****

USACE / NAVFAC / AFCEC / NASA | **UFGS-46 53 62 (February 2011)**
Change 1 - 08/14

Preparing Activity: USACE | **Superseding**
UFGS-44 42 59 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 53 62

CONTINUOUS LOOP REACTOR WASTEWATER TREATMENT SYSTEM

02/11, CHG 1: 08/14

PART 1 GENERAL

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

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Design Requirements
2.1.2 Mixing Parameters
2.1.3 Aeration Parameters
2.2 MANUFACTURED UNITS
2.2.1 Standard Products
2.2.2 Nameplates
2.2.3 Protection of Moving Parts
2.3 MATERIALS
2.3.1 Steel Plates, Shapes and Bars
2.3.2 Pipe
2.3.2.1 Steel Pipe
2.3.2.2 Ductile-Iron Pipe
2.3.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings
2.3.3 Pipe Hangers and Supports
2.3.4 Valves
2.3.4.1 Gate Valves
2.3.4.2 Plug Valves
2.3.4.3 Check Valves
2.3.5 Joint Compound
2.3.6 Joint Tape
2.4 DISC AND ROTOR AERATORS
2.4.1 Aeration Mechanism
2.4.1.1 Disc Assembly
2.4.1.2 Rotor Assembly
2.4.1.3 Velocity Baffles

2.4.1.4 Splash Plates
2.4.1.5 Disc and Rotor Immersion Requirements
2.4.1.6 Shafts and Bearings
2.4.1.7 Protective Covering
2.4.2 Drive System
2.4.2.1 Reducer
2.4.2.2 Housing
2.4.2.3 Rating
2.4.2.4 Bearings
2.4.2.5 Lubrication
2.4.2.6 Couplings
2.4.3 Mounting
2.5 LOW SPEED SURFACE AERATORS
2.5.1 Impeller Shaft
2.5.2 Impeller
2.5.3 Drive System
2.5.3.1 Reducer
2.5.3.2 Housing
2.5.3.3 Rating
2.5.3.4 Bearings
2.5.3.5 Lubrication
2.5.3.6 Couplings
2.5.4 Mounting
2.5.5 Protective Covering
2.6 SUBMERGED TURBINE DRAFT TUBE AERATORS
2.6.1 Impeller Shaft
2.6.2 Impeller
2.6.3 Drive System
2.6.3.1 Reducer
2.6.3.2 Housing
2.6.3.3 Rating
2.6.3.4 Bearings
2.6.3.5 Lubrication
2.6.3.6 Couplings
2.6.4 Draft Tube
2.6.5 Mounting
2.6.6 Air Supply Equipment
2.7 JET AERATION
2.7.1 Submerged Jets
2.7.2 Recirculation Pumps
2.7.2.1 Vertical Propeller Pump
2.7.2.2 Submersible Centrifugal Pumps
2.7.2.3 Self-Priming Centrifugal Pumps
2.7.2.4 Vertical Turbine Pumps
2.7.2.5 Pump Suction Screens
2.7.3 Blowers
2.8 DIFFUSED AERATION/SLOW SPEED MIXER SYSTEM
2.8.1 Diffused Aeration System
2.8.2 Slow Speed Mixer (With Submersible Electric Motor)
2.8.2.1 Mixer Propeller
2.8.2.2 Drive System
2.8.2.3 Shafts and Seals
2.8.2.4 Mounting
2.8.3 Slow Speed Mixer (With Hydraulic Motors)
2.8.3.1 Mixer Propeller
2.8.3.2 Drive System
2.8.3.3 Mounting
2.9 LUBRICATION REQUIREMENTS
2.10 ELECTRIC MOTORS

2.10.1 Frame
2.10.2 Design
2.10.3 Enclosure
2.10.4 Terminal Boxes
2.10.5 Bearings
2.10.6 Windings
2.10.7 Motor Characteristics
2.10.8 Motor Controls
2.11 SPECIAL TOOLS

PART 3 EXECUTION

3.1 EXAMINATION
3.2 TREATMENT SYSTEM INSTALLATION
3.2.1 Welding
3.2.2 Pipe and Valve Installation
3.2.2.1 Flanged Joints
3.2.2.2 Screwed Joints
3.2.2.3 Push-On Joints for PVC Pipe
3.2.2.4 Solvent-Weld Joints for PVC Pipe
3.2.2.5 Valves
3.2.3 Equipment Installation
3.2.4 Electrical Work
3.3 PAINTING
3.3.1 Preparation and Application
3.3.2 Coating Examination
3.3.3 Coating Repair
3.4 FRAMED INSTRUCTIONS
3.5 FIELD TESTS AND INSPECTIONS
3.5.1 Basin Leakage Test
3.5.2 Operating Tests
3.5.3 Velocity Test
3.5.4 Standard Oxygen Transfer Efficiency Test (S.O.T.E.)
3.5.5 Reporting Test Results
3.6 MANUFACTURER'S SERVICES
3.6.1 Supervise Installation, Adjustment, and Testing
3.6.2 Field Training
3.7 OPERATING AND MAINTENANCE INSTRUCTIONS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA	**UFGS-46 53 62 (February 2011)** **Change 1 - 08/14** **----------**
Preparing Activity: USACE	**Superseding** **UFGS-44 42 59 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION 46 53 62

CONTINUOUS LOOP REACTOR WASTEWATER TREATMENT SYSTEM
02/11, CHG 1: 08/14

****

NOTE: This guide specification covers the requirements for continuous loop reactor wastewater treatment system.

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

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 GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6013	(2006A; R2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 2-06	(2007) Measurement of Oxygen Transfer in Clean Water

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B31.1	(2020) Power Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm)

	and Larger
AWWA C500	(20019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2015) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2014; Errata 2015) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2016) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A420/A420M	(2020) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
ASTM A707/A707M	(2019) Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

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

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

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

Treatment System Installation; G[, [_____]]

SD-03 Product Data

Manufactured Units; G[, [_____]]

Spare Parts; G[, [_____]]

Framed Instructions; G[, [_____]]

Manufacturer's Written Instructions; G[, [_____]]

Welding

SD-06 Test Reports

Field Tests and Inspections; G[, [_____]]

Furnish test results in booklet form not less than 30 days prior to the date of work completion.

SD-10 Operation and Maintenance Data

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

[Six] [_____] [hard] [optical disc] copies.

1.3 DELIVERY, STORAGE, AND HANDLING

Protect from damage, deterioration, weather, humidity and temperature variations, dirt and dust, or other contaminants, equipment in storage as required by the manufacturer.

1.4 EXTRA MATERIALS

Submit spare parts data for all materials and for each different item of equipment specified, after approval of the detail drawings, and not later than [3] [_____] months prior to the date of work completion. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: A continuous loop reactor or oxidation ditch utilizes biological action to degrade organics in the wastewater. Consideration should be given to wastewaters from industrial facilities to ensure there are no components detrimental to microorganisms. In addition, Army facilities utilizing continuous loop reactors should include pretreatment equipment such as bar screens, comminuters and a grit chamber as required by the process conditions. Final clarification, sludge handling and disinfection equipment is also generally required. These and other possible components of the complete treatment system guide are not covered under this section.

As required for military construction, only sprayed concrete (shotcrete) or placed reinforced concrete will be acceptable for the basin construction. Clay lined or synthetic membrane lined basins (even those protected from erosion) are not acceptable.

****

The work required by this section consists of furnishing and installing a continuous loop reactor (CLR). The system shall be a modified form of the activated sludge process and classified as an extended aeration system. The basin shall be an [earthen channel with an impervious sprayed concrete surface] [reinforced concrete structure], constructed at the depth and configuration indicated. The basin shall include all aeration/mixing equipment, [piping,] [pumps,] [baffles,] [weirs] and [turning walls] necessary for proper performance and operation.

2.1.1 Design Requirements

****

NOTE: Some states and regulatory agencies require a minimum detention time of 24 hours. Check the governing regulations for activated sludge/extended aeration processes for the project location.

Insert average daily and peak daily flow rates and the required BOD5 removal efficiency. Typically, 90-95 percent removal can be achieved in a continuous loop reactor. Comply with UFC 3-240-02 to determine design criteria.

****

Treatment of the wastewater shall be accomplished by contact with the waste activated sludge in the CLR for a minimum of [18] [_____] hours. The CLR shall be sized for an average daily flow of [_____] L/second mgd and a peak daily flow of [_____] L/second mgd. The CLR shall remove a minimum of [_____] percent of the influent five day BOD at the average daily flow rate and influent five day BOD.

2.1.2 Mixing Parameters

The aeration/mixing system selected shall provide the propelling force for circulation and mixing of the basin contents. The aeration/mixing unit(s) shall be sized to maintain an average horizontal velocity of not less than [0.305] [_____] m/second [1.0] [_____] fps throughout the basin and maintain a uniform mixed liquor suspended solids (MLSS) concentration throughout the basin at MLSS concentrations up to [5000] [_____] mg/L, with one aeration/mixing device not operating.

2.1.3 Aeration Parameters

****

NOTE: The Actual Oxygen Requirement (AOR) is calculated by the designer. The oxygen required for oxidation of BOD and the oxygen required for nitrification must be included in the AOR. Typical values are 0.82 kg 1.8 pounds of oxygen per 0.45 kg 1.0 pound of BOD applied and 2.1 kg 4.6 pounds of oxygen per 0.45 kg 1.0 pound of TKN applied. The alpha coefficient is defined as the ratio of the oxygen transfer in the wastewater to the oxygen transfer in clean water and may vary from 0.2 to 1.5. The alpha coefficient is a direct multiplier in determining oxygen transfer capabilities and is affected by mixed liquor temperature, liquid depth and basin geometry, the level of turbulence, mixing patterns and the nature of dissolved organics and mineral constituents in the wastewater and even the type of aeration equipment. Fine bubble aeration systems typically have lower alpha values than mechanical aeration systems. Because of this variation in alpha value a default value is not shown below. The Beta coefficient is defined as the ratio of oxygen saturation level for the wastewater (mixed liquor) to the oxygen saturation level for tap water. Theta is a temperature correction coefficient for oxygen transfer efficiency (OTE). Values of 1.020 to 1.028 are normally used for diffused air systems, while a value of 1.024 is normally used for mechanical aeration systems.

An OTE of 0.507 mg oxygen per joule 3.0 lb. oxygen/hp-hr under standard conditions is an average value for aeration equipment commonly used in closed loop reactor applications. Designer should contact the aerator manufacturer for the OTE of a particular aerator. An aeration system in this range will provide oxygen transfer for an average power cost. Insert the efficiency value desired for the particular design.

The requirement to maintain a minimum dissolved oxygen concentration of 0.5 mg/L should be omitted if the designer has provided for an anoxic zone within the reactor.
****

The aeration/mixing system selected shall be based upon the following process requirements:

a. Actual Oxygen Requirement (AOR) [_____] kg oxygen/day lbs. oxygen/day.

b. Alpha Coefficient [_____].

c. Beta Coefficient [0.95] [_____].

d. Theta Coefficient [1.024] [_____].

e. Wastewater temperature [20] [_____] degrees C [68] [_____] degrees F.

The aeration/mixing system selected shall provide no less than [_____] mg oxygen/joule lb. oxygen/hp-hr under standard (clean water) conditions [and be capable of maintaining a dissolved oxygen concentration of not less than [0.5] [_____] mg/L anywhere in the CLR]. Provide factory test results for a similar treatment application and configuration to substantiate the OTE.

2.2 MANUFACTURED UNITS

A complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; installation instructions; and a recommendation on quantities of spare parts to have on hand at all times for each piece of equipment.

2.2.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and which essentially duplicate items that have been in satisfactory use in similar facilities for at least 2 years prior to bid opening. All aeration/mixing equipment, associated accessories, and appurtenances shall be supplied by the same manufacturer. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2.2 Nameplates

Provide pumps, blowers and motors with the manufacturer's name, address, type or style, model or serial number, and catalog number on a stainless steel plate permanently secured to the item of equipment.

2.2.3 Protection of Moving Parts

Belts, chains, couplings, and other moving parts shall be completely enclosed by guards to prevent accidental personal injury. Guards shall be removable or so arranged as to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, this shall be sufficient protection and no additional guards are necessary.

2.3 MATERIALS

Materials and equipment shall conform to the following requirements.

2.3.1 Steel Plates, Shapes and Bars

ASTM A36/A36M.

2.3.2 Pipe

Piping shall be furnished and installed as indicated and be in accordance with the applicable standard specification.

2.3.2.1 Steel Pipe

ASTM A53/A53M, all pipe sizes.

a. Flanged Joints: ASTM A707/A707M.

b. Slip Joints: AWWA C200.

c. Mechanical Joints: AWWA C200.

d. Welded Joints: AWS D1.1/D1.1M.

e. Bolts: ASTM A307, Grade B.

f. Fittings: ASTM A420/A420M.

2.3.2.2 Ductile-Iron Pipe

AWWA C115/A21.15, all pipe sizes.

a. Flanged Pipe: AWWA C115/A21.15 with ASME B16.1, Class 125 flanges.

b. Rubber-Gasket Joints: AWWA C111/A21.11.

c. Fittings: AWWA C110/A21.10.

d. Push-On Joints: AWWA C151/A21.51.

e. Bolts and Nuts: ASTM A307, Grade B.

f. Coatings and Linings: Buried piping shall have standard bituminous coating.

2.3.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings

PVC pipe and fittings less than 102 mm 4-inch diameter shall be in accordance with ASTM D1785 or ASTM D2241. PVC pipe and fittings 102 mm 4 inch in diameter and larger shall be in accordance with ASTM D2241 and shall have push-on joints.

a. Push-On Joints: ASTM D3139 or ASTM F477.

b. Solvent Cement: ASTM D2564.

2.3.3 Pipe Hangers and Supports

MSS SP-58.

2.3.4 Valves

2.3.4.1 Gate Valves

Gate valves shall withstand a working pressure of not less than1.03 MPa 150 psi. Valves shall have a clear waterway equal to the full diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel handle shall have an arrow, cast in metal, indicating the direction of opening. Valves for buried service shall be non-rising stem (NRS), 50 mm 2 inch square nut operated with joints applicable to the pipe or installation. Buried valves shall be furnished with extension stems comprising socket, extension stem and operating nut, and shall be long enough to bring operating nut to within 150 mm 6 inch of grade. One 1.2 m 4 foot "T" handle valve wrench shall be furnished for each quantity of six buried valves. Gate valves which are exposed or installed inside shall be outside screw and yoke (OS&Y), handwheel operated with flanged ends unless otherwise indicated. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.

a. Valves smaller than 75 mm 3 inch shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.

b. Valves 75 to 305 mm 3 to 12 inch in size shall be resilient-seated gate valves conforming to AWWA C509.

c. Valves 355 mm 14 inch and larger shall be iron body, bronze mounted and shall conform to AWWA C500. Valves shall be the solid wedge type. Valves shall be equipped with gearing to reduce operating effort. Valves installed in horizontal lines in the horizontal position with stems horizontal shall be equipped with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Valves installed in vertical pipe lines with stems horizontal shall be fitted with slides to assist the travel of the gate assembly.

2.3.4.2 Plug Valves

Plug valves shall be the eccentric type and shall withstand a minimum working pressure of 1.03 MPa 150 psi. Flange valve ends shall conform to ASME B16.1, Class 125. Mechanical or push-on type rubber gasket joint ends shall conform to AWWA C110/A21.10 and AWWA C111/A21.11. Port area for valves shall be at least 80 percent of full pipe area. Valve bodies, plugs or discs, seats, shafts, shaft seals and actuators shall conform to AWWA C504. Valves shall open counterclockwise and the operating nut or wheel shall have an arrow, cast in metal, indicating the direction of opening. Valves shall meet all performance, leakage, and hydrostatic test required by AWWA C504. On request, furnish a certified statement from the manufacturer that proof-of-design tests were carried out as described in AWWA C504 and all requirements were successfully met.

2.3.4.3 Check Valves

Check valves shall permit free flow of sewage forward and provide a positive check against backflow. Check valves shall withstand a minimum working pressure of 1.03 MPa 150 psi or as indicated. The body shall be

iron. Directly cast on the body shall be the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow. Flanges shall be the 56 kg 125 pound type complying with ASME B16.1.

a. Ball check valves shall have flanged or threaded ends and shall be the non-slam type. Ball shall be stainless steel unless otherwise specified.

b. Swing check valves shall comply with AWWA C508, shall be bronze mounted, and shall have flanged ends. Check valves shall be equipped with [outside lever and spring] [_____].

2.3.5 Joint Compound

Joint compound for threaded joints shall be a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.3.6 Joint Tape

Joint tape for threaded joints shall comply with ASTM D3308.

2.4 DISC AND ROTOR AERATORS

****

NOTE: The paragraphs that follow contain optional types of aeration systems which may be used by the designer. Only the paragraphs applying to the selected system should be left and the others removed. However, if the disc and rotor option is selected note that these aerators can normally be substituted, one for the other, in the same basin configuration so that both disc and rotors may be specified.

****

2.4.1 Aeration Mechanism

The [disc] [or] [rotor] aeration system shall be provided as indicated. The units shall be complete and include [disc] [or] [rotor] assemblies, shaft, or torque tube, drive unit, bearings, supports and all appurtenances necessary for the proper operation of the equipment. The [disc] [or] [rotor] aeration system shall be designed for continuous operation.

2.4.1.1 Disc Assembly

****

NOTE: Twelve individual discs or rotors in an assembly are typical. The diameter of the unit is variable and should be designed based upon basin configuration, oxygen transfer rates, velocity and efficiency requirements.

****

Each assembly shall contain individual molded [plastic] [fiberglass] discs, [_____] mm inch in diameter and mounted not less than 150 mm 6 inch on center. The number and spacing of disc assemblies shall be provided as indicated. The disc assemblies shall be secured to the shaft with a clamp

ring, by using a keyed shaft or by another method that will hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. The discs shall be split into two sections for attachment or removal without disassembling the shafting. Stainless steel positioning bolts shall be supplied to hold the two halves together on the shaft.

2.4.1.2 Rotor Assembly

****

NOTE: Twelve individual discs or rotors in an assembly are typical. The diameter of the unit is variable and should be designed based upon basin configuration, oxygen transfer rates, velocity and efficiency requirements.

****

Each blade assembly shall consist of [12] [_____] individual or six dual [stainless steel] [plastic] [epoxy coated steel] [hot-dipped galvanized steel] blades, [_____] mm inch in diameter and mounted not less than 150 mm 6 inch on center. The number and spacing of rotor assemblies shall be provided as indicated. The blade assemblies shall be secured to the shaft with a clamp ring, by using a keyed shaft, by compression between the assembly blades and the shaft or by another method that will hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. The blades shall be removable by unbolting. Welding blades to the shaft will not be permitted.

2.4.1.3 Velocity Baffles

Provide velocity baffles at the indicated locations and alignment and in accordance with all structural and installation requirements as recommended by the manufacturer of the aeration mechanism.

2.4.1.4 Splash Plates

****

NOTE: If outboard bearings are not required or if they are designed to be wetted, or if protective covering hoods include splash protection delete this paragraph.

****

Fabricated [steel] [aluminum] [stainless steel] plates shall be mounted in the vertical concrete walls at the drive assembly and outboard bearings and shall be bolted to the frames as indicated. The opening in the wall formed by the splash plate shall be of sufficient width for removal shafts. Where the shaft passes through the splash plates a rubber gasket seal shall be provided on both sides to seal water from the service area.

2.4.1.5 Disc and Rotor Immersion Requirements

****

NOTE: To maintain the water level within the recommended range it is very important that the effluent weir be sized properly and be manually adjustable.

The immersion depth will vary with the diameter of rotor selected. The depths indicated assume a

standard 1220 mm 48 inch diameter unit.
****

To ensure the most efficient operation of the aeration system and to avoid damage to the drive system the [discs shall be operated with a minimum immersion of [300] [_____] mm [12] [_____] inch and a maximum immersion of [535] [_____] mm [21] [_____] inch] [rotor blades shall be operated with a minimum immersion of [100] [_____] mm [4] [_____] inch and a maximum immersion of [355] [_____] mm [14] [_____] inch].

2.4.1.6 Shafts and Bearings

****
NOTE: There are no apparent mechanical or operational advantages in stub shafts and continuous through shafts. Different manufacturers market different shafts. Check with potential manufacturers before specifying shaft type. Contractor should usually be allowed to use either shaft.
****

The [disc] [or] [rotor] assembly shall be supported at both ends by a shaft. The shaft shall be fabricated of steel conforming to ASTM A36/A36M. The shaft shall be [solid steel] [a steel torque tube with a minimum 9.5 mm 0.375 inch wall thickness]. Each [disc] [or] [rotor] assembly shall be furnished with support bearing assemblies. Bearings shall be waterproof, self aligning and consist of a cast-iron pillow block set on adjustable anchor plates. The bearings shall be grease lubricated and have a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11.

2.4.1.7 Protective Covering

Provide an [ultraviolet light protected fiberglass] [_____] cover, extending over the length of each aeration unit. The cover shall be designed to protect all adjacent structures from splashing caused by the units. The cover shall be mounted independent of the aeration equipment and be installed in accordance with the manufacturer's requirements.

2.4.2 Drive System

2.4.2.1 Reducer

The drive system reducer shall be constructed to maintain alignment of bearings and gearing while absorbing the external loads of the [disc] [or] [rotor] assembly. The unit shall be designed to continuously withstand all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. The unit shall also be designed to withstand all external loadings produced by torque, out-of-balance and vibration resulting from operating conditions. The speed reducer shall be provided with lifting lugs. The interior of the gear case shall be vented by an approved breather, constructed to retard the entrance of water vapor.

2.4.2.2 Housing

Drive housing shall be weatherproof and constructed of steel in accordance with ASTM A36/A36M or high grade cast-iron in accordance with ASTM A48/A48M. A protective coating shall be applied that will not peel, crack or

discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.4.2.3 Rating

The drive gearing shall have a minimum service factor of at least [1.4] [_____] times the rated brake horsepower of the drive motor. The gear reduction system shall be suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for gear motor reducers or gear motors using helical and spiral bevel gears.

2.4.2.4 Bearings

Power transmission bearings shall be antifriction type and shall have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Bearings shall be fully sealed and protected from water spray.

2.4.2.5 Lubrication

****
NOTE: If lubricating pumps are not used delete subparagraph b. and edit accordingly.
****

a. Lubrication shall be provided by [gears running in an oil bath] [an oil slinger] [pumps]. The drive shall be provided with an oil "dam", spring loaded lip seals or other means of positive protection against lubricant leakage around the output shaft. An oil level gauge or sight glass and drain fittings shall also be provided. The thermal rating of the gear reducer shall exceed the design load or proper cooling shall be provided.

b. Lubricating pumps shall be removable for maintenance without disassembly of the drive and/or removal of the motor. Either a low pressure or low oil level switch shall be provided to shut off the unit in the event of insufficient lubrication.

2.4.2.6 Couplings

Power transmission from the motor to the gear reduction system shall be supplied by [a flexible coupling, direct driven. The coupling shall be a nonlubricant type, manufacturer's standard, and shall be selected to provide a minimum service factor of 2.0] [sheaves and [V-belts] [chains]. To reduce the output speed, the sheaves shall be removable.] The assembly shall be covered with a suitable guard and shall be protected from splashing.

2.4.3 Mounting

The drive system shall be a base mounted type which is separately mounted on a concrete pier or a shaft mounted type which is supported by the drive side rotor bearing.

2.5 LOW SPEED SURFACE AERATORS

The low speed mechanical surface aerators shall be furnished and installed as indicated. Each unit shall be complete and include an electric motor, a gear reducer, shaft and impeller driven at a constant speed, and all

necessary fasteners, stabilizers, anchoring devices, and other mechanical and structural appurtenances necessary for the mounting and operation of the units. The aerators shall be designed for continuous operation.

2.5.1 Impeller Shaft

The shaft shall be constructed of [carbon steel] [_____] and shall be sized to withstand all torque loads and bending moments produced by operation of the system. The shaft and bearing assembly shall be designed to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. The shaft shall be so constructed that its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. The shaft supporting the impeller shall be removable from the drive assembly, without disassembly of the gear box. Rolling, antifriction type bearings on the impeller shaft shall have a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11. The entire weight of the shaft and impeller shall be supported by a thrust bearing integral with the gear reducer. A rigid coupling shall be used to connect the shaft and turbine assembly to the output shaft of the reducer. Bearings on the shaft shall be either grease or oil lubricated, and shall be positively sealed against penetration of moisture, or leakage of lubricant down the shaft. Provisions shall be included for checking the adequacy of lubrication.

2.5.2 Impeller

The impeller shall be constructed of [carbon steel] [_____] and shall be positively fastened to the shaft with all [carbon steel] [_____] hardware. Means shall be provided for adjustment of the impeller. If the adjustment is on the shaft, a means shall be provided to prevent the impeller from dropping off the shaft during adjustment. Impeller submergence shall be determined by the equipment supplier to ensure the most efficient operation of the aeration system.

2.5.3 Drive System

2.5.3.1 Reducer

The drive system reducer shall be constructed to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. The unit shall be designed to withstand continuously all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. The unit shall also be designed to withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating conditions. The speed reducer shall be provided with lifting lugs. The interior of the gear case shall be vented by an approved breather, constructed to retard the entrance of water vapor.

2.5.3.2 Housing

Drive housing shall be weatherproof and shall be constructed of steel in accordance with ASTM A36/A36M or high grade cast-iron conforming to ASTM A48/A48M. A protective coating shall be applied that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.5.3.3 Rating

The gearing shall have a minimum service factor of at least [2.5] [_____] times the rated brake horsepower of the drive motor. The gear reduction system shall be suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for motor reducers or gear motors using helical and spiral bevel gears.

2.5.3.4 Bearings

Power transmission bearings shall be antifriction type and shall have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Bearings shall be fully sealed and protected from water spray.

2.5.3.5 Lubrication

****
NOTE: If lubricating pumps are not used delete subparagraph b. and edit accordingly.
****

a. Lubrication shall be provided by [gears running in an oil bath] [an oil slinger] [pumps]. Drive shall be provided with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft. An oil level gauge or sight glass and drain fittings shall also be provided. The thermal rating of the gear reducer shall exceed the design load. If this is not the case, then proper cooling shall be provided.

b. Lubricating pumps shall be removable for maintenance without disassembly of the drive and/or removal of the motor. Either a low pressure or low oil level switch shall be provided to shut off the unit in the event of insufficient lubrication.

2.5.3.6 Couplings

Power transmission from the motor to the gear reduction system shall be supplied by a nonlubricated coupling, direct driven. Couplings shall be the manufacturer's standard and shall be selected to provide a minimum service factor of 2.0.

2.5.4 Mounting

****
NOTE: To maintain the water level within the recommended range it is very important that the effluent weir be sized properly and be manually adjustable. Verify immersion depth with potential manufacturers.
****

A [structural bridge of steel conforming to ASTM A36/A36M] [concrete bridge] and support assembly designed to mount each aeration unit shall be constructed as indicated. The bridge assembly shall be structurally anchored to the basin walls. To ensure the most efficient operation of the aeration system, the aerator shall be mounted with the top of the impeller blades [50] [_____] mm [2] [_____] inch above the minimum water surface elevation. The blades shall not be submerged more than [200]

[_____] mm [8] [_____] inch at the maximum water surface elevation.

2.5.5 Protective Covering

The manufacturer shall supply an [ultraviolet light protected fiberglass] [_____] cover for each aeration unit. The cover shall be designed to protect all adjacent structures from splashing caused by the unit. The cover shall be mounted independent of the aeration equipment and be installed in accordance with the manufacturer's requirements.

2.6 SUBMERGED TURBINE DRAFT TUBE AERATORS

The submerged turbine draft tube aeration system shall be furnished and installed as indicated. The unit shall be complete and include blowers, drive unit, turbine aerator unit and supports, draft tube assembly, and all appurtenances necessary for the proper operation of the equipment. The aerators shall be designed for continuous operation.

2.6.1 Impeller Shaft

The shaft shall be constructed of [carbon steel] [_____] and shall be sized to withstand all torque loads and bending moments produced by operation of the system. The shaft and bearing assembly shall be designed to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. The shaft shall be so constructed that its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. The shaft supporting the impeller shall be removable from the drive assembly, without disassembly of the gear box. Rolling, antifriction type bearings on the impeller shaft shall have a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11. The entire weight of the shaft and turbine will be supported by a thrust bearing integral with the gear reducer. A rigid coupling shall be used to connect the shaft and turbine assembly to the output shaft of the reducer. Bearings on the shaft shall be either grease or oil lubricated and shall be positively sealed against penetration of moisture or leakage of lubricant down the shaft. Provisions shall be included for checking the adequacy of lubrication.

2.6.2 Impeller

The impeller shall be constructed of [carbon steel] [_____] and shall be positively fastened to the shaft with all [carbon steel] [_____] hardware. The impeller shall be removable from the shaft. Means shall be provided for adjustment of the impeller. If the adjustment is on the shaft, a means shall be provided to prevent the impeller from dropping off the shaft during adjustment.

2.6.3 Drive System

2.6.3.1 Reducer

The drive system reducer shall be constructed to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. The unit shall be designed to withstand continuously all internal loadings developed at the full load motor wattage horsepower, including motor starting torques up to 250 percent of motor running torques. The unit shall also be designed to withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating

conditions. The speed reducer shall be provided with lifting lugs. The interior of the gear case shall be vented by an approved breather, constructed to retard the entrance of water vapor.

2.6.3.2 Housing

Drive housing shall be weatherproof and shall be constructed of steel in accordance with ASTM A36/A36M or high grade cast-iron conforming to ASTM A48/A48M. A protective coating shall be applied that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.6.3.3 Rating

The gearing shall have a minimum service factor of at least [2.0] [_____] times the rated brake horsepower of the drive motor. The gear reduction system shall be suitable for continuous operation and moderate shock loading in accordance with ANSI/AGMA 6113AGMA 6013 for motor reducers or gear motors using helical and spiral bevel gears.

2.6.3.4 Bearings

Power transmission bearings shall be antifriction type and shall have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Bearings shall be fully sealed and protected from water spray.

2.6.3.5 Lubrication

****
NOTE: If lubricating pumps are not used delete subparagraph b. and edit accordingly.
****

a. Lubrication shall be provided by [gears running in an oil bath] [an oil slinger] [pumps]. Drive shall be provided with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft. An oil level gauge or sight glass and drain fittings shall also be provided. The thermal rating of the gear reducer shall exceed the design load or proper cooling shall be provided.

b. Lubricating pumps shall be removable for maintenance without disassembly of the drive and/or removal of the motor. Either a low pressure or low oil level switch shall be provided to shut off the unit in the event of insufficient lubrication.

2.6.3.6 Couplings

Power transmission from the motor to the gear reduction system shall be supplied by a nonlubricated coupling, direct driven. Couplings shall be the manufacturer's standard and shall be selected to provide a minimum service factor of 2.0.

2.6.4 Draft Tube

Each draft tube shall consist of upper and lower sections of epoxy coated steel. The upper section shall consist of the suction cone, supports for connection to the turbine support assembly, air distribution assembly,

deflection limiting system, flow direction baffles, and supports for connection to the bottom section. The bottom section shall be [_____] mm feet long, sufficient to carry the design flow with minimal pressure drop. Bottom section shall be shaped to carry the wastewater to a sufficient depth to dissolve the required oxygen and direct the flow forward in the channel. The draft tube shall be [_____] mm inch in diameter with a 6 mm 1/4 inch minimum wall thickness, and shall be equipped with grout rings as shown.

2.6.5 Mounting

A [structural bridge of steel conforming to ASTM A36/A36M] [concrete bridge] and support assembly designed to mount each aerator shall be constructed as indicated. The bridge assembly shall be sufficient to support the turbine aerator, suction cone, air sparge assembly and the flow directional baffle assembly.

2.6.6 Air Supply Equipment

The blower shall conform to Section 46 51 00.00 10 AIR AND GAS DIFFUSION EQUIPMENT.

2.7 JET AERATION

****

NOTE: Jet aeration systems require that preliminary treatment system be included upstream of the CLR to remove grit and other larger particles to reduce the likelihood of plugging the nozzles.

The aeration equipment covered in this specification is listed below along with some general requirements for their use. For further assistance in determining the applicability of the CLR, refer to UFC 3-230-14A and for design criteria refer to UFC 3-240-02.

a. Disc or Rotor (Brush) Aerators: This type of aeration system creates surface agitation to provide oxygen transfer and imparts a horizontal velocity by the rotation of the unit. The channel may be constructed with either sloped or vertical side walls. Typically the channels are constructed 2.4 m 8 feet to 3.7 m 12 feet deep. Channels greater than 2 m 7 feet deep may require a velocity baffle downstream of the aeration unit to help impart a downward velocity to the wastewater and improve mixing along the channel bottom. The CLR should not be constructed with a sidewater depth greater than 4.3 m 14 feet if disc or brush aerators are specified. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners.

b. Low Speed Surface Aerators: This type of aeration system creates surface agitation to provide oxygen transfer and imparts a velocity to the wastewater by the swirling action created by the impeller. The aerators must be placed at the turns

in the channel to achieve effective horizontal velocity. At bends where aerators are not located, turning walls are recommended to maintain channel velocities around the corners. Floating aerators should not be considered for use in a CLR application due to the area required for the pontoons. The channel may be constructed with either sloped or vertical side walls. With this equipment, vertical side walls are recommended at the turns. Channel depths will vary from 2 to 5 m 6 to 16 feet). Draft tubes should be provided when recommended by the manufacturer.

c. Submerged Turbine Aerators: Submerged turbine aerators used in CLR's utilize a downward pumping impeller to force an air and water mixture through a draft tube that extends below the bottom of the basin and through a barrier wall extending across the basin. The barrier wall may be constructed of concrete, compacted clay or reinforced earth. The turbine's impeller should be located at a depth of approximately 20 percent of the basin sidewater depth. The air is discharged through a sparge ring below the impeller and becomes entrained in the downward flow of water through the draft tube. The system requires an air blower, as well as the turbine unit. However, the system offers turn down flexibility because the turbine and blower are operated independent of each other. Sloped or vertical walls are acceptable with this system and the basin should have a single side water depth within the range of 2.4 to 5 m 8 to 16 foot sidewater depth. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners.

d. Jet Aeration: Jet aeration combines air flow and pumped liquid in a vortex jet nozzle which is discharged just above the channel floor. The jet system consists of a recirculation pumping system and an air blower, each feeding headers that discharge through the jet nozzles. The typical configuration utilizes a concrete basin with a 3.7 to 6 m 12 to 20 foot sidewater depth, preferably with vertical side walls. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners. The jet nozzles can be fixed or they can be mounted on removable or swing headers to facilitate maintenance. Removable and swing header systems will require the construction of thrust blocks located behind the nozzles to prevent any deflection caused by the jet action.

e. Diffused Aeration/Low Speed Mixer System: In this system, a coarse, medium or fine bubble diffused aeration system is used in conjunction with a submerged low speed mixing unit that supplies the horizontal velocity. The propeller type mixer,

mounted on guide rails, is positioned immediately upstream of the diffusers. Vertical or sloping side walls are acceptable with basin sidewater depth ranging between 3.7 to 6 m 12 to 20 foot. In addition, turning walls are recommended at each bend to maintain channel velocities around the corners. Vertical side walls are recommended in the area of the diffusers to maximize oxygen transfer. Consideration should also be given to providing a removable or swing header system to facilitate maintenance of the diffusers.

f. System Choice: Since the configuration of the channel will vary with the type of equipment selected, the choice of aeration system must be decided upon first. Each aeration system listed above is specified herein. Only the paragraphs applying to the aeration system selected should be included in the specification. All paragraphs and subparagraphs for the other aeration systems should be deleted.

****

The jet aeration system shall be provided as indicated. The system shall include air-liquid jet manifolds, [vertical propeller] [submerged centrifugal] pumps, pneumatic backflush system, air blowers, and all in-basin air and liquid piping and supports. The jet aeration system shall be designed for continuous operation.

2.7.1 Submerged Jets

****

NOTE: The nozzle size will affect the performance of the system by changing the water and air mixture. The standard nozzle size is 40 mm 1-1/2 inches, however, the process requirements should be checked to determine proper nozzle size. The number and size of nozzles is site specific and is effected by the tank size, solids concentration, oxygen demand requirements and other factors. Designer should contact the equipment manufacturer for information on nozzle sizing.

****

The jet aeration system shall consist of [fiberglass reinforced plastic] [_____] jet nozzles, oriented in a common direction and attached to a common manifold. The manifold shall consist of separate liquid and air piping so that the air and liquid do not mix prior to reaching the mixing chamber of the jet. The liquid portion of the manifold shall provide uniform distribution of mixed liquor from the inlet of the manifold to each of the jets. The jets shall consist of 2 nozzles and a mixing chamber constructed integrally with the manifold. The primary jet shall direct the mixed liquor into the mixing chamber where air will be introduced and combined with the liquid. The air-liquid mixture shall then be discharged into the secondary nozzle and, hence horizontally into the basin. The two nozzles shall be carefully molded to maintain proper alignment and tolerances. To reduce the likelihood of plugging, each jet nozzle shall have a minimum intake and discharge diameter of 40 mm 1-1/2 inches. The manifold assembly shall be constructed of [fiberglass

reinforced plastic] [epoxy coated carbon steel] [_____]. The manifold shall be designed to withstand all normal stresses encountered in shipping, handling and operation.

2.7.2 Recirculation Pumps

****

NOTE: Select the applicable pump from the following paragraphs:

****

2.7.2.1 Vertical Propeller Pump

****

NOTE: Vertical propeller pump manufacturer design manuals should be consulted to determine spacing of pumps to avoid influence of the pump suctions.

Pumps should be identified on the drawings by a number. Insert the identification number in part b. of this paragraph; part b. should be repeated as necessary for pumps of the same type with different operating characteristics.

****

a. General: The pumping system shall be installed as indicated and be suitable for outdoor installation. The unit, consisting of vertical shaft, [single] [multistage] propeller type pump and motor shall be designed to operate safely in the reverse direction of rotation, due to water returning through the pump. The weight of the revolving parts of the pump, including the unbalanced hydraulic thrust of the propeller, shall be carried by a thrust bearing in the motor. The pump shall be supported from a base plate by means of a vertical column having horizontal discharge located below the base plate.

b. Pump Characteristics: Pump number(s) [_____] shall have the following operating characteristics:

(1) Pump Service.

(2) Design Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(3) Maximum Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(4) Minimum Operating Point: [_____] L/second gpm flow, [_____] mm feet head, [_____] percent efficiency.

(5) Propeller Type: [_____].

(6) Discharge Diameter: [_____] mm inch.

(7) Bell Diameter: [_____] mm inch.

(8) Column Length: [_____] mm feet.

(9) Operating Speed: [_____] rpm.

(10) Minimum Bell Submergence: [_____] mm inch.

(11) Pump Control: [_____].

c. Pump Column and Discharge Elbow: The pump supporting column shall be made of steel pipe with a minimum [6] [_____] mm [1/4] [_____] inch thickness. The discharge opening shall be flanged for connection to the discharge pipe. The discharge elbow shall be the long radius type, and shall be of [welded steel] [cast-iron].

d. Base Plate: The pumping unit shall be suspended from a base plate of adequate structural design to support the weight of the complete unit filled with water. The base plate shall be cast iron or steel and shall be sized to allow the entire pump to be removed, with the discharge flange attached; base plate mounting hardware shall be stainless steel. The packing box shall be located on or above the base plate to provide for easy maintenance. The motor shall be mounted above the pump.

e. Suction Bell and Impeller Housing: The suction bell and impeller housing shall be made of [ductile] [cast] iron [_____] and shall be designed for easy removal of the propeller and lower bearing. The suction bell shall have a flared inlet designed to reduce entrance loss and be provided with flanges to adequately support the lower bearing and support the weight of the propeller and propeller shaft.

f. Propeller: The pump propeller shall be constructed of [bronze] [_____] and shall be balanced statically and dynamically to reduce vibration and wear.

g. Propeller Shaft: The propeller shaft shall be sized to operate without objectionable distortion or vibration in both forward and reverse rotation. The propeller shaft shall be made of [stainless steel] [_____] and be direct coupled to the line shaft. The propeller shaft shall be adjustable with reference to the bowl. The line shaft shall be constructed of [carbon steel] [_____] and extend as one unit to the motor shaft. The line shaft shall be enclosed in a water-tight steel column.

h. Bearings: The pump shall have a [bronze] [_____] sleeve bearing immediately above the propeller, and a [bronze] [_____] lower support bearing below the propeller. For line shafts greater than 3 m 10 feet in length, [bronze] [_____] intermediate shaft bearings shall also be provided. The intermediate shaft bearings shall be inside the water-tight steel column. At the top of the line shaft, a [bronze] [_____] tension bearing with a tension nut and tension ring shall be included. All bearings shall be easily replaceable and shall be spaced to provide adequate support for the shaft and to prevent vibration. All bearings shall have an L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11.

i. Lubrication: The pump shall be equipped with an automatic lubricating system which shall supply grease lubricant to all but the lower support bearings. The lower support bearings shall be grease packed.

2.7.2.2 Submersible Centrifugal Pumps

The submersible centrifugal pumps used for the jet aeration system shall be in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.7.2.3 Self-Priming Centrifugal Pumps

The self-priming centrifugal pumps used for the jet aeration system shall be in accordance with Section 22 13 29 SANITARY SEWERAGE PUMPS.

2.7.2.4 Vertical Turbine Pumps

****
NOTE: Vertical turbine pump manufacturer design manuals should be consulted to determine spacing of pumps to avoid influence of the pump suctions.
****

The vertical turbine pumps used for the jet aeration system shall be in accordance with Section 23 21 23 HYDRONIC PUMPS.

2.7.2.5 Pump Suction Screens

A [stainless steel] [_____] screen shall be mounted to the suction of the pump. The screen shall allow nothing larger than 25 mm 1 inch in diameter to pass.

2.7.3 Blowers

The blowers shall be in accordance with Section 46 51 00.00 10 AIR AND GAS DIFFUSION EQUIPMENT.

2.8 DIFFUSED AERATION/SLOW SPEED MIXER SYSTEM

The diffused aeration/slow speed mixer system shall be furnished and installed as indicated. The system shall be complete and shall include air supply, distribution and diffuser equipment designed to satisfy the oxygen requirement, and the adequate number of submersible mixing units to create and maintain a horizontal velocity in the basin and maintain solids suspension. The air supply and distribution system shall include blowers, piping, valves, diffusers, supports and all necessary appurtenances to ensure proper operation of the equipment. The mixing units shall consist of a propeller driven by a [submersible electric motor] [hydraulic system], a support structure that allows the unit to be easily removed from the basin, and all cables and appurtenances necessary to ensure proper operation of the equipment. The combined system shall be designed for continuous operation.

2.8.1 Diffused Aeration System

The diffused aeration and blower system shall be as specified in Section 46 51 00.00 10 AIR AND GAS DIFFUSION EQUIPMENT.

2.8.2 Slow Speed Mixer (With Submersible Electric Motor)

****
NOTE: Designer will allow bids on either hydraulic motors or electric motors unless job requirements warrant eliminating one of the options.
****

All components of the mixer, including the motor, shall be capable of continuous underwater operation while the mixer blade is both completely

submerged or partly submerged. In addition, all components of the mixer, including motor, shall be capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.8.2.1 Mixer Propeller

The propeller shall be constructed of [ASTM A167, Type 304 stainless steel] [cast-iron] [molded fiberglass] [_____] and shaped so that no solids, fibrous material and other material found in normal wastewater applications will collect on the blades. The propeller shall be dynamically balanced to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and shall [be internally keyed for engagement with the shaft] [slide onto the shaft and be securely fastened with a screw washer and sleeve] [_____].

2.8.2.2 Drive System

Each mixer shall be a direct-driven, close-coupled, completely submersible unit. The mixer motor shall be a squirrel-cage induction, shell type design, housed in an air-filled, watertight chamber. The stator winding shall be insulated with moisture-resistant Class F insulation in accordance with NEMA MG 1 and shall be designed for continuous duty. The cable entry shall be an integral part of the stator casing and shall be leakproof. In addition, all mating surfaces where water tight sealing is required shall be machined and fitted with [nitrile] [_____] rubber O-rings.

2.8.2.3 Shafts and Seals

The mixer motor shaft shall be integral with the propeller shaft and shall rotate on two permanently lubricated bearings. The ball bearings shall have a minimum L-10 life of 100,000 hours as defined by ABMA 9 or ABMA 11. Each mixer shall be provided with a tandem mechanical rotating shaft seal system on the propeller shaft. Seals shall be of the lapped end face type and shall run in an oil reservoir. The inner seal shall contain one stationary and one positively driven rotating ceramic ring. The outer seal shall contain one stationary and one positively driven rotating tungsten carbide ring.

2.8.2.4 Mounting

The mixer shall be capable of being raised and lowered from the basin for ease of repair and maintenance. The mixer shall be mounted on and guided by a sliding bracket which shall be constructed to withstand all thrust created by the mixer. A lifting cable and winch mechanism shall be provided to permit raising and lowering of the mixer on the sliding bracket.

2.8.3 Slow Speed Mixer (With Hydraulic Motors)

Each hydraulic horizontal mixer shall consist of a hydraulic power unit and motor, a direct drive shaft and propeller, hydraulic lines, and all mounting and support brackets to provide for proper operation. In addition, all components of the mixer shall be capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.8.3.1 Mixer Propeller

The propeller shall be constructed of [cast-iron] [molded fiberglass]

[_____] and shaped so that no solids, fibrous material and other material found in normal wastewater applications will collect on the blades. The propeller shall be dynamically balanced to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and shall [be internally keyed for engagement with the shaft] [slide onto the shaft and be securely fastened with a screw washer and sleeve] [_____].

2.8.3.2 Drive System

a. Hydraulic Motor: The hydraulic motor shall be of the low speed, high torque, fixed displacement type to drive the propeller. The hydraulic motor shall be capable of withstanding end thrust loads of not less than 4.45 kN 1000 pounds either into or out from the motor. The hydraulic motor shall be rated for a B-10 life of not less than 100,000 hours in accordance with ABMA 9 or ABMA 11. The hydraulic motor shall be connected to the hydraulic pump with a hose having a continuous pressure rating of not less than 20.7 MPa 3000 psi.

b. Hydraulic Pump: The hydraulic pump shall be enclosed in the hydraulic reservoir which shall be mounted directly to the electric motor adapter. The hydraulic pump shall have a continuous pressure rating of not less than 13.8 MPa 2000 psi. The hydraulic fluid flow control mechanism shall be locking and fully adjustable to allow for infinitely variable speed control.

c. Reservoir and Accessories: The hydraulic reservoir shall be constructed of steel. The unit shall include a filler/breather assembly, and a fluid level/temperature gauge and clean-out cover. The hydraulic reservoir shall be connected to the hydraulic motor with a hose having a continuous pressure rating greater than the rating of the hydraulic pump but not less than 20.7 MPa 3000 psi.

2.8.3.3 Mounting

The mixer shall be capable of being raised and lowered from the basin for ease of repair and maintenance. The mixer shall be mounted on and guided by a sliding bracket which shall be constructed to withstand all thrust created by the mixer. A lifting cable and winch mechanism shall be provided to permit raising and lowering of the mixer on the sliding bracket.

2.9 LUBRICATION REQUIREMENTS

An adequate means of lubrication shall be provided for all moving parts subject to wear. Except as otherwise specified, lubrication shall be by grease or oil. Grease fittings shall be provided for all grease-type bearings. If bearings are not easily accessible, grease tubing shall be provided in a convenient location. Bearings shall be provided with relief ports to prevent build-up of pressures which might damage the bearings or seals. Oil reservoirs shall be liberal in size and shall be provided with an opening for filling, an overflow opening at the proper location to prevent overfilling, and a drain opening at the lowest point. Reservoirs shall be properly vented to prevent pressure build-up.

2.10 ELECTRIC MOTORS

A squirrel-cage induction motor suitable for continuous duty shall be used. The motor shall have a power rating which will be nonoverloading for any conditions under which the driven equipment must function.

2.10.1 Frame

The motor frame size shall be selected in accordance with NEMA MG 1. Motors of the same rating, mounting, and characteristics shall be interchangeable.

2.10.2 Design

Induction motors shall be Design B as defined in NEMA MG 1, with normal torque and low starting current.

2.10.3 Enclosure

A totally enclosed fan cooled enclosure shall be provided.

2.10.4 Terminal Boxes

Cast-iron terminal boxes shall be sized for the space required, for the allowable bending radius and stiffness of the motor supply cables, and for terminating a grounding conductor. The terminal boxes shall be gasketed and have threaded conduit entrances or hubs. Terminal boxes shall be rotatable for connection from any one of four directions at 90 degree intervals with a motor lead seal and separator gasket provided between the motor frame and terminal box.

2.10.5 Bearings

Grease lubricated, shielded, antifriction steel ball bearings shall be provided and greased with a moisture resistant grease. Grease fittings and excess grease purge plugs shall be readily accessible and shall be located externally so that bearing lubricant can be changed without removing fan housing or dismantling the motor.

2.10.6 Windings

Motor windings shall be nonhygroscopic, epoxy coated.

2.10.7 Motor Characteristics

Motor rotors shall receive a standard dynamic balance. The maximum amplitude (peak to peak) of motor vibration, as measured at the bearing housing, and the method of measurement shall be in accordance with NEMA MG 1. The motor characteristics such as wattage horsepower, speed, rpm, voltage and phase requirements and insulation class shall be as indicated.

2.10.8 Motor Controls

NEMA ICS 1.

2.11 SPECIAL TOOLS

One set of special tools, calibration devices, and instruments required for operation, calibration and maintenance of the equipment shall be provided.

PART 3 EXECUTION

3.1 EXAMINATION

Verify all dimensions in the field, and advise the Contracting Officer of any discrepancy in the contract documents before performing the work.

3.2 TREATMENT SYSTEM INSTALLATION

Submit drawings containing complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings showing proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances required for maintenance and operation. Piecemeal submittals will not be accepted.

Excavation, filling, and backfilling shall be in accordance with Section 31 00 00 EARTHWORK. Reinforced concrete, of the size and design indicated, shall be installed in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.1 Welding

Piping shall be welded in accordance with AWS D1.1/D1.1M by welders certified to have passed tests using procedures in accordance with AWS B2.1/B2.1M or ASME BPVC SEC IX. The welder or welding operator shall apply the assigned personal symbol near each weld made, as a permanent record. Structural members shall be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING. Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.

Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and the tests shall be performed at the work site if practicable.

3.2.2 Pipe and Valve Installation

Piping shall be installed with all joints tight and with no undue marring of finishes. Installed piping, valves, and fittings shall be free from strain and excessive stresses caused by weight or misalignment.

3.2.2.1 Flanged Joints

Bolts shall be tightened uniformly to prevent overstressing flanges and misalignment.

3.2.2.2 Screwed Joints

Screwed joints shall be made tight with joint compound, applied to the male threads only, or with joint tape.

3.2.2.3 Push-On Joints for PVC Pipe

Pipe ends shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. Gaskets shall be lubricated to

prevent displacement. Care shall be exercised to ensure that the gasket remains in proper position in the bell or coupling while joints are made.

3.2.2.4 Solvent-Weld Joints for PVC Pipe

Joints shall be made in accordance with the manufacturer's written instructions.

3.2.2.5 Valves

Valves shall be installed and located for easy access for operation.

3.2.3 Equipment Installation

Equipment installation shall be in accordance with the manufacturer's written instructions.

3.2.4 Electrical Work

Electrical work shall be in accordance with the applicable requirements of Section [_____].

3.3 PAINTING

All metal surfaces, except aluminum, bronze, brass, galvanized steel, and stainless steel shall be painted. Surface preparation and painting shall be performed in the field. Manufactured items, such as motors and switchboards, shall be finished with the manufacturer's standard finish.

3.3.1 Preparation and Application

Ferrous metal surfaces shall be prepared in accordance with SSPC SP 6/NACE No.3 and painted with a three coat MIL-DTL-24441 epoxy paint to achieve a total dry film thickness of 150 microns (6 mils). Master Painter's Institute (MPI) #120 Epoxy, High build, Self Priming, Low Gloss, may be substituted for MIL-DTL-24441.

3.3.2 Coating Examination

Coatings shall be examined for flaws and tested for thickness and holidays. Thickness of coatings shall be measured wet and dry using a commercial film thickness gauge. Notify the Contracting Officer in advance of any painting. Additional coats shall not be applied until the previous coat has been approved. Repair or additional coatings shall be accomplished at no additional cost to the government.

3.3.3 Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, repair shall consist of preparing the affected area in compliance with SSPC SP 6/NACE No.3 and reapplying the coating to that area. If holidays are detected or film thickness is insufficient, the surface shall be prepared and additional coats applied in the affected area in compliance with the manufacturer's instructions.

3.4 FRAMED INSTRUCTIONS

Submit approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control

sequence, framed under glass or in approved laminated plastic, for posting where directed. In addition, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems

3.5 FIELD TESTS AND INSPECTIONS

Water required for the field tests will be supplied. The Contracting Officer will witness all field tests and conduct field inspections. Give the Contracting Officer [14] [_____] days prior notice of the dates and times for acceptance tests. Any deficiencies found shall be rectified and work affected by such deficiencies shall be completely retested at the Contractor's expense.

3.5.1 Basin Leakage Test

After completion of the installation and as soon as practical, a leakage test shall be conducted on the CLR basin. The basin shall be filled with clean water and left standing for 24 hours. Basin leakage shall not exceed 25 mm 1 inch drop in water surface elevation in 24 hours. Any leaks encountered shall be repaired and the basin shall be retested. The basin shall be watertight prior to proceeding with the tests specified below.

3.5.2 Operating Tests

After completion of the installation and as soon as practical, an operating test of the CLR and all equipment shall be performed to demonstrate that the system functions properly. The tests shall include all manufacturer's recommended tests for equipment vibration, horizontal and vertical alignment and structural integrity. Wattage Horsepower [and air flow rates] shall be checked and verified with the manufacturer's design data for the specified equipment. Aerator wattage horsepower shall be nameplate plus or minus five percent. After completion of all tests, the system shall be adjusted for proper operation in accordance with the manufacturer's written instructions and the operating and maintenance instructions.

3.5.3 Velocity Test

After completion of the basin leakage and operating tests, a velocity test shall be conducted on the basin. Velocity cross-sections shall be taken at a distance of 3 m 10 feet upstream of the shaft centerline of each aerator. Each cross-section shall consist of a minimum of 16 velocity measurements equidistantly spaced so that the distance between measurement points does not exceed 1.2 m 4 feet vertically or horizontally. Measurement points shall begin at approximately 0.6 m 2 feet from walls. The average velocity at each cross-section shall not be less than 0.3 m/s 1.0 fps. Where average velocities are found to be less than that specified, make modifications to the system as needed to produce the required velocities at no extra cost to the Government.

3.5.4 Standard Oxygen Transfer Efficiency Test (S.O.T.E.)

After completion of the velocity test an S.O.T.E. test shall be performed. This test shall be in accordance with ASCE 2-06. The aeration system oxygenation capacity shall not be less than [1.4] [_____] kg [3]

[_____] pounds of oxygen per watt horsepower per hour with [_____] aeration units operating at a combined power draw of [_____] watts horsepower. The test shall be repeated in the same water until ten tests have been run or until the total dissolved solids (TDS) exceed 2000 mg/L. A minimum to maximum power curve shall be plotted from the results. Power input shall be based on wire power. Test shall be performed by a nationally recognized independent testing laboratory.

3.5.5 Reporting Test Results

Upon completion and testing of the installed system, submit test reports showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls. Reporting of results shall be in accordance with paragraph 9.0 "REPORTING" of ASCE 2-06.

3.6 MANUFACTURER'S SERVICES

3.6.1 Supervise Installation, Adjustment, and Testing

Obtain the services of the manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified to supervise the installation, adjustment and testing of the equipment in accordance with manufacturer's written instructions.

3.6.2 Field Training

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total [_____] hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the Operating and Maintenance Instructions, as well as demonstrations of routine maintenance operations. Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

3.7 OPERATING AND MAINTENANCE INSTRUCTIONS

Furnish instructions including the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. Instructions shall include, but not be limited to, the following:

a. System layout showing piping, valves, and controls.

b. Approved wiring and control diagrams.

c. A control sequence describing startup, operation, and shutdown.

d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts lists, and recommended spare parts.

f. Simplified diagrams for the system as installed.

-- End of Section --