raised structural steel platform.

B. All structural steel shall conform to ASTM A36 with minimum tensile strength 58,000 psi.

C. The platform shall be so designed to support all associated equipment and piping when completely filled with water or wastewater, with main support members adequately sized to bear loads applied by lifting the unit at four points on its perimeter. Cross members shall be located to bear the loads applied by various components. All structural members to be joined by a minimum ¼-inch fillet weld.

D. Lifting cleats shall be attached at four (4) points along the platform perimeter to allow lifting by cable and spreader bars. Each cleat shall be adequately sized to bear the load of the entire assembly.

2.05 SURFACE PREPARATION AND SHOP PAINTING

A. All surfaces shall be degreased, prepared and coated in accordance Section 09 90 00, Painting and Coating.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The pumps and motors shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings. Field verify the location and elevation of the connected piping and coordinate this information with the manufacturers of the proposed equipment. The pump manufacturers shall field verify all quantities and dimensions for the skid mounted pump support as shown on the Drawings.

B. Suction pipe connections shall be vacuum tight. Fasteners at all pipe connections must be tight.

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.

D. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

A. Each skid mounted pump unit shall be subjected to a non-witnessed performance test in the manufacturer's shop, in accordance with the applicable test code requirements of the Hydraulic Institute and as specified herein prior to shipping. Pumps shall be tested with the actual motors furnished under this Section.

B. Certified pump performance curves shall be submitted, including head, capacity, brake horsepower and pump efficiency for each pump supplied. The cost for tests shall be included in the cost of the equipment.

C. Four (4) certified copies of all factory pump test data shall be furnished to the Engineer.

3.03 INSPECTION AND TESTING

A. Furnish the services of a factory representative for one (1) day who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test run of the equipment. These services may be combined with those provided under Paragraph 1.05 above.

B. After all pumps have been completely installed, and working under the direction of the manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that pump efficiency and discharge conform to this Section. Field tests shall include all pumps included under this Section. Supply all electric power and water or wastewater to complete the field tests.

C. If the pump performance does not meet the specified requirements, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. Up to a 24-hour operating period of the pumps may be required before acceptance, at the discretion of the Engineer.

END OF SECTION

SECTION 43 21 13.03
SUBMERSIBLE SOLIDS HANDLING PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install, place in operation, and field test two (2) submersible pumps to be installed in the sludge filtrate pump station.

2. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, and as required for an installation incorporating the highest standard for this type of service including field testing of the entire installation and instructing the regular operating personnel in the care, operation and maintenance of all equipment.

4. In order to provide single source responsibility, and compatibility between the various equipment items, control panels for pumps specified in this Section shall be furnished by the supplier of the pumping equipment.

1.02 QUALIFICATIONS

A. The pumps covered by these Specifications are intended to be standard pumping units of proven ability as manufactured by a manufacturer having a minimum of five (5) years experience in the production of such pumps. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed. Pumps shall be manufactured in accordance with the Hydraulic Institute Standards.

B. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of

manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years.

C. The pumps shall be furnished complete with accessories required and shall be as manufactured by Flygt, ABS, KSB, or an approved equal.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of Section 01 33 00. Submittals shall include at least the following:

1. Shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSH, submergence and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to pump capacity at minimum specified TDH. Catalog sheets showing a family of curves will not be acceptable.

4. The total weight of the equipment including the weight of the single largest item.

5. A complete total bill of materials of all equipment.

6. A list of the manufacturer's spare parts to be supplied in accordance with Paragraph 1.05.

7. All submittal data required by the General Conditions.

8. Complete motor data including:

Nameplate identification
No-load current
Full load current
Full load efficiency
Locked rotor current
High potential test data
Bearing inspection report

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

1.04 OPERATING INSTRUCTIONS

A. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01 78 23.

1.05 SPARE PARTS AND TOOLS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys. Spare parts for pumps shall include the following as a minimum:

1. Two (2) sets of radial and thrust berings
2. Two (2) sets of gaskets and seals
3. One (1) set of mechanical seals

C. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage. Spare parts shall be delivered to the Owner prior to pump station start-up.

1.06 PRODUCT HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

G. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY

A. The pump manufacturer shall warrant the units being supplied against defects in workmanship and material for a period of five (5) years or 10,000 hours of operation.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The pumping units required under this Section shall be complete including pumps and motors with proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done.

B. Each discharge connection for each pump shall be rigidly and accurately anchored into position. All necessary anchor bolts, nuts, and washers shall be Type 316 stainless steel and shall be furnished by the pump manufacturer for installation by the Contractor.

C. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed, and all other pertinent data shall be attached to each pump and motor.

2.02 PUMPS

A. The pumps shall be totally submersible non-clog centrifugal pumps with submersible closed coupled motors. The design shall be such that the pumping units shall be automatically connected to the discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for this purpose, and no need for personnel to enter the pump well. Each pump shall be fitted with a Type 316 stainless steel lifting chain of adequate strength. A 1/4" Type 316 stainless steel cable, air craft rating, shall be provided between the cable holder and lifting chain.

B. The impeller shall be constructed of gray cast iron, ASTM A-48, Class 30. The design shall permit low liquid velocities and gradual acceleration and change of

flow direction of the pumped media. The impeller/casing design shall result in a passage free of surfaces to which solid or fibrous materials can adhere. The overall pump design shall combine high efficiency, low required NPSH, large sphere passage and the ability to handle high solids concentrations efficiently. All other parts shall be of close grain gray iron construction, with all parts coming into contact with the pumped liquid protected by approved sewage resistant coating. Metal surfaces that will be in contact with the pumped liquid, other than stainless steel or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer. Exterior surfaces of the pump shall also receive a polyester resin finish coating. All external bolts and nuts shall be of Type 316 stainless steel. The impeller shall be of a centrifugal non-clog type, capable of passing solids and fibrous material of the size specified in Table 43 21 13.03-A.

C. Each pump shall be provided with a tandem double mechanical seal running in an oil reservoir, composed of two separate lapped face seals, each consisting of one stationary and one rotating tungsten-carbide ring with each pair held in contact by a separate spring. Lapped seal faces must be hydrodynamically lubricated at a constant rate. The lower seal unit, between the pump and oil chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. Silicone-carbide may be used in place of tungsten-carbide for the lower seal. The upper seal unit, between the oil pump and motor housing, shall contain one stationary tungsten-carbide ring and one positively driven rotating tungsten-carbide ring. The compression spring shall be protected against exposure to the pumped liquid. The pumped liquid shall be sealed from the oil reservoir by one face seal and the oil reservoir from the motor chamber by the other. The seals shall require neither maintenance nor adjustment, and shall be easily replaced. Conventional double mechanical seals with a single spring between the rotating faces, requiring constant differential pressure to effect sealing and subject to opening and penetration by pumping forces shall not be considered equal to tandem seals specified and required.

D. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a nitrile rubber coated steel ring insert that is drive fitted to the volute inlet. On pumps 20 horsepower and larger, a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller shall also be provided.

E. A sliding guide bracket shall be an integral part of the pumping unit; the pump casing shall have a machined connection flange to connect with the cast iron discharge connection, which shall be bolted to the floor of the wet-well with Type 316 stainless steel anchor bolts and so designed as to receive the pump connection without the need of any bolts or nuts. Sealing of the pumping units to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided by two (2) Schedule 40 Type 316 L stainless steel guides. No portion of the pump shall bear

directly on the floor of the sump and no rotary motion of the pump shall be required for sealing. Sealing at the discharge connection by means of a diaphragm, o-ring, or similar method of sealing will not be accepted as an equal to a metal-to-metal contact of the pump discharge and mating discharge connection which is specified and required. The pump with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.

F. Pump motors shall be housed in an air-filled watertight casing and shall have Class F insulation windings which shall be moisture resistant. Pump motors shall be 460 volt, 3 phase, 60 Hertz. Motors shall be NEMA Design B, rated 155 degrees C maximum and shall have a service factor of 1.15. Pump motors shall have cooling characteristics suitable to permit continuous operation, in a totally, partially or non-submerged condition. Each motor shall incorporate an ambient temperature compensated overheat sensing device. The protective device shall be wired into the pump controls in such a way that if the device operates the pump will shut down. The device shall be self-resetting. The cable shall be fixed to the pump using a watertight assembly. The pump shall be capable of running continuously in a totally dry condition under full load without damage, for extended periods. The pump shall be capable of sustaining a minimum of ten (10) evenly spaced starts per hour continuously without damaging the pump or motor in any way. Before final acceptance, a field running test demonstrating this ability, with 24 hours of continuous operation under the above conditions, shall be performed for all pumps being supplied, if required by the Owner. Pump motor cable shall be suitable for submersible pump applications and shall be properly sealed.

G. The pump cable entry water seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall be comprised 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 entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. Control conductors shall be included in the cable. The pump supplier shall provide a watertight connector, equal to Crouse Hinds Type CGB or Hubbel Type SLB, with a neoprene gland to terminate the cable in the control panel. Secondary sealing systems using epoxy potting compounds are also acceptable.

H. The junction chamber, containing the terminal board, shall be sealed from the motor by an elastomer compression seal (0-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding posts permanently affixed to a terminal board and thus perfectly leak proof.

I. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to back flow through the pump.

J. Performance Requirements: The pumps furnished shall meet the "Performance Requirements" set forth at the end of this Section in Table 11208-A. The brake horsepower required by each pump shall not exceed the nameplate horsepower of the pump drive motor over the entire pump-operating curve.

K. The pump discharge elbow connection shall be permanently installed in the basin along with the discharge piping. The pump shall be automatically connected and sealed to its discharge connection elbow when lowered into place.

L. Automatic reset normally closed thermal switches shall be imbedded in the motor windings to provide overheating protection. These thermal switches shall be connected to the control panel.

2.03 PUMP GUIDES

A. Lower guide holders shall be integral with the discharge connection. Guide bars for each pump shall consist of two (2) Schedule 40, seamless welded Type 316 L, stainless steel pipes of the size and length required by the pump manufacturer. Upper guide bracket holders shall be provided by the pump supplier to anchor the guides for each pump. The pump supplier shall also provide intermediate guide bar brackets if they are recommended by the pipe manufacturer. All brackets shall be fabricated of Type 316 stainless steel.

2.04 SHOP PAINTING

A. Before exposure to weather and prior to shop painting, all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.

B. All pumps and motors shall be shop coated, with manufacturer's standard coating.

C. All nameplates shall be properly protected during painting.

D. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

2.05 ACCESS HATCHES AND ACCESSORIES

A. Access hatches shall be provided for all openings in the top slabs for the pump station wet wells and valve vaults. Each hatch shall include an extruded aluminum frame incorporating a continuous concrete anchor and shall be complete with hinges and slide bar equipped covers. Each wet well hatch shall include stainless steel pump guide bar holders. A Type 316 stainless steel level sensor holder shall be provided for each pumping application and where there are multiple hatches for an application the holder shall be secured to one of the hatches as shown on the Drawings. Hatch frames and covers shall be constructed of aluminum and designed for a live load of 300 pounds per square foot. Hatch doors shall be of aluminum checkerplate with reinforcing ribs as required to meet the specified design criteria. All hardware for hatches shall be of Type 316 stainless steel. All aluminum surfaces that will be in contact with concrete shall be coated with a high-build paint, applied by the hatch manufacturer, in order to protect the aluminum. Hatches shall be Series S1R as manufactured by Halliday Products, Inc. or an approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. The Contractor shall submit a certificate from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.02 INSPECTION AND TESTING

A. General:

1. The Engineer shall have the right to inspect, test or witness tests of all materials or equipment to be furnished under these Specifications, prior to their shipment from the point of manufacture.

2. The Engineer shall be notified in writing prior to initial shipment, in ample time so that arrangements can be made for inspection by the Engineer.

3. The Engineer or his representative shall be furnished all facilities, including labor, and shall be allowed proper time for inspection and testing of material and equipment.

4. Materials and equipment shall be tested or inspected as required by the Engineer, and the cost of such work shall be included in the cost of the equipment. The Contractor shall anticipate that delays may result because of the necessity of inspection, testing and accepting materials and equipment before their use is approved.

5. The services of a factory representative shall be furnished for one (1) day and he shall have complete knowledge of proper operation and maintenance to inspect the final installation and supervise the test run of the equipment. With the permission of the Owner these services may be combined with those provided under Paragraph 1.04 of this Section.

6. Field tests shall not be conducted until such time as the entire installation is complete and ready for testing.

B. Pumps:

1. After all pumps have been completely installed, and working under the direction of the manufacturer, conduct in the presence of the Engineer, such tests as are necessary to indicate that pumps conform to the Specifications. Field tests shall include all pumps included under this Section. Supply all electric power, water or wastewater, labor, equipment and incidentals required to complete the field tests.

2. If the pump performance does not meet the Specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance. During this 24-hour operating period, the Contractor shall supply all power necessary.

3.03 FIELD TESTING

A. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all specifications.

B. The Contractor shall perform initial testing of the equipment ensuring to himself that the tests listed in the Final Acceptance Test paragraph below can be satisfactorily completed.

C. The Contractor shall give written notice, seven (7) days in advance, of the date of Final Acceptance Test to the Owner and Engineer. All tests shall be in conformance with other applicable Sections of these Specifications.

D. The Final Acceptance Test shall demonstrate that all items of these Specifications have been met by the equipment as installed and shall include, but not be limited to, the following tests:

1. That the quick release lift-out feature functions properly and allows the pump to be raised and lowered without draining the pit.

2. That all units have been properly installed and are in correct alignment.

3. That the units operate without overheating or overloading any parts and without objectional vibration.

4. That there are no mechanical defects in any of the parts.

5. That the pumps meet the specified hydraulic requirements.

6. That the pumps shall be capable of pumping raw, unscreened sewage.

7. That the pump sensors and controls perform satisfactorily as to sequence control, correct start and stop elevations, and proper alarm functions.

E. In the event that the equipment does not meet the Final Acceptance Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until full satisfaction is indicated by the Engineer and written certification is received thereof.

F. The Owner will pay the salaries of the personnel selected by the Owner for operation of the equipment. Payment of all other salaries, public utility services, and operating expenses shall be borne by the Contractor for the test period and any additional test period required.

3.04 PUMP PERFORMANCE SCHEDULE

A. Pumps shall be furnished according to "Table 43 21 13.03-A, Pump Performance Schedule" on the following page.

TABLE 43 21 13.03-A

PUMP PERFORMANCE SCHEDULE

Parameter	Plant Drain Pump Station
Number of Pumps	2
Pump Type	Standard Submersible
Type of Drive	Constant Speed
Design Capacity per Pump, GPM/Ft. TDH	500 / 25
Minimum Efficiency at Design Capacity, Percent	57
Minimum Size Solids, In.	3
Minimum Discharge Size, In.	4
Maximum Horsepower Per Pump, HP	7.5

Notes

1. System curve points under minimum TDH conditions for the Filtrate Pumps are presented below. Pump operation shall not result in cavitation, excessive vibration, or other undesirable conditions at the minimum TDH conditions specified below. The minimum TDH conditions will occur when there is 1 foot of liquid above the pump volute.

Minimum TDH System Curve Data for Filtrate Pumps	
Flow	TDH (ft.)
0	15
500	18
1,000	28
1,500	43
2,000	63

END OF SECTION

SECTION 43 33 00
LIQUID CHEMICAL FEED PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work

1. This Section covers the furnishing of all labor, materials, equipment, accessories, and incidentals required and installation, placing in operation, and field testing of the chemical metering pumps, motors, controls, and accessories as specified herein and as shown on the Drawings.

2. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the specific equipment application. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation of all materials, equipment and appurtenances for the complete pumping units, controls, and accessories as specified herein, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

4. Contractor shall furnish terminal boxes as shown on Drawings and as specified herein for a complete system.

B. General Design

1. All of the equipment specified herein is intended to be new standard equipment for use in the liquid chemical feed systems and shall include, but not be limited to, the following items of material and equipment:

a. Mechanically actuated metering pumps.

b. Electronically actuated metering pumps.

c. Peristaltic metering pumps.

d. Calibration columns.

e. Pressure relief valves.

f. Pulsation dampeners with integral pressure gauge.

g. Backpressure valves.

h. Inlet strainer.

i. Pump drives and controls.

2. All working parts of identical pumps and motors, such as bearings, check valves, shafts, sleeves, motors, etc., shall be of standard dimension built to limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the operation and maintenance manuals furnished.

1.02 QUALITY ASSURANCE

A. To assure unity of responsibility, the motors, controls, and accessories shall be furnished and coordinated by the pump manufacturer or supplier. The supplier shall assume complete responsibility for the satisfactory installation and proper operation of the entire pumping system including pumps, motors, controls, and accessories. The diaphragm metering pumps shall be as manufactured by Wallace and Tiernan ChemFeed, or an approved equal. The peristaltic pumps shall be manufactured by Watson-Marlow Bredel or an approved equal. The pumps shall be as shown in Table 43 33 00.

B. Should equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the the basis that any revisions in the layout and construction of the structures, piping and appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no additional cost to the Owner and as approved by the Engineer.

C. The pumps covered by these Specifications shall be new and unused and shall be standard pumping equipment of proven ability as manufactured by a reputable, qualified manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years. The pumps furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of the General Conditions and Section 01 33 00, Submittal Procedures. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves based on actual shop tests of similar units which show that they meet the specified requirements for head, capacity, linearity, and horsepower. Curves shall be submitted on 8-1/2 inch by 11 inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at zero stroke speed to pump capacity at specified total head.

4. Data including principle dimensions, materials and construction, space required, clearances, piping and electrical connections and requirements, controls, type of finish, installation instructions and other pertinent information.

5. A complete total bill of materials of all equipment including the weights of equipment furnished.

6. A list of the manufacturer's recommended spare parts. Include gaskets, packing, diaphragms, etc. on the list. List bearings by the bearing manufacturer's numbers only.

7. Complete motor data.

8. Copies of all factory test results, if specified in PART 2 - PRODUCTS of this Section of the Specifications.

9. The recommended summer and winter grades of lubricants along with alternative references to equal products of other manufacturers.

10. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, terminal boxes, etc., including connections to work of other Sections.

12. Quality Control Submittals:

a. Manufacturer's certification of compliance demonstrating that all materials of construction that come into direct or indirect contact with the chemicals being pumped are fully compatible for the specified service.

b. Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

c. Special shipping, storage and protection, and handling instructions.

d. Manufacturer's printed installation instructions.

e. Manufacturer's Certificate of Proper Installation.

f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

g. Field performance test certificate.

1.04 OPERATION AND MAINTENANCE DATA

A. Operating and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The number and special requirements shall be as specified in Section 01 78 23, Operating and Maintenance Data.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged storage period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished iron or steel surfaces not shop painted shall be properly protected to prevent rust and corrosion.

E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

G. The finished surfaces of all exposed flanges shall be protected by wooden blind flanges, strongly built and securely bolted thereto.

1.06 WARRANTY AND GUARANTEES

A. Provide full equipment service/parts warranty as specified in Section 01 74 00.

PART 2 - PRODUCTS

2.01 GENERAL

A. The pumping units required under this Section shall be complete including proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.

B. All equipment and piping shall be rigidly and accurately anchored into position and all necessary foundation bolts, plates, nuts, and washers shall be furnished and installed. All bolts, nuts, and washers shall be of Hastelloy C for the sodium hypochlorite and hydrofluorosilicic acid pumps and equipment and Type 316 stainless steel for the other equipment.

C. Stainless steel nameplates giving the name of the manufacturer, model number, rated capacity, speed, and any other pertinent data shall be attached to each item of equipment.

D. A separate stainless steel nameplate with the equipment identification number as specified herein and as shown on the Drawings shall be attached to each item of equipment in an easily visible location. The lettering shall be stamped on using 1/4 inch high or larger letters.

E. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and other pertinent data shall be attached to each motor.

F. Engraved laminated nameplates giving the name and function of all selector switches, pushbuttons, alarm lights and control devices shall be securely attached to each panel furnished.

G. All electrical materials and equipment shall be Underwriters Laboratories, Inc. listed and shall otherwise be equal to those specified under Divisions 26, 28, and 40.

2.02 MATERIALS AND EQUIPMENT

A. Metering Pumps - Mechanically Actuated

1. The chemical metering pumps shall be of the positive displacement, single diaphragm design with the diaphragm actuated and balanced mechanically, consisting of simplex pumping heads. The pump, motor, gear reducer, and stroke controller, where required, shall be mounted on a common baseplate.

2. Mechanically actuated pumps shall include integral motor and oil-lubricated gear reducers. All drive components shall be oil lubricated. All drive bearings shall be tapered rollers and all fasteners shall be of Type 316 stainless steel.

3. Pumps shall be provided with precise seating, suction, and discharge ball check valves. The check valves shall be removable from the liquid end for servicing or replacement. The suction and discharge check valve cartridges or seats and element shall be easily field replaceable. Check valves shall be single or double ball, in line (straight-through) type check valves. No spring-loaded check valves will be acceptable. The valve retainers shall be clear PVC for integral sight flow indication and shall connect to the pump head and pipe connectors via O-rings. All check valve components shall be compatible with the materials to be pumped as listed in Table 43 33 00.

4. The diaphragm shall be Teflon-faced, fabric reinforced and bonded to preformed elastomeric support. The diaphragm shall encompass a steel body plate. Provide an O-ring groove in the head's diaphragm cavity for a complete leak-free seal. The diaphragm materials shall be compatible with the materials to be pumped as listed in Table 46 33 00.

5. The pumps shall have a steady state flow accuracy of within ±2 percent over a turndown ratio of 10:1. The pumps shall be capable of accepting manual or electric control, either factory mounted or by field conversion. Pumps shall be provided with manual 10-turn stroke adjustment via a unit mounted micrometer and automatic stroke adjustment mechanism when

specified in Table 43 33 00. The manual stroke adjustment shall be capable of being performed while the pump is operating or idle. A percent scale and vernier shall indicate stroke length in 0.25 percent increments.

6. Materials of construction for the pumping units shall be compatible with the fluids to be pumped and as listed in Table 43 33 00.

7. The motor shall be coupled to the gearbox via a field retrofittable, 4-step pulley and belt drive mechanism.

   a. Each range shall have 10:1 turn down adjustment thereby extending the total operation turndown to 40:1 with a standard induction motor and 800:1 with a variable speed DC motor.

8. A secondary diaphragm shall completely seal and separate the pump head from the drive vent to eliminate a risk of cross-contamination lubricant and process fluid.

9. Motor and Control

   a. Each mechanically actuated pump shall be driven by an integrally mounted DC motor.

   b. Motors shall be standard totally enclosed fan cooled (TEFC) DC units and of the frame size selected by the manufacturer to prevent overheating when continuously operated at 10 percent speed and constant torque loaded. Drives shall be suitable for continuous operation over a 20 to 1 speed range within plus or minus 2 percent of selected operating speed. Each pump and drive including coupling and guard shall be factory mounted on a common base and tested.

   c. A thermal switch shall be furnished in each drive motor and wired under Divisions 26, 28, and 40 to stop motor on high winding temperature.

   d. The metering pump motor speed shall be adjustable by use of a DC SCR Drive. DC SCR drive shall not cause more than 1 period harmonic distortion into power supply voltage wave form, as defined by IEEE Standard 519. Furnish isolation transformers or filtering devices as necessary.

   e. The pump controller shall accept an analog signal such that stroke frequency is proportional to a 4-20 mA DC signal. The pump

controller shall be capable of control through the remote signal or manually at the controller.

f. Electronic Stroke Control

i. Each chemical feed pump shall be equipped with an electronic stroke controller if scheduled herein under Table 43 33 00. The electronic stroke controller shall automatically adjust the stroke length of the pump in response to a 4 to 20 mA DC analog signal as specified under Instrumentation to provide linear adjustment of stroke setting from 0 to 100 percent. The control system shall be constructed to completely isolate the control signal from the AC power supply.

ii. Provide manual override using either integral handwheel or knob, or separate manual adjustments specified above. Provide selection or AUTO or MANUAL position adjustment.

10. The metering pumps shall be provided with all the signals as shown on the Instrumentation Drawings.

C. Metering Pumps – Electronically Actuated

1. Chemical metering pumps shall be positive displacement non-hydraulic, microprocessor-controlled solenoid driven, mechanically actuated diaphragm type pumps. Output shall be adjustable while pumps are in operation. Positive flow shall be adjustable while pumps are in operation. Positive flow shall be ensured by a minimum of four ball type check valves. A bleed valve shall be provided for the manual evacuation of entrapped air or vapors and safe relief of pressure in the discharge line.

2. To prevent damage to pump from overheating, the solenoid shall have automatic reset thermal overload protection. For overpressure conditions, pump shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by not more than 35% when pump is set at maximum stroke.

3. The pump liquid end shall be physically separated from the drive unit.

4. The pump shall be capable of a minimum 100:1 turndown ratio.

5. Pump drive shall be encased in a water resistant housing constructed of a chemically resistant glass filled polypropylene. The electronic circuitry

shall be mounted at the rear of the pump for maximum protection against chemical intrusion.

6. Pump valves shall be ball type, with balls seating on combination valve seat and seal ring. Valve seat and seal rings shall be renewable by replacing only the combination seat-seat ring.

7. The metering pump shall accept a 4-20 mA DC signal for stroke speed control and provide a 4-20 mA DC output signal indicating pump status and alarms.

8. Materials of construction for the pumping units shall be compatible with the fluids to be pumped and as listed in Table 43 33 00.

D. Peristaltic Metering Pumps

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

2. Peristaltic pumping action shall be created by the compression of the flexible tube between the pump head rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum creating restitution of the tube.

3. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30 feet vertical water column. Maximum pressure rating shall be 30 psi.

4. Pump shall not require the use of check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within the pump tubing and shall not directly contact any rotary or metallic components.

5. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

6. Pump Head:

   a. Pump head shall consist of a fixed track, a hinged guard door, and spring- loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees. At all times, one roller shall be fully engaged with the tubing providing complete compression and

preventing backflow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4 mm wall thickness tubing and shall not require adjustment.

b. Pump head guard shall be transparent for the purpose of viewing direction of rotation. When closed, the pump head guard shall seal against the pump track for leak containment and controlled waste through the pump head waste port in the event of a tube failure. Pumps in which the direction of rotation cannot be visually verified and/or do not have a controlled waste port are not acceptable.

c. Pump Head Assembly:

1) Pump track geometry must have a minimum 96.6 mm swept diameter through a minimum track angle of 180°.

2) Provide high corrosion/impact materials as specified.
   a) Track Construction: Polyphenylene sulfide (PPS).

   b) Guard Construction: Hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.

   c) Rotor Construction: Polyphenylene sulfide (PPS).

d. Rotor Assembly:

1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:

   a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution. Compressing rollers shall be of Type 316 stainless steel with low friction stainless steel bearings and PTFE seals, minimum diameter of 18 mm.

   b) Provide non-compressing guide rollers constructed of corrosion resistant Nylatron.

2) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.

3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gear motor via a slotted collet and central retaining screw.

4) Pump heads requiring disassembly or special tools for tube changing are not acceptable.

7. Tubing:

a. Pump shall be supplied with a Load Sure tubing element with molded fittings, which shall be self-locating when fitted into the pump head. Tube element shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the element fittings. The tubing shall be replaceable without the use of tools and with no disassembly of the pump head.

b. Load Sure element shall be constructed with tubing material specified in Table 43 33 00 with male PVDF quick-release connectors.

c. Supply one (1) tube element of the specified size per pump.

d. Supply two (2) one-meter long flexible reinforced PVC hoses for connection of pump to suction and discharge process lines. Flexible hose shall have a PVDF female quick-release fitting for connection to the Load Sure element and male quick-release fitting for connection to NPT adaptor with built in shut-off valve for ease of maintenance and connection to process lines.

e. Supply two (2) quick-release to NPT Adaptors.

8. Drive:

a. Rating : Continuous 24 hour operation, 40 degrees C ambient.

b. Supply: 120VAC single-phase field switchable. Supply nine-foot length power cord with standard three-prong plug.

c. Enclosure: NEMA 4X.

d. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. Unpainted housings are not acceptable.

e. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.

1) Backlit graphical LCD capable of up to four lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions.

2) Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.

3) Menu driven on screen programming of manual or automatic control, flow and remote signal calibration , and general programming.

4) Programmable "auto restart" feature to resume pump status in the event of power interruption.

5) Programmable "keypad lock" to allow operator lockout of all keys except emergency start/stop.

6) Programmable "maximum speed" to allow operator to set the maximum speed of the pump within 0.1-220 rpm.

f. Supply automatic control features to meet the following minimum functionality requirements for use with the SCADA system. All control signal features must be located internally to the pump. Pumps not meeting this minimum functionality or that require additional external control boxes are not acceptable.

1) Remote Control Inputs:

a) Speed Control:

- Primary analog 4-20 mA DC trimmable speed input, with input signal and speed scaleable over any part of the drive speed range.
- Secondary analog 4-20 mA DC scaling input, with input signal trimmable and programmable scaling factor.

- Provisions for alternative remote accessory potentiometer (if supplied by others) for primary speed control or secondary speed scaling.

b) Start/Stop Control: Via 5V TTL, 24V industrial logic or dry contact. Configurable command sense allowing open to equal run or open to equal stopped.

c) Forward/Reverse Control: Via 5V TTL, 24V industrial logic or dry contact.

d) Auto/Manual Mode Control: Via 5V TTL, 24V industrial logic or dry contact.

e) Leak Detector Run/Stop Control: Via 5V TTL, 24V industrial logic, or dry contact.

2) Status Outputs:

a) Four relay contacts rated for a 30 VDC with a maximum load of 30W, NO or NC software configurable to indicate the following:

- Running/Stopped status.
- Forward/Reverse status.
- Auto/Manual status.
- General Alarm status.
- Leak Detected status.

b) Speed Output: Analog 4-20mA DC.

3) Accepts RS485 data protocol.

4) Termination: Supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump.

g. Drive Motor: Brushless DC motor with integral gearbox and tachometer feedback.

1) Speed control range of 2200: 1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range.

2) Closed loop microprocessor controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm.

3) Circuitry complete with temperature and load compensation and protection.

h. Mounting: Drive shall be self-supporting and shall not require anchoring.

i. Leak Detection: Pump manufacturer shall supply float-type leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure.

E. Electrical Termination Junction Box

1. Provide wall mounted NEMA 4X FRP power supply and control signal terminal junction box (TJB) for each group of pumps as shown in the Drawings. The TJB shall be suitable for accepting a single point external 120 VAC, 1-phase, 60 HZ power supply connection. All control and signal wires shall be wired to the TJB. The TJB shall be sized in accordance with NEC requirements and shall contain appropriate terminal strips for metering pump wiring and external wiring.

2. See Drawings for input and output signals and alarms. Furnish complete wiring diagrams for all TJBs. Clearly identify customer connection points for all external wiring for proper system operation.

2.03 ACCESSORIES

A. Calibration Columns:

1. Provide transparent calibration column to be mounted on the suction piping of each metering pump as shown on the Drawings. The calibration column shall be piped such that one (1) metering pump can be calibrated while the other pumps are fully operational. The calibration chamber shall have materials compatible with intended chemical use; pyrex, plexiglass, acrylic or butyrate.

2. The calibration columns shall be furnished with flanged connection to suction piping and end cap fitted with ball valve for air venting, as indicated on Drawings.

3. The height and diameter shall be sized that the measureable capacity of the chamber is approximately 1 minute discharge of each pump at maximum pumping capacity.

4. Each pump suction pipe shall be furnished with valves and flanges for attachment of calibration chamber. Calibration chambers shall be rigidly installed and not supported from the piping system. Pump suction and discharge pipe shall be arranged so as not to interfere with location and use of the calibration chambers.

B. Pressure Relief Valves: Pressure relief valves shall be provided on the discharge piping of each metering pump as shown on the Drawings. Pressure relief valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with and fully resistant to corrosion by the liquids being pumped. The size of the pressure relief valve shall match the associated metering pump capacity.

C. Backpressure (Pressure Sustaining) Valves: Backpressure valves shall be provided on the discharge piping of the metering pumps as shown on the Drawings. Backpressure valves shall use a diaphragm design and be externally adjustable by means of a screwdriver. All materials of construction shall be compatible with and fully resistant to corrosion by the liquids being pumped. The size shall match the associated metering pump's capacity.

D. Pulsation Dampeners:

1. Pulsation dampeners shall be hydro-pneumatic type and of vertical design. A pulsation dampener shall consist of two chambers: an upper pressure chamber and a lower process fluid chamber. The chambers shall be separated by a flexible, elastomeric bladder, a PTFE bellow or a diaphragm.

2. Pulsation dampener shall be designed at a minimum safety margin of 4:1 burst pressure to maximum operating pressure. Pulsation dampener shall be capable of handling pump's maximum stroke volume. The pressure chamber shall be charged with compressed air to pump manufacturer's recommended charging pressure.

3. The pulsation dampeners shall be equipped with a pressure gauge and charging valve mounted on top of the gas chamber. All materials of construction shall be compatible with and fully resistant to corrosion by the liquids being pumped. Pulsation dampeners shall be supplied by the pump manufacturer.

E. Pressure Gauge Assemblies:

1. A pressure gauge shall be furnished on the discharge side of each pump to indicate pump discharge pressure.

2. Pressure gauge shall be furnished as part of a complete factory assembly, including gauge, snubber, diaphragm seal, liquid fill, isolation valve and interconnecting piping.

3. The gauge dial shall be a white background with black markings and sealed to prevent entrance of moist air. The gauges shall be liquid filled with glycerin and shall be provided with a filler/breather cap. The socket shall be Type 316 stainless steel with bottom connection.

4. Each pressure gauge assembly shall be equipped with an isolation valve and diaphragm seal to protect the gauge from contact with fluid in the pipeline. The isolation valve shall be a ball valve. The valve and diaphragm seal housing shall be constructed of the same material as the applicable chemical piping system and shall have either socket weld, socket fuse or flanged process connection. The diaphragm shall be Teflon. Mineral oil fill between the diaphragm seal and the gauge shall be furnished with the unit.

F. Inlet Strainer:

1. A suction line wye strainer shall be furnished on the suction line as shown on the Drawings. Wye strainers shall have 1/32-in perforations. Strainers shall be one size larger than the suction line which they are installed.

2. Strainer for all chemicals except for sodium hypochlorite shall have a clear PVC body, solvent ends, PVC mesh and EPDM O-ring. Strainer for sodium hypochlorite system shall have a clear PVC body, solvent weld ends, PVC mesh, Viton O-ring.

3. Strainers shall be as manufactured by ASAHI, George Fischer, or an approved equal.

2.04 SPARE PARTS

A. All special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the manufacturer.

B. The following spare parts shall be furnished for each hydraulically or mechanically actuated metering pump:

1. Two (2) extra sets of all gaskets, seals, diaphragms, packing, etc. of each different type.

2. One (1) container of each type of lubricating or hydraulic oil required.

3. Check valve assemblies.

4. One (1) box of fuses of each size furnished.

C. The following spare parts shall be furnished for each peristaltic metering pump:

1. One (1) spare pump head assembly and rotor for each size pump.

2. One (1) spare hose (tubing) with appropriate connectors per pump.

D. Contractor shall supply one (1) spare metering pump for each set of pumps specified.

E. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for storage. All tools shall be furnished in steel tool boxes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation of the pumps, drivers, and accessories shall be in strict accordance with the manufacturer's instructions and recommendations in the location shown on the Drawings. Anchor bolts shall be set in accordance with the manufacturer's recommendations and setting plans.

B. Installation shall include furnishing the required lubricants for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Installation shall include any pipe and fittings necessary to connect the metering pumps to the suction and discharge piping.

C. Submit a certificate from the equipment manufacturer stating that all the installation of their equipment is satisfactory, that the equipment is ready for operation and that operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.03 INSPECTION AND TESTING

A. Furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise test runs of the equipment.

B. Field test shall be conducted after the entire installation is complete and ready for testing. The Contractor shall furnish all the electric power, water and chemical shall be furnished for the field test.

C. Field test shall be conducted under the direction of the manufacturer's representative and in the presence of the Engineer. Field test shall demonstrate

that the pumps conform to the service requirements and design conditions specified. A 24-hour operating period of the pumps will be required before acceptance. If pump performance does not meet the specified requirement, corrective measures shall be taken or the pumps shall be removed and replace with pumps which satisfy the conditions specified. All costs associated with the field tests or any required corrective action shall be at no additional cost to the Owner.

D. All chemical metering pumps shall be field calibrated in the presence of the Engineer. Field calibration of each pump shall include graphing of pump capacity curves for 25, 50, 75 and 100 percent stroke adjustment. Curves shall be developed for 25, 50, 75 and 100 percent of motor speed. Six (6) sets of calibration curves shall be provided.

E. Test capacity data shall be monitored at point of discharge at selected strokes and speeds to confirm repeatability of settings.

3.04 START-UP AND INSTRUCTION

A. Contractor shall furnish at his expense the services of a factory-trained service engineer for system start-up, field testing, calibration and instruction briefings for operating personnel.

B. Manufacturer's Representative: Present at site or classroom site as designated by Owner, for minimum days listed below, travel time excluded with additional time furnished if required to correct problems or deficiencies:

1. One (1) day for installation assistance and inspection.

2. Three (3) days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

3. One (1) day for pre-startup classroom or site training.

4. One (1) day for facility startup.

Table 43 33 00 – Chemical Feed Pump Schedule

Pump Designation	Unit	Capacity, gph	Design Pressure, psi	Pump Type	Materials	Controls	Adjustable Speed Control
Alum Feed Pumps							
23-MP-1A, 23-MP-1B	2	120	75	Diaphragm, Encore 700	Gear Box: Epoxy coated cast iron Pump Head: PVC Valve Balls: Ceramic Seals: EPDM Diaphragm: PTFE Hardware: Stainless Steel	Automatic and Manual Stroke Length and Speed Control	Yes
Sodium Hypochlorite Feed Pumps							
24-MP-1A/1B 24-MP-2A/2B 24-MP-4A/4B	6	50 25 40	30	Peristaltic, Watson Marlow 520 Series	Tubing: Marprene Rollers: Stainless Steel	Automatic and Manual Speed Control	Yes
Sodium Hydroxide Feed Pumps							
25-MP-1B 25-MP-1C 25-MP-2A 25-MP-2B	4	30	30	Peristaltic, Watson Marlow 520 Series	Tubing: Marprene Rollers: Stainless Steel	Automatic and Manual Speed Control	Yes
Corrosion Inhibitor Feed Pumps							
26-MP-1A 26-MP-1B	2	1.0	80	Diaphragm, Premia Econo Series	Pump Head: Glass Filled Polypropylene Diaphragm: PTFE Valve Balls: Ceramic Seals: EPDM Hardware: Stainless Steel	Automatic and Manual Speed Control Manual Stroke Length Control	Yes

Pump Designation	Unit	Capacity, gph	Design Pressure, psi	Pump Type	Materials	Controls	Adjustable Speed Control
Fluoride Feed Pumps							
27-MP-1A 27-MP-1B	2	4	30	Peristaltic, Watson Marlow 520 Series	Tubing: Sta-Pure PCS Rollers: Stainless Steel	Automatic and Manual Speed Control	Yes
Sodium Thiosulfate Feed Pumps							
29-MP-1A 29-MP-1B	2	16	30	Peristaltic, Watson Marlow 520 Series	Tubing: Marprene Rollers: Stainless Steel	Automatic and Manual Speed Control	Yes
Polymer Feed Pumps							
28-MP-1A 28-MP-1B	2	12	30	Peristaltic, Watson Marlow 520 Series	Tubing: Marprene Rollers: Stainless Steel	Automatic and Manual Speed Control	Yes

END OF SECTION

SECTION 43 33 66
LIQUID CHEMICAL TRANSFER AND RECIRCULATION PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. This Section covers the furnishing of all labor, materials, equipment, accessories, and incidentals required and installation, placing in operation, and field testing of the following equipment:

   a. One (1) magnetic drive sodium hydroxide recirculation pump (23-P-1).

   The pump system shall be furnished complete with controls and accessories as specified herein and as shown on the Drawings. The sodium hydroxide recirculation pump shall pump up to 50 percent solution from the bulk storage tank back into the bulk storage tank to provide mixing.

2. These Specifications are intended to give a general description of what is required, but do not cover all details, which will vary in accordance with the requirements of the specific equipment application. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation of all materials, equipment, and appurtenances for the complete pumping units, controls, and accessories as specified herein, whether specifically mentioned in these Specifications or not.

3. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not, as required for an installation incorporating the highest standards for this type of service.

B. Description of System

1. The chemical transfer pump to be provided shall be of the centrifugal, seal-less, magnetic-coupled type suitable for the service of pumping the respective chemical. Pump materials and design characteristics shall be as specified in Table A of this Section.

2. All working parts of identical pumps and motors, such as bearings, check valves, shafts, sleeves, motors, etc., shall be of standard dimension built to

limit gauges or formed to templates such that parts will be interchangeable between like units and such that the Owner may at any time in the future obtain replacement and repair parts for those furnished in the original machines. All parts shall be properly stamped for identification and location in the machines as shown on the operation and maintenance manuals furnished.

1.02 QUALITY ASSURANCE

A. The chemical transfer pump manufacturer shall have experience in the design and manufacture of equipment of similar size and capacity and shall present proof of successful operations involving each piece of equipment furnished. All equipment shall be as manufactured by March Pumps, or approved equal.

B. Qualifications

1. To assure unity of responsibility, the motor, controls, and accessories shall be furnished and coordinated by the pump manufacturer or supplier. The supplier shall assume complete responsibility for the satisfactory installation and proper operation of the entire pumping system including pump, motor, controls, and accessories.

2. The pump covered by these Specifications is intended to be standard pumping equipment of proven ability as manufactured by a reputable, qualified manufacturer having extensive experience in the production of such equipment. The pump furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

3. All equipment furnished under this Specification shall be new and unused and shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein a minimum of five (5) years.

C. Standards: The equipment shall be designed, manufactured, and tested in accordance with Federal, State, and Local requirements and applicable sections of the latest editions of the following codes and standards:

1.	ANSI	American National Standards Institute
2.	ASTM	American Society for Testing and Materials
3.	HI	Hydraulic Institute
4.	NEMA	National Electrical Manufacturers Association

5. UL Underwriters Laboratories

1.03 SUBMITTALS

A. Submittals of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of Section 01 33 00: Submittal Procedures. Submittals shall include at least the following:

1. Manufacturer's literature, illustrations, cut-sheets, and applicable data for the pump, including the total weight of the equipment.

2. Manufacturer's certified curves illustrating pump characteristics of head, discharge, brake horsepower and efficiency. Curves shall be submitted on 8 1/2-inch by 11-inch sheets, at the largest practical scale. Curves shall be plotted from no flow at shut off head to maximum pump runout head and flow allowed by the manufacturer. Points of operation which cause excessive stress or shaft deflection in excess of the manufacturer's tolerances for continuous operation shall be indicated on the submitted curves.

3. The Shop Drawings shall include details of pump assembly installation layouts, procedures, types of materials used in pump construction, details on all pump accessories, and dimensions of major components. Where applicable, and pump are provided as part of a complete package inclusive of controls, control diagrams shall be provided.

4. A complete total bill of materials for all equipment.

5. A list of manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item.

6. Pumping equipment requiring special tools for maintenance shall be provided with one (1) set of tools labeled, packed with instruction for use, and housed in a metal tool box with lock-end hoop.

7. Complete installation, hauling, and storage instructions.

8. Complete motor data including rpm at full load, frequency, voltage, full load current, code and design letter, efficiency, horsepower, number of phases, time rating, temperature rise, and service factor.

B. Prepare the above information as a single package shop drawing submittal.

1.04 OPERATING & MAINTENANCE INSTRUCTIONS

A. Operating and Maintenance Instruction: For all pumps furnished under this Section, the Contractor shall submit six (6) copies of operation and maintenance manuals in accordance with requirements of Section 01 78 23: Operating and Maintenance Data. The manuals shall be prepared specifically for this installation and shall include, at a minimum, the following:

1. Equipment function.

2. Description.

3. Normal and limiting operating characteristics.

4. Installation instructions (assembly, alignment, and adjustment procedures).

5. Operation instructions (normal startup and shutdown procedures, normal operating conditions, and emergency situations).

6. Lubrication and maintenance instructions.

7. Troubleshooting guide.

8. Parts list and predicted life of parts subject to wear.

9. Drawings - cross sectional view, assembly, and wiring diagrams.

10. Performance curves.

11. A factory representative of the pump manufacturer, who has complete knowledge of proper operation and maintenance, shall be provided for one (1) day to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the permission of the Owner, this work may be conducted in conjunction with the inspection of the installation and demonstration test as provided under PART 3 - EXECUTION of this Section. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.05 TOOLS AND SPARE PARTS

A. All special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the manufacturer.

B. The manufacturer shall recommend and supply all spare parts necessary for the first five (5) years of operation. Spare parts shall be marked with part numbers and packed in suitable containers also marked with the part numbers.

C. All tools and spare parts shall be furnished in containers clearly identified with indelible markings as to their contents. Each container shall be packed with its contents protected for storage. All tools shall be furnished in steel tool boxes.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is complete and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Finished surfaces of all exposed pump openings shall be covered and protected.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 WARRANTY

A. The Contractor shall furnish to the Owner a warranty as specified in Section 01 74 00 – Warranties and Bonds.

B. The warranty shall cover all necessary labor, equipment and replacement parts resulting from faulty or improper assembly or erection, defective workmanship and materials, leakage, breakage or other failure of all equipment and components furnished by the manufacturer. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period.

C. The warranty period shall at final completion. The Owner shall incur no labor or equipment cost during the warranty period.

PART 2 - PRODUCTS

2.01 GENERAL

A. Seal-Less Magnetic Drive Pump

1. The pump shall be of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

2. The pump shall conform to all requirements stipulated in Table A.

3. Equipment shall be designed and built for 24 hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.

4. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness, and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs, and adjustment.

5. The base of the pump shall be rigidly and accurately anchored into position, precisely leveled, and aligned, so that the complete installation is free from stress and distortion. All necessary foundation bolts, plates, nuts, and washers shall be furnished and installed by the Contractor to conform to the recommendations and instruction of the manufacturers. Anchor bolts, nuts, and washers shall be Type 316 stainless steel. Base plates shall be fabricated of corrosion resistant material recommended by manufacturer and approved by Engineer.

6. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed, and any other pertinent data shall be attached to each pump.

7. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and all other pertinent data shall be attached to the pump motor.

8. The nameplate ratings for the motor shall not be exceeded, nor shall the design factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

2.02 PUMP MATERIALS AND CONSTRUCTION

A. Pump design shall be single-stage, end suction, close-coupled, frame mounted, leak-proof, seal-less magnetic drive design.

B. Seal-Less Magnetic Drive Pump

1 The transfer pump shall be of the seal-less magnetic-coupled centrifugal type suitable for pumping the specified liquids in Table A.

2. The pump shall be constructed of high-quality materials suited for pumping the intended chemical.

3. The pump and motor shall be coupled in such a manner that there is no rotating shaft or seal to wear which would allow the liquid being pumped to leak, providing a leak-proof sealess coupling.

4. The pump inlet and outlet connections shall be ANSI 150# rated flanges, with the sizes as noted in Table A.

5. The pump shall have an internal pressure capacity of 50 pounds per square inch (psi) and be capable of pumping liquids with temperatures up to 190 degrees F.

C. Casing:

1. Vertically split, with back pull-out arrangement to maintain impeller without disconnection of piping.

2. Provide thrust washer and mounting for impeller spindle in casing.

3. All wetted parts (casing, impeller, O-rings, bushing, etc.,) shall be constructed of the materials specified herein and suitable for intended application.

4. Pump shall be capable of at least a 5 percent head increase at rated conditions by installing a new impeller.

D. Drive:

1. Provide pump coupled to motor through a seal-less magnetic drive. Drive to consist of drive magnet, impeller magnet, impeller magnet housing, and motor bracket.

2. Provide O-ring seal between impeller magnet housing and pump casing.

3. Drive magnet shall be completely isolated from pumped fluid.

4. Drive magnet to act as clutch to prevent motor overload.

5. Motor shall be US Electric, General Electric, Baldor, or Marathon as specified in Section 26 20 00, Low-Voltage AC Induction Motors.

6. Motor shall be NEMA Design B, TEFC type.

7. Provide corrosion resistant fan.

8. Motor shall have cast iron frame and end brackets.

9. Provide cast conduit box with gasketed, large diagonal split-type cover.

10. Provide non-wicking strong leads.

11. Provide heavily plated hex hardware.

12. Motor shall be built in accordance with latest NEMA, IEEE, ANSI, and AFBMA standards where applicable.

13. Baseplate: Provide foot mounted baseplate suitable for supporting motor and close coupled pump.

E. Materials

1. Front Housing: Polypropylene

2. Rear Housing: Ryton

3. Impellers: Glass-filled polypropylene

4. O-Rings: Teflon encapsulated Viton

5. Shafting: Ceramic

2.03 ACCESSORIES

A. Equipment Identification Parts: 16-gauge, Type 316 stainless steel with die stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Type 316 stainless steel.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.