****
USACE / NAVFAC / AFCEC / NASA **UFGS-22 13 29 (February 2011)**

Preparing Activity: USACE **Superseding**
UFGS-44 46 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 13 29

SANITARY SEWERAGE PUMPS

02/11

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 DELIVERY, STORAGE, AND HANDLING
1.4 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Nameplates
2.1.2 Equipment Guards
2.1.3 Special Tools
2.1.4 Electric Motors
2.1.5 Motor Controls
2.1.6 Bolts, Nuts, Anchors, and Washers
2.1.7 Pressure Gauges
2.1.8 Seal Water Systems
2.1.8.1 Float Valve
2.1.8.2 Auxiliary Equipment
2.1.8.3 Controls
2.1.8.4 System Characteristics
2.2 CENTRIFUGAL SOLIDS HANDLING PUMPS
2.2.1 Pump Characteristics
2.2.2 Pump Casing
2.2.3 Impeller
2.2.4 Wearing Rings
2.2.5 Pump Shaft
2.2.6 Pump Shaft Sleeve
2.2.7 Stuffing Box
2.2.8 Mechanical Seals
2.2.9 Bearings
2.2.10 Lubrication
2.2.11 Pump Support
2.2.12 Coupling
2.3 SUBMERSIBLE CENTRIFUGAL PUMPS

2.3.1 Pump Characteristics
2.3.2 Pump Casing
2.3.3 Mating Surfaces
2.3.4 Coatings
2.3.5 Impeller
2.3.6 Wearing Rings
2.3.7 Pump Shaft
2.3.8 Seals
2.3.9 Bearings
2.3.10 Motor
2.3.11 Power Cable
2.3.12 Installation Systems
2.3.12.1 Rail Mounted Systems
2.3.12.2 Bolt Down Systems
2.3.12.3 Lifting Chain
2.4 SELF-PRIMING CENTRIFUGAL PUMPS
2.4.1 Pump Characteristics
2.4.2 Pump Casing
2.4.3 Impeller
2.4.4 Wear Plate
2.4.5 Pump Shaft
2.4.6 Pump Shaft Sleeve
2.4.7 Seals
2.4.8 Bearings
2.4.9 Lubrication
2.4.10 Suction Check Valve
2.4.11 Pump Support
2.4.12 Coupling
2.5 SCREW PUMPS
2.5.1 Pump Characteristics
2.5.2 Lower Bearing Assembly
2.5.2.1 Seals
2.5.2.2 Bearing Shield
2.5.3 Spiral Screw
2.5.3.1 Torque Tube
2.5.3.2 Shafts
2.5.4 Flow Defector Plates
2.5.5 Upper Bearing Assembly
2.5.5.1 Housing
2.5.5.2 Bearing
2.5.5.3 Seals
2.5.5.4 Mounting Plate
2.5.5.5 Cover
2.5.6 Drive Assembly
2.5.6.1 Gear Reducer
2.5.6.2 Backstop
2.5.6.3 Drive
2.5.7 Lubrication System
2.5.8 Radius Screed
2.6 PLUNGER PUMPS
2.6.1 Pump Characteristics
2.6.2 Pump Base
2.6.3 Pump Body
2.6.4 Valves
2.6.5 Connecting Rod, Eccentric, Eccentric Bearings, and Shaft
2.6.6 Plungers
2.6.7 Cylinders
2.6.8 Stuffing Box
2.6.9 Air Chambers

2.6.10 Sampling Valve
2.6.11 Pressure Relief Valve
2.6.12 Lubrication
2.6.13 Chain Drive
2.6.14 V-Belt and Integral Gear Drive
2.6.15 Gear Reducer Drive
2.7 PROGRESSIVE CAVITY PUMPS
2.7.1 Pump Characteristics
2.7.2 Casing
2.7.3 Rotor
2.7.4 Stator
2.7.5 Drive Shaft and Connecting Rod
2.7.6 Flexible Drive Shaft
2.7.7 Seals
2.7.8 Bearings
2.8 DIAPHRAGM PUMPS
2.8.1 Pump Characteristics
2.8.2 Casing
2.8.3 Suction and Discharge Check Valves
2.8.4 Pulsation Dampers
2.8.5 Air-Operated Actuators
2.8.5.1 Valve
2.8.5.2 Timer
2.8.5.3 Muffler
2.8.5.4 Pressure Regulator
2.8.5.5 Strainer
2.8.5.6 Assist
2.8.6 Mechanical Actuators
2.9 RECESSED IMPELLER PUMPS
2.9.1 Pump Characteristics
2.9.2 Pump Casing
2.9.3 Impeller
2.9.4 Pump Shaft
2.9.5 Sleeve
2.9.6 Seals
2.9.6.1 Packing
2.9.6.2 Mechanical Seals
2.9.7 Bearings
2.10 ROTARY LOBE PUMPS
2.10.1 Pump Characteristics
2.10.2 Casing
2.10.3 Rotors
2.10.4 Shafts and Sleeves
2.10.5 Packing Glands
2.10.6 Bearings
2.11 ELECTRICAL WORK

PART 3 EXECUTION

3.1 EXAMINATION
3.2 EQUIPMENT INSTALLATION
3.2.1 Pump Installation
3.2.2 Concrete
3.2.3 Grouting Screw Pump Flow Channel
3.3 PAINTING
3.4 FRAMED INSTRUCTIONS
3.5 FIELD TESTING AND ADJUSTING EQUIPMENT
3.5.1 Operational Test
3.5.2 Retesting

3.5.3 Performance Test Reports
3.6 MANUFACTURER'S SERVICES
3.7 FIELD TRAINING

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA	**UFGS-22 13 29 (February 2011)**

Preparing Activity: USACE	**Superseding**
	UFGS-44 46 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION 22 13 29

SANITARY SEWERAGE PUMPS
02/11

****
NOTE: This guide specification covers the requirements for sewage and sludge pumps for domestic type waste.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**
****

PART 1 GENERAL

****
NOTE: This specification guide covers pumps for domestic sewage and sludge. Industrial wastewater and sludge may require special consideration and design. Refer to UFC 3-240-01 and consult the published data of representative manufacturers and the Hydraulics Institute. Pneumatic ejectors are specified in Section 22 13 36 PNEUMATIC SEWAGE EJECTORS. The following are the types of pumps included and the general uses:

a. Centrifugal solids handling pumps have high head (up to 69 m 225 feet) and high capacity (up to 2840 L/second 45,000 gpm) capabilities and high efficiency relative to other solids handling pumps. They are ideal for sewage applications.

b. Submersible centrifugal pumps have high head (up to 55 m 180 feet) and high capacity (up to 1390 L/second 22,000 gpm) capabilities but are less efficient than standard centrifugal pumps. They have higher operating costs but lower installation costs than standard centrifugal pumps. They are ideal for sewage and low concentration sludge applications.

c. Self-priming centrifugal pumps have moderate head (up to 31 m 100 feet) and moderate capacity (up to 158 L/second 2,500 gpm) capabilities and are less efficient than standard centrifugal pumps. They have higher operating costs but lower installation costs than standard centrifugal pumps. They are ideal for raw sewage applications where occasional service interruptions are acceptable.

d. Screw pumps have low head (up to 9 m 30 feet) and high capacity (up to 5050 L/second 80,000 gpm) capabilities and are relatively efficient (70 to 75 percent). They are ideal for raw sewage, storm water, and activated sludge lift stations.

e. Plunger pumps have high head 76 to 92 m 250 to 300 feet and moderate capacity (up to 35 L/second 550 gpm) capabilities. They are ideal for sludges of various consistencies.

f. Progressive cavity pumps have high head (up to 54 m 175 feet per stage) and moderate capacity (up to 35 L/second 500 gpm) capability. They may not perform well under abrasive conditions.

g. Diaphragm pumps have low head (up to 8 m 25 feet static head) and low capacity (up to 10 L/second 150 gpm) capabilities. They are ideal for pumping primary sludges and corrosives, abrasives, and slurries to 75 percent solids.

h. Recessed impeller pumps have high head (up to 69 m 225 feet) and high capacity (up to 316 L/second 5,000 gpm) capabilities. They are ideal for sludges up to 4 percent solids and possibly as high as 5 percent solids.

i. Rotary lobe pumps have high head (up to 107 m 350 feet) and moderate capacity (up to 95 L/second 1500 gpm) capabilities. They are ideal for sludges of various consistencies.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in

the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016a) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2018) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

1.2 SUBMITTALS

****
NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal

items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation; G[, [_____]]

SD-03 Product Data

Materials and Equipment
Framed Instructions
Spare Parts

SD-06 Test Reports

Field Testing and Adjusting Equipment

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G[, [_____]]

1.3 DELIVERY, STORAGE, AND HANDLING

Protect from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants all equipment delivered and placed in storage.

1.4 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Pump casings shall be constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Impellers shall be [cast iron] [ductile iron] [unless otherwise specified for rotors].

2.1.1 Nameplates

Provide each major item of equipment with the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.2 Equipment Guards

Enclose or guard belts, pulleys, chains, gears, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto.

2.1.3 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

2.1.4 Electric Motors

Motors shall conform to NEMA MG 1.

2.1.5 Motor Controls

Controls shall conform to NEMA ICS 1.

2.1.6 Bolts, Nuts, Anchors, and Washers

Bolts, nuts, anchors, and washers shall be steel; galvanized in accordance with ASTM A153/A153M.

2.1.7 Pressure Gauges

Compound gauges shall be provided on the suction side of pumps and standard pressure gauges on the discharge side of pumps. Gauges shall comply with ASME B40.100. Gauge ranges shall be as appropriate for the particular installation.

2.1.8 Seal Water Systems

****
NOTE: Alternate seal water systems utilize filtered effluent recirculated back to pump seals as water supply. Consult water seal manufacturers for details. Delete entire paragraph if seal water not specified for pumps.
****

Pumping systems requiring seal water shall utilize [potable] [_____] water. A package seal water system, consisting of a [189 L 50 gallon] [_____] galvanized tank, float valve mounted directly on the tank, and 2 centrifugal pumps of equal capacity, with close coupled motors, shall be factory assembled and supplied as a single self-contained unit.

2.1.8.1 Float Valve

The float valve shall be mounted on the tank to maintain a water level below an overflow provided near the top of the tank and to maintain a 152 mm 6 inch air gap between the water system and the top of the tank.

2.1.8.2 Auxiliary Equipment

Auxiliary equipment required to complete the system shall be as indicated and shall include the necessary piping, valving, pressure gauges, pressure regulators, pressure switches, solenoid valves, strainers, and accessories.

2.1.8.3 Controls

The solenoid valve shall open whenever the process pump motor is energized. The pressure switch shall signal an alarm and stop the process pump whenever the seal pressure is below a set point. The pressure regulating valve shall be located on a bypass line back to the seal water reservoir tank. The pressure switch and pressure regulating valve set points shall be determined by the process pump manufacturer. A valved bypass around each solenoid valve shall also be provided.

2.1.8.4 System Characteristics

****
NOTE: Insert data for each seal water system required. Repeat paragraph as necessary for seal water systems with different characteristics.
****

The seal water systems for pump number[s] [_____] shall be sized for [_____] L/second gpm at [_____] kPa psi and [_____] W horsepower.

2.2 CENTRIFUGAL SOLIDS HANDLING PUMPS

Centrifugal solids handling pumps shall be of the nonclogging centrifugal

type designed to pump solids up to 76 mm 3 inches in diameter and which provide no internal interstices that catch solids and stringy materials to cause clogging.

2.2.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Impeller Type	[_____]
Operating Speed	[_____] rpm
Maximum NPSH Required at Maximum Operating Point	[_____]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.2.2 Pump Casing

Pump casing shall be constructed with tapped and plugged holes for venting and draining the pump. The casing shall be capable of withstanding pressures 50 percent greater than the maximum operating pressure. The volute shall have smooth passages. The casing shall be such that the impeller can be removed without disturbing the suction and discharge connections. The casing shall have a handhole to permit inspection and cleaning of the pump interior. Lifting eyes shall be provided to facilitate handling of the pump.

2.2.3 Impeller

The impeller shall be designed with smooth passages to prevent clogging and pass stringy or fibrous materials. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to

the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.2.4 Wearing Rings

Renewable wearing rings shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Wearing rings shall be constructed of [steel] [cast iron]. Wearing rings shall be designed for ease of maintenance and shall be secured to prevent rotation. Replaceable steel wear plates fastened to casing may be used in lieu of wearing rings on casing and impeller.

2.2.5 Pump Shaft

Pump shaft shall be of stainless or high grade alloy steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.2.6 Pump Shaft Sleeve

The pump shaft shall be protected from wear by a stainless steel, high grade alloy steel, or bronze shaft sleeve. The joint between the shaft and sleeve shall be sealed to prevent leakage.

2.2.7 Stuffing Box

The stuffing box shall be of the same material as the casing and shall be [grease] [or] [water] sealed. The stuffing box shall be designed for a minimum of five rings of packing and shall have easily removable split type glands.

2.2.8 Mechanical Seals

****

NOTE: Specify double mechanical seals in high pressure applications.

****

[Single] [Double] mechanical seals shall be provided to seal the pump shaft against leakage. Each seal interface shall be held in contact by its own spring system, supplemented by external liquid pressures. The seal system shall be constructed to be readily removable from the shaft.

2.2.9 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have an ABEMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11.

2.2.10 Lubrication

****

NOTE: Delete the inapplicable types of lubrication. Normally use grease for vertical shaft pumps. Use either grease or oil for horizontal shaft pumps.

****

Bearings shall be [oil bath] [or] [grease] lubricated. [An oil reservoir shall be provided for oil bath lubricated bearings. The reservoir shall have an overflow opening to prevent overfilling and shall have a drain at the lowest point.] [A grease fitting shall be provided for grease-lubricated bearings. The grease fitting shall be of the type that prevents overlubrication and the building up of pressure injurious to the bearings. If the grease fitting is not easily accessible, grease tubing shall be provided to a convenient location.]

2.2.11 Pump Support

****
NOTE: Delete inapplicable types of support.
****

Horizontal centrifugal pumps shall be provided with a common base plate for the pump and motor. Vertical shaft centrifugal pumps shall be provided with separate bases for the pump and motor. Vertical dry pit centrifugal pumps shall be supported by a heavy cast iron base with adequate legs to provide maximum rigidity and balance.

2.2.12 Coupling

****
NOTE: Delete inapplicable types of couplings.
****

Couplings shall be of the heavy-duty flexible type, keyed or locked to the shaft. Disconnecting of the coupling shall be possible without removing the driver half or the pump half of the coupling from the shaft. Couplings for extended shaft vertical centrifugal pumps may be of the universal type.

2.3 SUBMERSIBLE CENTRIFUGAL PUMPS

Submersible centrifugal pumps shall be centrifugal type pumps designed to pump solids up to 76 mm 3 inches in diameter and shall be capable of withstanding submergence as required for the particular installation.

2.3.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency

Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Impeller Type	[_____]
Operating Speed	[_____] rpm
Depth of Submergence	[_____] mm feet
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.3.2 Pump Casing

The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

2.3.3 Mating Surfaces

Mating surfaces where watertight seal is required, including seal between discharge connection elbow and pump, shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between mating surfaces, resulting in proper compression of the O-rings without the requirement of specific torque limits.

2.3.4 Coatings

Exterior surfaces of the casing in contact with sewage shall be protected by a sewage resistant coal tar epoxy coating. All exposed nuts and bolts shall be stainless steel.

2.3.5 Impeller

The impeller shall be of the [single] [double] shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.3.6 Wearing Rings

Wearing rings, when required, shall be renewable type and shall be provided on the impeller and casing and shall have wearing surfaces normal to the axis of rotation. Material for wear rings shall be standard of pump manufacturer. Wearing rings shall be designed for ease of maintenance and shall be adequately secured to prevent rotation.

2.3.7 Pump Shaft

The pump shaft shall be of high grade alloy steel and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

2.3.8 Seals

****

NOTE: Do not specify ceramic seals where sudden changes in temperature can occur and cause the seal to crack. Tungsten carbide seals are standard for many manufacturers. Delete last sentence if conventional seals are acceptable.

****

A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of [_____] with each interface held in contact by its own spring system. [Conventional mechanical seals which require a constant pressure differential to effect sealing will not be allowed.]

2.3.9 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have an ABEMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11.

2.3.10 Motor

The pump motor shall have Class F insulation, NEMA B design, in accordance with NEMA MG 1, and shall be watertight. The motor shall be either oil filled, air filled with a water jacket, or air filled with cooling fins which encircles the stator housing.

2.3.11 Power Cable

****

NOTE: Last sentence may eliminate several manufacturers. However, this requirement may be needed for protection of motor and to reduce maintenance costs. Evaluate for each specific pump application.

****

The power cable shall comply with NFPA 70, Type SO, and shall be of standard construction for submersible pump applications. The power cable shall enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. 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. [Epoxies, silicones, or other secondary sealing systems are not acceptable.]

2.3.12 Installation Systems

****
NOTE: In following three paragraphs, delete inapplicable installation systems.
****

2.3.12.1 Rail Mounted Systems

Rail mounted installation systems shall consist of guide rails, a sliding bracket, and a discharge connection elbow. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. The sliding guide bracket shall be an integral part of the pump unit. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection and service without entering the pump well.

2.3.12.2 Bolt Down Systems

The pump mount system shall include a base designed to support the weight of the pump. The base shall be capable of withstanding all stresses imposed upon it by vibration, shock, and direct and eccentric loads.

2.3.12.3 Lifting Chain

Lifting chain to raise and lower the pump through the limits indicated shall be provided. The chain shall be galvanized and shall be capable of supporting the pump.

2.4 SELF-PRIMING CENTRIFUGAL PUMPS

Self-priming centrifugal pumps shall be designed to pump solids up to 76 mm 3 inches in diameter and shall be of the centrifugal type capable of repeated reprime when handling trash-laden sewage.

2.4.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency

Minimum Operating Point	[_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency
Maximum Priming Lift	[_____] mm feet
Maximum Reprime Lift	[_____] mm feet
Impeller Type	[_____]
Rotation Direction	[Clockwise] [Counterclockwise]
Operating Speed	[_____] rpm
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.4.2 Pump Casing

The casing shall be capable of withstanding pressures 50 percent greater than the maximum operating pressures. The pump casing shall contain no openings of smaller diameter than the specified sphere size. There shall be no internal devices that will inhibit maintenance or interfere with priming and performance. The pump shall be designed to retain sufficient liquid in the casing to ensure unattended operation. The casing shall be such that the impeller can be removed without disturbing the suction and discharge connections. Front access shall be provided to the pump interior to permit inspection and cleaning of the pump interior without removing suction or discharge piping.

2.4.3 Impeller

The impeller shall be of the two-vane, semi-open, non-clog type with pump-out vanes cast integrally on its backside. The impeller shall be statically, dynamically, and hydraulically balanced within the operating range and to the first critical speed at 150 percent of the maximum operating speed. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction.

2.4.4 Wear Plate

****
NOTE: Steel is standard with most manufacturers.
****

A replaceable wear plate constructed of [cast iron] [alloy steel] shall be provided.

2.4.5 Pump Shaft

Pump shaft shall be of high grade alloy steel or stainless steel and shall be of adequate size and strength to transmit the full driver wattage

horsepower with a liberal safety factor.

2.4.6 Pump Shaft Sleeve

The pump shaft shall be protected from wear by a high grade alloy steel or stainless steel shaft sleeve. A seal, if needed, shall be placed between the shaft and sleeve to prevent leakage.

2.4.7 Seals

The pump shaft shall be sealed against leakage by [oil lubricated] [water lubricated] mechanical seal. The stationary sealing member shall be [tungsten carbide] [silicon carbide] and the rotating member shall be [tungsten carbide] [silicon carbide]. The seal shall be such that the faces will not lose alignment during shock loads that cause deflection, vibration, and axial or radial movement of the pump shaft.

2.4.8 Bearings

Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction.

2.4.9 Lubrication

****

NOTE: Delete the inapplicable types of lubrication. Normally use grease for vertical shaft pumps. Use either grease or oil for horizontal shaft pumps.

****

Bearings shall be [oil bath] [or] [grease] lubricated. [An oil reservoir for oil bath lubricated bearings shall be provided. The reservoir shall have an overflow opening to prevent overfilling and shall have a drain at the lowest point.] [A grease fitting shall be provided to add grease for grease-lubricated bearings. The grease fitting shall be of the type that prevents overlubrication and the building up of pressure injurious to the bearings. If the grease fitting is not easily accessible, grease tubing to a convenient location shall be provided.]

2.4.10 Suction Check Valve

****

NOTE: If the pump is in an application where a high degree of reliability is desired, retain the last sentence.

****

The pump shall contain a suction check valve to maintain prime. The suction check valve shall be removable without disturbing the suction piping. [The pump shall be capable of prime or reprime in the event of check valve failure.]

2.4.11 Pump Support

A common fabricated steel base plate shall be provided for the pump and motor.

2.4.12 Coupling

****
NOTE: Delete inapplicable type of couplings.
****

Power shall be transmitted from the motor to the pump by a [flexible coupling] [V-belt drive assembly]. [Flexible couplings shall be of the heavy duty type, keyed or locked to the shaft.] [The V-belt drive assembly shall have a minimum of two belts. The drive assembly shall be selected on the basis of the power to be transmitted from the motor to the pump. The drive shall be enclosed on all sides by a solid metal guard.]

2.5 SCREW PUMPS

****
NOTE: Edit paragraph for enclosed or tube mounted screw pumps. Tube mounted screw pumps do not require concrete trough.
****

Screw pumps shall have a spiral flight screw operating in a concrete trough with the screw rotation elevating the liquid up the inclined trough. The pump shall consist of a lower bearing assembly, a spiral screw with deflectors, an upper bearing assembly, a drive assembly, and an automatic grease lubricated system for the lower bearing.

2.5.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following characteristics:

Pump Service	[_____]
Total Lift	[_____] mm feet
Angle of Inclination	[22] [30] [38] [_____] degrees from horizontal
Spiral Screw Diameter	[_____] mm feet [_____] inches
Flight Thickness	[_____] mm feet
Quantity of Flights	[1] [2] [3]
Design Capacity	[_____] L/second gpm
Tube Diameter	[_____] mm feet [_____] inches
Screw Speed	[_____] rpm

Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.5.2 Lower Bearing Assembly

The lower bearing assembly shall be sleeve or roller bearing type design. If sleeve bearing is utilized, either the bronze phosphor sleeve shall rotate around stationary shaft or shaft shall be attached to bronze bushing which rotates inside stationary cartridge. Sleeve bearing shall be hermetically sealed, automatic grease lubricated. Roller bearings shall be oil lubricated and designed to guard against oil leakage. Labyrinth arrangement shall protect fire seal from damage. Bearings shall have L-10 life of 100,000 hours. The bearing housing shall permit precise adjustment in the field. A spare lower bearing assembly shall be provided.

2.5.2.1 Seals

Contaminants shall be prevented from entering the bearing by two spring-loaded lipseals, one to exclude wastewater and contaminants and one to retain the grease in the bearing, or by a fixed journal with hollow axis to allow grease to the top end of the bearing where it flows the length of the bearing sealing out contaminants.

2.5.2.2 Bearing Shield

A heavy-duty bearing shield shall be provided to protect the bearing assembly from heavy debris.

2.5.3 Spiral Screw

The spiral screw shall consist of a steel torque tube with steel flights welded to the exterior of the tube, a drive shaft, and lower stub shaft.

2.5.3.1 Torque Tube

The torque tube shall be sealed at both ends with welded steel plates. Care shall be taken to insure that the end plates are parallel after welding. The flights shall be continuously welded to the tube on both sides. The drive shaft and lower stub shaft shall be bolted to the torque tube ends with a registered fit to ensure axial alignment of the tube and shafting.

2.5.3.2 Shafts

The upper and lower shafts and the outside diameter of the flights of the completed spiral screw shall have the same axis. The maximum deflection at midspan shall not exceed 4 mm 5/32 inch when calculated as a uniformly loaded horizontal simple beam supported between the upper and lower bearings. The completed spiral screw shall be statically balanced.

2.5.4 Flow Defector Plates

****

NOTE: Deflector plates may be extended to completely enclose pump or pump may be tube mounted.
****

Flow deflector plates shall be provided for installation in the pump trough along the uptake side of the spiral screw for the full length of the spiral. The deflector plates shall be concave to effect an extension of the circular arch of the trough to at least the height of the top surface of the torque tube. The deflector plates shall be fabricated from not less than 3 mm 1/8 inch thick steel plate and shall be complete with stiffeners and anchors where required.

2.5.5 Upper Bearing Assembly

The upper bearing assembly shall consist of an upper bearing housing, bearing, seals, mounting, and cover.

2.5.5.1 Housing

The upper bearing housing shall be cast iron and shall have grease fittings on the exterior of the housing for periodic manual lubrication.

2.5.5.2 Bearing

The upper bearing shall have an ABEMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and shall be one of the following: a dual bearing consisting of a spherical roller thrust type bearing for pump thrust loads and a spherical roller bearing for radial loads; or a single combination radial and thrust, self-aligning, spherical roller bearing.

2.5.5.3 Seals

Two seals shall be provided for protection of the upper bearings. One seal shall be attached to the extended shaft of the spiral screw to prevent contamination from entering the bearing top side. The other seal shall be on the bottom side to retain the grease within the bearing.

2.5.5.4 Mounting Plate

A fabricated steel mounting plate and anchor bolts shall be provided for mounting the upper bearing assembly.

2.5.5.5 Cover

A fabricated steel cover shall be provided to close the opening in the wall for the spiral shaft.

2.5.6 Drive Assembly

The drive assembly shall consist of a motor, gear reducer, and backstop.

2.5.6.1 Gear Reducer

The gear reducer shall have the torque rating for the spiral speed based upon continuous operation with a uniform load. The gear reducer shall have an outer cast iron housing, totally enclosed and rigidly constructed to maintain precise alignment of the gears and bearings. The gear reducer shall be designed with a service factor of not less than [_____] based on the torque requirements of the screw or [_____] based on the motor

horsepower, whichever is greater. Gears and bearings shall be splash lubricated or, if necessary, pressure lubricated to ensure oil is provided to all gears and bearings. Shaft-mounted gear reducers shall be positively secured to the screw shaft and shall have a torque arm anchored to the floor. Double lip oil seals shall be provided on the shaft. Non-shaft-mounted gear reducers shall be provided with an adjustable base and shall be connected to the screw shaft by a flexible coupling.

2.5.6.2 Backstop

A backstop shall be provided to prevent the reverse rotation of the spiral screw and drive assembly when the power to the motor is disconnected.

2.5.6.3 Drive

The gear reducer shall be connected to the drive motor by means of belts and sheaves designed with the same service factor as the gear reducer. A safety cover shall be provided for the belt drive.

2.5.7 Lubrication System

An automatic grease lubricator with grease pump and reservoir shall be provided to continuously grease the lower bearing when the pump is operating. The grease pump shall have a [_____] W hp, [_____] volts ac, [_____] phase, [60] [_____] Hz motor. The grease pump shall be interlocked with the screw pump motor to prevent the screw pump from operating if the lubricator malfunctions. A visual or automatic indicator shall be provided to confirm that the lower bearing is receiving grease from the lubrication system.

2.5.8 Radius Screed

Provide a radius screed and any additional sheaves and belts as necessary to adjust screw speed to enable the installation of the grout in the trough with the screw installed.

2.6 PLUNGER PUMPS

Plunger pumps shall be of the positive displacement type designed to pump sewage sludges with a minimum amount of clogging.

2.6.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Capacity	[_____] L/second gpm

Design Head	[_____] mm feet
Suction Lift	[_____] mm feet
Stroke Speed	[_____] strokes per minute
Pump Type	[simplex] [duplex] [triplex] [quadraplex]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.6.2 Pump Base

A common, welded steel, drip-rim base with a 25 mm 1-inch threaded drain connection shall be provided for the pump and motor. The base shall be of heavy section, fully braced to withstand all shock loads and to resist buckling when properly anchored.

2.6.3 Pump Body

The pump body shall be cast iron. The pump shall be of heavy construction, designed to handle its maximum rated capacity and head on a continuous duty basis and shall be hydrostatically tested at 1.5 times the maximum rated head of the pump. The pump body shall be of sectional construction so that the stuffing box, valve bodies, and air chamber adapters are independently removable. The construction shall permit removal of the stuffing box, plunger, and connecting rod without disturbing the body, valve chambers, manifolds, piping, or shaft.

2.6.4 Valves

Valve chambers shall be provided on both the inlet and discharge connections of each cylinder. The valve chambers shall be constructed with contoured interiors to minimize clogging. Valves shall be ball type, at least 130 mm 5-1/8 inches in diameter, and constructed of neoprene. Valve seats shall be independent, fully machined plates which may be replaced without disturbing valve bodies or piping.

2.6.5 Connecting Rod, Eccentric, Eccentric Bearings, and Shaft

The connecting rod and eccentric strap assembly shall be cast as one piece and shall have a quality hot-poured Babbitt lining. The eccentric, bearings, and shaft shall be designed to handle the stresses and deflections imposed upon it by the specified service. [The shaft shall be

offset from the vertical centerline of the cylinder by an amount appropriate to the cylinder diameter to reduce lateral thrust on the cylinder during the discharge stroke.]

2.6.6 Plungers

Plungers shall be ductile iron and shall have a plugged drain hole in the bottom which shall be accessible through the top of the plunger.

2.6.7 Cylinders

Cylinders shall be machined to a smooth bore to provide a uniform surface throughout the full travel of the plunger.

2.6.8 Stuffing Box

The cylinder and plunger shall have an effective packing arrangement to provide lubrication for the plunger and maintain the most effective vacuum. The stuffing box shall be of heavy cast construction and shall be provided with a circular drain lip and 25 mm 1 inch threaded drain connection. The stuffing box shall be provided with a minimum of four rings of [_____] packing.

2.6.9 Air Chambers

****

NOTE: Generally provide air chambers on suction side of all pumps and always on discharge side of all pumps.

****

Air chambers shall be provided on [the discharge side] [both suction and discharge sides] of the pump. Air chambers shall have a minimum capacity of 0.0295 cubic meters 1800 cubic inches and a minimum 76 mm 3 inch diameter opening.

2.6.10 Sampling Valve

A 50 mm 2 inch sampling valve shall be provided on the discharge side of the pump.

2.6.11 Pressure Relief Valve

A pressure relief valve shall be provided with a bypass line from the main suction and discharge manifolds. The valve shall be factory set to prevent motor overload or pump damage.

2.6.12 Lubrication

Each pump eccentric shall be provided with a sight-feed oil lubricator.

****

NOTE: Delete inapplicable drive systems. The gear reducer is recommended for 11.2 kW 15 hp and larger applications.

****

2.6.13 Chain Drive

Capacity variations shall be provided by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Overall drive reduction shall be obtained through the combination of a gearhead motor and silent roller chain. Motor gearhead shall be totally enclosed and running in oil. Chain capacity shall be at least 150 percent of the chain manufacturers published horsepower rating. The entire chain drive assembly shall be completely enclosed in a sealed lip, dust resistant steel guard.

2.6.14 V-Belt and Integral Gear Drive

Capacity variations shall be provided by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Overall drive reduction shall be obtained through a combination of gears and V-belts. Gears shall run in an oil bath contained in an oil-tight cast iron or aluminum enclosure. The gear reduction design, gear materials and face widths, shafting, and bearings shall be selected for the specified operating conditions. The entire V-Belt drive assembly shall be covered by a rigid safety guard.

2.6.15 Gear Reducer Drive

Capacity variations shall be provided by pump speed change only. The low speed shaft of the reducer shall be directly connected to the main shaft of the pump through a flexible coupling with shear pin protection. The shear pin overload protection shall be designed for release at 150 percent to 175 percent of normal torque. The high speed shaft of the reducer shall be connected to the motor by a heavy duty flexible coupling. The entire gear reduction unit shall be enclosed in a dustproof and oil-tight housing.

2.7 PROGRESSIVE CAVITY PUMPS

****

NOTE: For sludges of solids concentration exceeding 18 percent, installation of bridge breaker on the inlet port should be investigated. Designs vary and manufacturer's specifications should be consulted.

****

Progressive cavity pumps shall consist of a single helical rotor rotating in a double helical stator.

2.7.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Capacity	[_____] L/second gpm
Operating Head	[_____] mm feet

Operating Speed	[_____] rpm
[Single] [Double] stage	
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.7.2 Casing

[The pump body shall be cradle mounted such that the suction chamber can be rotated to allow the suction port to accommodate any piping configuration.] Two inspection ports shall be incorporated 180 degrees apart in the suction housing to provide access to internal parts. A drain plug shall be provided in the casing.

2.7.3 Rotor

****

NOTE: Tool steel and stainless steel are common rotor materials. Other materials are also available. Chrome plating is standard for most manufacturers but may be deleted, depending upon the application.

****

The pump rotor shall be a helix constructed of machined and polished [high quality tool steel] [stainless steel] [and shall be covered with a layer of hard chrome plate].

2.7.4 Stator

The rotor shall revolve in a helix elastomeric stator consisting of Buna-N chemically bonded to a steel tube.

2.7.5 Drive Shaft and Connecting Rod

****

NOTE: Universal joint design is critical since this is a common problem area for this type pump. The pin or cardan type joints are inferior to the gear type but may be acceptable for some applications. Deleting the pin or cardan type joints will eliminate many manufacturers.

****

The rotor shall be driven by a connecting rod between the rotor and drive shaft, connected at each end with a crowned gear [or pin or cardan] type universal joint. The universal joints shall be of adequate design to transmit the required thrust and torque. The connecting rod and universal joint in combination shall impart no thrust on the seal. Universal joints

shall be [grease] [_____] lubricated and totally sealed and shielded. The seal shall prevent liquid from contaminating the joints, and the shields shall prevent foreign objects from damaging the seal.

2.7.6 Flexible Drive Shaft

****

NOTE: The spring steel flexible one-piece drive shaft is proprietary and should not be specified alone.

****

The rotor shall be driven by a one-piece, flexible, high strength spring steel drive shaft with a corrosion and abrasion-resistant thermoplastic coating.

2.7.7 Seals

Pump seals shall be a stuffing box with a split packing gland and lantern ring or shall be a mechanical seal. Fittings for [grease] [water] lubrication shall be provided.

2.7.8 Bearings

Bearings shall be designed for an ABEMA L-10 life of at least 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and shall be grease lubricated. Lubrication fittings in the bearing housing shall be provided.

2.8 DIAPHRAGM PUMPS

Diaphragm pumps shall be of the self-priming, positive displacement type designed to pump sludge of various concentrations and levels of abrasiveness. The pump shall be designed such that operating the pump without liquid in the pump casing will not damage any portion of the pump.

2.8.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Operator	[mechanical] [air]
Design Head	[_____] mm feet

Peak Capacity	[_____] L/second gpm flow
Total Dynamic Head	[_____] mm feet
Suction and Discharge Check Valve Size	[_____] mm inches
Pump Speed	[_____] strokes per minute
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.8.2 Casing

All interior wetted parts shall be lined with [6.4 mm 1/4 inch thick chlorosulfonated polyethylene]. The pump body shall be designed to permit access to the casing interior without disassembling the suction and discharge piping.

2.8.3 Suction and Discharge Check Valves

****

NOTE: Specify the appropriate type of valve for the material to be pumped. If large, pipe-size solids are to be pumped, specify the flap check valve. If maintenance will be infrequent, specify the in-line ball check valve. For other applications specify the quick-opening ball check valve.

****

The suction and discharge check valves shall be of the [quick opening ball check type,] [in-line ball check type,] [or] [in-line flap check type]. [Quick-opening ball check valves shall have replaceable [stainless steel,] [bronze,] [or] [cast iron] seats and an easily removable cover plate to permit inspection and cleaning of the valve interior without disassembling the adjacent piping.] [In-line ball check valves shall have a streamlined internal design, eliminating projections on which material can collect.] [In-line flap check valves shall have an elastomeric seal on the disc to insure sealing and shall have a removable cover to permit inspection and cleaning of the valve interior without disassembling the adjacent piping.]

2.8.4 Pulsation Dampers

****

NOTE: Specify inlet pulsation dampers for pumps with high suction head and discharge pulsation dampers for pumps with high discharge head.

****

An air chamber type pulsation damper shall be provided on the pump [inlet]

[and] [discharge].

2.8.5 Air-Operated Actuators

****
NOTE: Delete inapplicable drive type, mechanical or air-operated.
****

A complete air operated actuator shall be provided, with all accessories required for proper operation, including the following:

2.8.5.1 Valve

A three-way solenoid valve on the air supply line. The valve shall operate on a signal from the flow control timer.

2.8.5.2 Timer

An adjustable solid state flow control timer to control pump stroke rate and length. Stroke rate shall be adjustable from 0 to [40] [_____] strokes per minute. Stroke length shall be adjustable from [0.75] [_____] to [1.25] [_____] seconds.

2.8.5.3 Muffler

An air exhaust muffler to ensure quiet operation.

2.8.5.4 Pressure Regulator

An air pressure regulator to maintain a constant air supply pressure to the pumping system. The air pressure regulator shall be field adjustable from [_____] to [_____] kPa [_____] to [_____] psi.

2.8.5.5 Strainer

An air supply strainer to remove particles larger than [_____] microns from the air supply. The strainer shall have a removable cover to permit cleaning without dismantling adjacent piping.

2.8.5.6 Assist

Spring assist or air cylinder assist as required for adequate suction lift.

2.8.6 Mechanical Actuators

The mechanical actuator shall consist of an electric motor and [gear reducer] [belt drive] connected to the diaphragm by a connecting rod and eccentric.

2.9 RECESSED IMPELLER PUMPS

Recessed impeller pumps shall be of the vortex type designed to handle fluids containing solids, air, and stringy material normally found in sewage. Pumps shall be designed to pump solids up to 76 mm 3 inches in diameter.

2.9.1 Pump Characteristics

Pump number[s] [_____] located in [_____] shall have the following operating characteristics:

Pump Service	[_____]
Design Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Maximum Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Minimum Operating Point	[_____] L/second gpm flow at [_____] mm feet head
Discharge Diameter	[_____] mm feet
Suction Diameter	[_____] mm feet
Operating Speed	[_____] rpm
Maximum NPSH Required at Maximum Operating Point	[_____]
Seal Type	[packing] [mechanical]
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.9.2 Pump Casing

Pump casing shall be constructed with tapped and plugged holes for priming, venting, and drainage of the pump. The casing shall be capable of withstanding pressures 50 percent greater than the maximum operating pressure. All internal casing clearances shall be equal to the discharge nozzle diameter so that all material that can pass through the discharge nozzle can pass through the casing. Casing connections shall be flanged.

2.9.3 Impeller

The impeller shall be of the recessed design. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened from either forward or reverse direction.

2.9.4 Pump Shaft

****

NOTE: Specify manufacturer's standard pump shaft material. High grade alloy steel is standard with most manufacturers.

****

Pump shaft shall be of [high grade alloy steel] [or] [stainless steel] and shall be sized to provide a minimum amount of deflection.

2.9.5 Sleeve

****

NOTE: Specify manufacturer's standard pump shaft sleeve material. Stainless steel is standard with most manufacturers.

****

The pump shaft shall be protected throughout the packing area by a removable [stainless steel] [or] [bronze] sleeve.

2.9.6 Seals

A stuffing box, designed for the interchangeable use of packing or mechanical seals, and suitable for use of grease, oil, or water as the sealing liquid, shall be provided.

2.9.6.1 Packing

The stuffing box shall be designed to accommodate a minimum of [_____] rings of [graphite] [oil] impregnated [nonasbestos] [metallic] packing with lantern ring and packing gland. Packing shall be readily removable from the shaft.

2.9.6.2 Mechanical Seals

Mechanical seals shall be of the [single] [double] type of [carbon-ceramic] [tungsten carbide] construction. Each seal interface shall be held in place by its own [stainless steel] spring system. The seal system shall be constructed to be readily removable from the shaft.

2.9.7 Bearings

Pump bearings shall be antifriction ball or roller type bearings designed to carry all radial or thrust loads. Bearings shall be [grease] [oil] lubricated and shall be contained in dust- and moisture-proof housings. [An oil reservoir with overflow and drain openings shall be provided.] [A grease fitting of the type that prevents overlubrication shall be provided. If the grease fitting is not readily accessible, an extension tube shall be provided.]

2.10 ROTARY LOBE PUMPS

Rotary lobe pumps shall be of the positive displacement type and shall consist of two tri-lobe rotors which draw product into pockets formed between the rotors and rotor case and push pumped material 180 degrees around the interior of the contoured rotor case and out through the discharge port.

2.10.1 Pump Characteristics

Pump number[s] located in [_____] shall have the following characteristics:

Pump Service	[_____]
Design Capacity	[_____] to [_____] L/second [_____] to [_____] gpm
Operating Head	[_____] mm feet maximum to [_____] mm feet minimum
Operating Speed	[_____] rpm
Discharge Diameter	[_____] mm feet
Suction Diameter	[_____] mm feet
Motor Type	[_____]
Electrical Characteristics	[_____] volts ac, [_____] phase, [60] [_____] Hz
Size	Within rated load driving pump at specified rpm
Pump Control	[_____]

2.10.2 Casing

Rotor casing shall be constructed of [ductile iron] [cast iron]. The gear casing shall be constructed of cast iron. A removable end cover shall allow access to tri-rotor elements without need to disturb packing glands, bearings, suction, or discharge connections.

2.10.3 Rotors

Pump rotors shall be tri-lobe form [profile machined in cast iron] [high quality tool steel encapsulated in urethane] [stainless steel]. A removable and replaceable wear plate shall be provided between the rotors and rotor case to protect the rotor case from wear. Rotors shall be located on shafts by positive locking assembly.

2.10.4 Shafts and Sleeves

Shafts shall be of [high grade alloy steel] [_____] fitted with replaceable stainless shaft sleeves where passing through gland area.

Shafts shall be timed in their rotation by zero backlash timing gears keyed to shafts and running in a separate oil chamber gear case. Seals shall prevent ingress of pumped material into gear case.

2.10.5 Packing Glands

Seals shall be of adjustable packing gland type. Stuffing box glands shall be provided with split lantern rings for through water flush.

2.10.6 Bearings

****
NOTE: Specify L-10 life expectancy based on check with manufacturers for actual pump models under consideration.
****

Pump shall have heavy duty antifriction roller or ball type bearings for shaft support, with a ABEMA L-10 life of [40,000] [100,000] hours at maximum operating conditions. Oil seals shall prevent ingress of pumpage into gear case. A slinger for each shaft shall be provided.

2.11 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, controls and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but not shown, shall be provided.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EQUIPMENT INSTALLATION

Submit Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the Drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.2.1 Pump Installation

Install pumping equipment and appurtenances in the position indicated and in accordance with the manufacturer's written instructions. Provide all appurtenances required for a complete and operating pumping system, including such items as piping, conduit, valves, wall sleeves, wall pipes, concrete foundations, anchors, grouting, pumps, drivers, power supply, seal water units, and controls.

3.2.2 Concrete

Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Grouting Screw Pump Flow Channel

****
NOTE: Delete if no screw pumps.
****

After installation and adjustment of the screw pump, place grout in the flow channel to the configuration and dimensions indicated and as required to insure a proper fit between the screw pump and flow channel. A radius screed provided by the pump manufacturer shall be temporarily attached to provide proper clearance between the screw and the flow channel. The flow channel shall be grouted in strict accordance with the manufacturer's instructions.

3.3 PAINTING

Pumps and motors shall be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Field painting required for ferrous surfaces not finished at the factory is specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FRAMED INSTRUCTIONS

Post, where directed, framed instructions containing wiring and control diagrams under glass or in laminated plastic. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system. Submit pump characteristic curves showing capacity in gpm, net positive suction head (NPSH), head, efficiency, and pumping horsepower from 0 gpm to 110 percent (100 percent for positive displacement pumps) of design capacity. Submit a complete list of equipment and material, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Diagrams, instructions, and other sheets proposed for posting.

3.5 FIELD TESTING AND ADJUSTING EQUIPMENT

3.5.1 Operational Test

Prior to acceptance, an operational test of all pumps, drivers, and control systems shall be performed to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that the equipment is not electrically, mechanically, structurally, or otherwise defective; is in safe and satisfactory operating condition; and conforms with the specified operating characteristics. Prior to applying electrical power to any motor driven equipment, the drive train shall be rotated by hand to demonstrate free operation of all mechanical parts. Tests shall include checks for excessive vibration, leaks in all piping and seals, correct operation of control systems and equipment, proper alignment, excessive noise levels, and power consumption.

3.5.2 Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted.

3.5.3 Performance Test Reports

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. In each test report indicate the final position of controls.

3.6 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.7 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Training shall be provided for a total period of [_____] hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals. Submit [six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. One complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

-- End of Section --