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USACE / NAVFAC / AFCEC **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 October 2024
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DIVISION 22 - PLUMBING

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SANITARY SEWERAGE PUMPS

02/11

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SECTION 22 13 29

SANITARY SEWERAGE PUMPS
02/11

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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

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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. 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	(2022) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

1.2 SUBMITTALS

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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 and Air Force 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.

****

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. Submittals not having a "G" or "S" classification are 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. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Provide pump casings constructed of cast iron of uniform quality and free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Impellers must 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

Provide motors conforming to NEMA MG 1.

2.1.5 Motor Controls

Provide controls conforming to NEMA ICS 1.

2.1.6 Bolts, Nuts, Anchors, and Washers

Provide steel bolts, nuts, anchors, and washers; galvanized in accordance with ASTM A153/A153M.

2.1.7 Pressure Gauges

Provide compound gauges on the suction side of pumps and standard pressure gauges on the discharge side of pumps complying with ASME B40.100. Use gauge ranges 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.
****

Utilize [potable] [_____] water for pumping systems requiring seal water. Provide a factory assembled 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, that is supplied as a single self-contained unit.

2.1.8.1 Float Valve

Mount float valve 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

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

2.1.8.3 Controls

Ensure solenoid valve opens whenever the process pump motor is energized. Ensure pressure switch signals an alarm and stops the process pump whenever the seal pressure is below a set point. Locate the pressure regulating valve on a bypass line back to the seal water reservoir tank. Determine the pressure switch and pressure regulating valve set points by the process pump manufacturer. Also provide a valved bypass around each solenoid valve.

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.
****

Size the seal water systems for pump number[s] [_____] for [_____] L/second gpm at [_____] kPa psi and [_____] W horsepower.

2.2 CENTRIFUGAL SOLIDS HANDLING PUMPS

Provide centrifugal solids handling pumps 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 [_____] must 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

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

2.2.3 Impeller

Design the impeller with smooth passages to prevent clogging and pass stringy or fibrous materials. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely 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

Provide renewable wearing rings on the impeller and casing and have wearing surfaces normal to the axis of rotation. Construct wearing rings

of [steel] [cast iron]. Design wearing rings for ease of maintenance and secure 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

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

2.2.6 Pump Shaft Sleeve

Protect pump shaft from wear by a stainless steel, high grade alloy steel, or bronze shaft sleeve. Seal the joint between the shaft and sleeve to prevent leakage.

2.2.7 Stuffing Box

Provide stuffing box of the same material as the casing and provide [grease] [or] [water] seal. Design the stuffing box for a minimum of five rings of packing and with easily removable split type glands.

2.2.8 Mechanical Seals

****
NOTE: Specify double mechanical seals in high pressure applications.
****

Provide [single] [double] mechanical seals to seal the pump shaft against leakage. Hold each seal interface in contact by its own spring system, supplemented by external liquid pressures. Construct the seal system to be readily removable from the shaft.

2.2.9 Bearings

Provide ball or roller type pump bearings designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Provide bearings that have an ABMA 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.
****

Provide [oil bath] [or] [grease] lubricated bearings. [Provide an oil reservoir for oil bath lubricated bearings. Provide reservoir with an overflow opening to prevent overfilling and a drain at the lowest point.] [Provide a grease fitting for grease-lubricated bearings that prevents overlubrication and the building up of pressure injurious to the bearings. If the grease fitting is not easily accessible, provide grease tubing to a convenient location.]

2.2.11 Pump Support

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

Provide horizontal centrifugal pumps with a common base plate for the pump and motor. Provide vertical shaft centrifugal pumps with separate bases for the pump and motor. Support vertical dry pit centrifugal pumps 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.
****

Provide couplings of the heavy-duty flexible type, keyed or locked to the shaft. Make disconnecting of the coupling 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

Provide submersible centrifugal pumps which are centrifugal type pumps designed to pump solids up to 76 mm 3 inches in diameter and are capable of withstanding submergence as required for the particular installation.

2.3.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must 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

Provide casing capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. Provide volute with smooth passages which provide unobstructed flow through the pump.

2.3.3 Mating Surfaces

Machine and fit surfaces where watertight seal is required, including seal between discharge connection elbow and pump, with nitrile rubber O-rings. Accomplish sealing 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

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

2.3.5 Impeller

Provide impeller of the [single] [double] shrouded non-clogging design to minimize clogging of solids, fibrous materials, heavy sludge, or other materials found in sewage. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely 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

Provide renewable type wearing rings, when required, on the impeller and casing with wearing surfaces normal to the axis of rotation. Use pump manufacurer's standard material for wear rings. Design wearing rings for ease of maintenance and adequately secure to prevent rotation.

2.3.7 Pump Shaft

Provide pump shaft consisting of high grade alloy steel and 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.

****

Provide a tandem mechanical shaft seal system running in an oil bath. Provide seals consisting 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

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

2.3.10 Motor

Provide pump motor that has Class F insulation, NEMA B design, in accordance with NEMA MG 1, and is watertight. Provide motor that is 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.

****

Provide power cable complying with NFPA 70, Type SO, and of standard construction for submersible pump applications. The power cable must enter the pump through a heavy duty entry assembly provided with an internal grommet assembly to prevent leakage. Separate the cable entry junction chamber and motor by a stator lead sealing gland or terminal board which isolates 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

Provide rail mounted installation systems consisting of guide rails, a sliding bracket, and a discharge connection elbow. Provide guide rails of the size and type standard with the manufacturer that do not support any portion of the weight of the pump. The sliding guide bracket must be an integral part of the pump unit. Permanently install the discharge connection elbow in the wet well along with the discharge piping. Connect

the pump automatically to the discharge connection elbow when lowered into place and easily remove for inspection and service without entering the pump well.

2.3.12.2 Bolt Down Systems

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

2.3.12.3 Lifting Chain

Provide lifting chain to raise and lower the pump through the limits indicated. Provide galvanized chain capable of supporting the pump.

2.4 SELF-PRIMING CENTRIFUGAL PUMPS

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

2.4.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must 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

Provide casing that is capable of withstanding pressures 50 percent greater than the maximum operating pressures and that contains no openings of smaller diameter than the specified sphere size. Internal devices that will inhibit maintenance or interfere with priming and performance are not permitted. Design the pump to retain sufficient liquid in the casing to ensure unattended operation. Provide casing such that the impeller can be removed without disturbing the suction and discharge connections. Provide front access to the pump interior to permit inspection and cleaning of the pump interior without removing suction or discharge piping.

2.4.3 Impeller

Provide two-vane, semi-open, non-clog type impeller with pump-out vanes cast integrally on its backside. Statically, dynamically, and hydraulically balance the impeller within the operating range and to the first critical speed at 150 percent of the maximum operating speed. Key the impeller securely 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.
****

Provide a replaceable wear plate constructed of [cast iron] [alloy steel].

2.4.5 Pump Shaft

Provide pump shaft consisting of high grade alloy steel or stainless steel and of adequate size and strength to transmit the full driver wattage horsepower with a liberal safety factor.

2.4.6 Pump Shaft Sleeve

Protect the pump shaft from wear by a high grade alloy steel or stainless steel shaft sleeve. Place a seal, if needed, between the shaft and sleeve to prevent leakage.

2.4.7 Seals

Seal the pump shaft against leakage by [oil lubricated] [water lubricated] mechanical seal. Provide stationary sealing member consisting of [tungsten carbide] [silicon carbide] and the rotating member consisting of [tungsten carbide] [silicon carbide]. Ensure the seal is 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

Provide ball or roller type pump bearings 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.
****

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

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

2.4.11 Pump Support

Provide a common fabricated steel base plate for the pump and motor.

2.4.12 Coupling

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

Transmit power from the motor to the pump by a [flexible coupling] [V-belt drive assembly]. [Flexible couplings must be of the heavy duty type, keyed or locked to the shaft.] Provide V-belt drive assembly that has a minimum of two belts. Select the drive assembly on the basis of the power to be transmitted from the motor to the pump. Enclose the drive 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.
****

Ensure screw pumps have a spiral flight screw operating in a concrete trough with the screw rotation elevating the liquid up the inclined trough. Provide pump consisting 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 [_____] must 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 must be sleeve or roller bearing type design. If sleeve bearing is utilized, either rotate the bronze phosphor sleeve around stationary shaft or attach shaft to bronze bushing which rotates inside stationary cartridge. Ensure sleeve bearing is hermetically sealed, automatic grease lubricated. Provide oil lubricated roller bearings designed to guard against oil leakage. Arrange labyrinth to protect fire seal from damage. Provide bearings that have L-10 life of 100,000 hours. The bearing housing must permit precise adjustment in the field. Provide a spare lower bearing assembly.

2.5.2.1 Seals

Prevent contaminants 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

Provide a heavy-duty bearing shield to protect the bearing assembly from heavy debris.

2.5.3 Spiral Screw

Provide spiral screw consisting 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

Seal torque tube at both ends with welded steel plates. Take care to insure that the end plates are parallel after welding. Weld flights continuously to the tube on both sides. Bolt the drive shaft and lower stub shaft to the torque tube ends with a registered fit to ensure axial alignment of the tube and shafting.

2.5.3.2 Shafts

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

2.5.4 Flow Defector Plates

****

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

****

Provide flow deflector plates for installation in the pump trough along the uptake side of the spiral screw for the full length of the spiral. Ensure deflector plates are 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. Fabricate deflector plates from no less than 3 mm 1/8 inch thick steel plate complete with stiffeners and anchors where required.

2.5.5 Upper Bearing Assembly

Provide upper bearing assembly consisting of an upper bearing housing, bearing, seals, mounting, and cover.

2.5.5.1 Housing

Provide cast iron upper bearing housing with grease fittings on the exterior of the housing for periodic manual lubrication.

2.5.5.2 Bearing

Provide upper bearing which hasan ABMA L-10 life of 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and is 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

Provide two seals for protection of the upper bearings. Attach one seal to the extended shaft of the spiral screw to prevent contamination from entering the bearing top side. Locate the other seal on the bottom side to retain the grease within the bearing.

2.5.5.4 Mounting Plate

Provide a fabricated steel mounting plate and anchor bolts for mounting the upper bearing assembly.

2.5.5.5 Cover

Provide a fabricated steel cover to close the opening in the wall for the spiral shaft.

2.5.6 Drive Assembly

Provide drive assembly consisting of a motor, gear reducer, and backstop.

2.5.6.1 Gear Reducer

Provide gear reducer that has the torque rating for the spiral speed based upon continuous operation with a uniform load. Ensure the gear reducer has an outer cast iron housing, totally enclosed and rigidly constructed to maintain precise alignment of the gears and bearings. Design gear reducer with a service factor of no less than [_____] based on the torque requirements of the screw or [_____] based on the motor horsepower, whichever is greater. Splash lubricate gears and bearings or, if necessary, pressure lubricate to ensure oil is provided to all gears and bearings. Positively secure shaft-mounted gear reducers to the screw shaft and anchor a torque arm to the floor. Provide double lip oil seals on the shaft. Provide non-shaft-mounted gear reducers with an adjustable base and connect to the screw shaft by a flexible coupling.

2.5.6.2 Backstop

Provide a backstop 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

Connect the gear reducer to the drive motor by means of belts and sheaves designed with the same service factor as the gear reducer. Provide a safety cover for the belt drive.

2.5.7 Lubrication System

Provide an automatic grease lubricator with grease pump and reservoir to continuously grease the lower bearing when the pump is operating. Provide grease pump with a [_____] W hp, [_____] volts ac, [_____] phase, [60] [_____] Hz motor. Interlock the grease pump with the screw pump motor to prevent the screw pump from operating if the lubricator malfunctions. Provide a visual or automatic indicator 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

Provide positive displacement type plunger pumps designed to pump sewage sludges with a minimum amount of clogging.

2.6.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must 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

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

2.6.3 Pump Body

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

2.6.4 Valves

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

2.6.5 Connecting Rod, Eccentric, Eccentric Bearings, and Shaft

Provide connecting rod and eccentric strap assembly that is cast as one piece and has a quality hot-poured Babbitt lining. Design the eccentric, bearings, and shaft to handle the stresses and deflections imposed upon it by the specified service. Offset the shaft 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

Provide ductile iron plungers with a plugged drain hole in the bottom which are accessible through the top of the plunger.

2.6.7 Cylinders

Machine cylinders to a smooth bore to provide a uniform surface throughout the full travel of the plunger.

2.6.8 Stuffing Box

Ensure the cylinder and plunger has an effective packing arrangement to provide lubrication for the plunger and maintain the most effective vacuum. Provide stuffing box heavy cast construction with a circular drain lip and 25 mm 1 inch threaded drain connection. Provide stuffing box 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.

****

Provide air chambers on [the discharge side] [both suction and discharge sides] of the pump with 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

Provide a 50 mm 2 inch sampling valve on the discharge side of the pump.

2.6.11 Pressure Relief Valve

Provide a pressure relief valve with a bypass line from the main suction and discharge manifolds. Ensure valve is factory set to prevent motor overload or pump damage.

2.6.12 Lubrication

Provide each pump eccentric 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

Provide capacity variations by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Obtain overall drive reduction through the combination of a gearhead motor and silent roller chain. Ensure motor gearhead is totally enclosed and running in oil. Provide chain capacity that is at least 150 percent of the chain manufacturers published horsepower rating. Enclose the entire chain drive assembly completely in a sealed lip, dust resistant steel guard.

2.6.14 V-Belt and Integral Gear Drive

Provide capacity variations by stroke adjustment accomplished at each eccentric assembly, through the use of eccentric flanges coupled to the eccentric body. Obtain overall drive reduction through a combination of gears and V-belts. Run gears in an oil bath contained in an oil-tight cast iron or aluminum enclosure. Select the gear reduction design, gear materials and face widths, shafting, and bearings for the specified operating conditions. Cover the entire V-Belt drive assembly by a rigid safety guard.

2.6.15 Gear Reducer Drive

Provide capacity variations by pump speed change only. Connect the low speed shaft of the reducer directly to the main shaft of the pump through a flexible coupling with shear pin protection. Design the shear pin overload protection for release at 150 percent to 175 percent of normal torque. Connect the high speed shaft of the reducer to the motor by a heavy duty flexible coupling. Enclose the entire gear reduction unit 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.

****

Provide progressive cavity pumps consisting of a single helical rotor rotating in a double helical stator.

2.7.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must 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

[Cradle mount the pump body such that the suction chamber can be rotated to allow the suction port to accommodate any piping configuration.] Incorporate two inspection ports 180 degrees apart in the suction housing to provide access to internal parts. Provide a drain plug 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 must be a helix constructed of machined and polished [high quality tool steel] [stainless steel] [and must be covered with a layer of hard chrome plate].

2.7.4 Stator

The rotor must 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.

****

Provide rotor 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. Design the universal joints to transmit the required thrust and torque. The connecting rod and universal joint in combination must impart no thrust on the seal. Provide universal joints that are [grease] [_____] lubricated and totally sealed and shielded. Ensure seal prevents liquid from contaminating the joints, and the shields 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.

****

Provide rotor which is driven by a one-piece, flexible, high strength spring steel drive shaft with a corrosion and abrasion-resistant thermoplastic coating.

2.7.7 Seals

Provide pump seals consisting of a stuffing box with a split packing gland and lantern ring or a mechanical seal. Provide fittings for [grease] [water] lubrication.

2.7.8 Bearings

Design bearings for an ABMA L-10 life of at least 50,000 hours minimum, as specified in ABMA 9 or ABMA 11, and grease lubricate. Provide lubrication fittings in the bearing housing.

2.8 DIAPHRAGM PUMPS

Provide diaphragm pumps of the self-priming, positive displacement type designed to pump sludge of various concentrations and levels of abrasiveness. Design pump 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 [_____] must 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

Line all interior wetted parts with [6.4 mm 1/4 inch thick chlorosulfonated polyethylene]. Design pump body 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.

****

Provide [quick opening ball check type,] [in-line ball check type,] [or] [in-line flap check type] suction and discharge check valves. [Provide quick-opening ball check valves that 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.] [Provide in-line ball check valves that have a streamlined internal design, eliminating projections on which material can collect.] [Provide in-line flap check valves that have an elastomeric seal

on the disc to insure sealing and 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.
****

Provide an air chamber type pulsation damper on the pump [inlet] [and] [discharge].

2.8.5 Air-Operated Actuators

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

Provide a complete air operated actuator 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. Operate the valve 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. Ensure stroke rate is adjustable from 0 to [40] [_____] strokes per minute. Ensure stroke length is 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. Ensure the air pressure regulator is field adjustable from [_____] to [_____] kPa [_____] to [_____] psi.

2.8.5.5 Strainer

Provide an air supply strainer to remove particles larger than [_____] microns from the air supply with 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

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

2.9 RECESSED IMPELLER PUMPS

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

2.9.1 Pump Characteristics

Pump number[s] [_____] located in [_____] must 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

Construct pump casing with tapped and plugged holes for priming, venting, and drainage of the pump. Provide casing capable of withstanding pressures 50 percent greater than the maximum operating pressure. Ensure all internal casing clearances are equal to the discharge nozzle diameter

so that all material that can pass through the discharge nozzle can pass through the casing. Provide flanged casing connections.

2.9.3 Impeller

The impeller must be of the recessed design. Key the impeller securely 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.
****

Provide [high grade alloy steel] [or] [stainless steel] pump shaft that is 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.
****

Protect the pump shaft throughout the packing area by a removable [stainless steel] [or] [bronze] sleeve.

2.9.6 Seals

Provide 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.

2.9.6.1 Packing

Design the stuffing box to accommodate a minimum of [_____] rings of [graphite] [oil] impregnated [nonasbestos] [metallic] packing with lantern ring and packing gland. Ensure packing is readily removable from the shaft.

2.9.6.2 Mechanical Seals

Provide mechanical seals concicting of the [single] [double] type of [carbon-ceramic] [tungsten carbide] construction. Hold each seal interface in place by its own [stainless steel] spring system. Construct the seal system to be readily removable from the shaft.

2.9.7 Bearings

Provide antifriction ball or roller type pump bearings designed to carry all radial or thrust loads. Provide bearing that are [grease] [oil] lubricated and contained in dust- and moisture-proof housings. [Provide an oil reservoir with overflow and drain openings.] [Provide a grease fitting of the type that prevents overlubrication. If the grease fitting is not readily accessible, provide an extension tube.]

2.10 ROTARY LOBE PUMPS

Provide positive displacement type rotary lobe pumps consisting 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 [_____] must 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

Construct rotor casing of [ductile iron] [cast iron]. Construct the gear casing of cast iron. Use a removable end cover to allow access to tri-rotor elements without need to disturb packing glands, bearings, suction, or discharge connections.

2.10.3 Rotors

Provide pump rotors that are tri-lobe form [profile machined in cast iron] [high quality tool steel encapsulated in urethane] [stainless steel].

Provide a removable and replaceable wear plate between the rotors and rotor case to protect the rotor case from wear. Locate rotors on shafts by positive locking assembly.

2.10.4 Shafts and Sleeves

Provide shafts consisting of [high grade alloy steel] [_____] fitted with replaceable stainless shaft sleeves where passing through gland area. Time shafts in their rotation by zero backlash timing gears keyed to shafts and running in a separate oil chamber gear case. Ensure seals prevent ingress of pumped material into gear case.

2.10.5 Packing Glands

Provide adjustable packing gland type seals. Provide stuffing box glands 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.

****

Provide pump with heavy duty antifriction roller or ball type bearings for shaft support, with a ABMA L-10 life of [40,000] [100,000] hours at maximum operating conditions. Ensure oil seals prevent ingress of pumpage into gear case. Provide a slinger for each shaft.

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. Specify or indicate electrical characteristics. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices but are not shown.

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

Provide concrete conforming 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. Attach a radius screed provided by the pump manufacturer temporarily to provide proper clearance between the screw and the flow channel. Grout the flow channel in strict accordance with the manufacturer's instructions.

3.3 PAINTING

Pumps and motors must 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. Frame condensed operating instructions, prepared in typed form, 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, perform an operational test of all pumps, drivers, and control systems to determine if the installed equipment meets the purpose and intent of the specifications. 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, rotate the drive train by hand to demonstrate free operation of all mechanical parts. 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, correct such deficiencies and reconduct the tests.

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. 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. Provide training for a total period of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. 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. 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. Include piping and equipment layout and simplified wiring and control diagrams of the system as installed in the maintenance manuals. Manuals must be approved prior to the field training course.

-- End of Section --