Preparing Activity: USACE Superseding
UFGS-46 53 62 (February 2011)

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SECTION 46 53 62

CONTINUOUS LOOP REACTOR (CLR) WASTEWATER TREATMENT SYSTEM

05/21

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SECTION 46 53 62

CONTINUOUS LOOP REACTOR (CLR) WASTEWATER TREATMENT SYSTEM
05/21

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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	(2022) 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	(2021) Ductile-Iron and Gray-Iron Fittings
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	(2019) 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	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2022) 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	(2021) 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	(2020) 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; R 2021) 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	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA MG 1	(2021) 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 MAINTENANCE MATERIAL SUBMITTALS

1.3.1 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.

1.4 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.

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.

Continuous loop reactors can take on many shapes (racetrack, folded U, concentric multi-channel, etc.) and configurations (serus, parallel, etc.). The designer is required to consider these options for space limitations, construction cost considerations, maintenane cost considerations, etc.

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 specified is a modified form of the activated sludge process and classified as an extended aeration system. The basin is to be constructed of an [earthen channel with an impervious sprayed concrete surface] [reinforced concrete structure], constructed at the depth and configuration indicated. The basin includes 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 is accomplished by contact with the waste activated sludge in the CLR for a minimum of [18] [_____] hours. Size the CLR for an average daily flow of [_____] L/second mgd and a peak daily flow of [_____] L/second mgd. The CLR is required to 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 provides the propelling force for circulation and mixing of the basin contents. Size the aeration/mixing unit(s) 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.

****

Base the aeration/mixing system selected 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.

Select the aeration/mixing system to provide no less than [_____] mg oxygen/joule lb. oxygen/hp-hr under standard (clean water) conditions [and to 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

Provide 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. Ensure all aeration/mixing equipment, associated accessories, and appurtenances is supplied by the same manufacturer. Ensure equipment is 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

Completely enclose, chains, couplings, and other moving parts by use of guards to prevent accidental personal injury. Configure guards to be removable or so arranged as to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, ensure housing provides sufficient protection and no additional guards are necessary.

2.3 EQUIPMENT

2.3.1 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.

****

2.3.1.1 Aeration Mechanism

Provide the [disc] [or] [rotor] aeration system as indicated. Provide complete units 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. Design the [disc] [or] [rotor] aeration system for continuous operation.

2.3.1.1.1 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.

****

Provide each assembly with individually molded [plastic] [fiberglass] discs, [_____] mm inch in diameter and mounted not less than 150 mm 6 inch on center. Provide the number and spacing of disc assemblies indicated. Secure the disc assemblies to the shaft with a clamp ring, by using a keyed shaft or by another method to hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. Split the discs into two sections for attachment or removal without disassembling the shafting. Supply stainless steel positioning bolts to hold the two halves together on the shaft.

2.3.1.1.2 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 consists of [12] [_____] individual or six dual [stainless steel] [plastic] [epoxy coated steel] [hot-dipped galvanized steel] blades, [_____] mm inch in diameter mounted not less than 150 mm 6 inch on center. Provide the number and spacing of rotor assemblies indicated. Secure the blade assemblies 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 to hold the assembly tightly, ensure no slippage, and provide continuous proper alignment. Provide the blades so they are removable by unbolting. Welding blades to the shaft is not allowed.

2.3.1.1.3 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.

2.3.1.1.4 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.
****

Mount fabricated [steel] [aluminum] [stainless steel] plates in the vertical concrete walls at the drive assembly and outboard bearings and bolt to the frames as indicated. Ensure the opening in the wall formed by the splash plate is of sufficient width for removal of shafts. Where the shaft passes through the splash plates, provide a rubber gasket seal on both sides to seal water from the service area.

2.3.1.1.5 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 [operate disc with a minimum immersion of [300] [_____] mm [12] [_____] inch and a maximum immersion of [535] [_____] mm [21] [_____] inch] [operate rotor blades with a minimum immersion of [100] [_____] mm [4] [_____] inch and a maximum immersion of [355] [_____] mm [14] [_____] inch].

2.3.1.1.6 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.

****

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

2.3.1.1.7 Protective Covering

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

2.3.1.2 Drive System

2.3.1.2.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the [disc] [or] [rotor] assembly. Design the unit 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. Design the unit to also withstand all external loadings produced by torque, out-of-balance and vibration resulting from operating conditions. Provide a speed reducer with lifting lugs. Vent the interior of the gear case by use of an approved breather, constructed to retard the entrance of water vapor.

2.3.1.2.2 Housing

Construct drive to be weatherproof and made of steel in accordance with ASTM A36/A36M or high grade cast-iron in accordance with ASTM A48/A48M. Apply a protective coating that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.3.1.2.3 Rating

Provide drive gearing with a minimum service factor of at least [1.4] [_____] times the rated brake horsepower of the drive motor. Ensure gear reduction system is 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.

2.3.1.2.4 Bearings

Provide power transmission bearings that are of the antifriction type and

have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings are fully sealed and protected from water spray.

2.3.1.2.5 Lubrication

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

a. Provide lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide the drive with an oil "dam", spring loaded lip seals or other means of positive protection against lubricant leakage around the output shaft. Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceeds the design load or provide proper cooling.

b. Ensure lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.1.2.6 Couplings

Transmit power from the motor to the gear reduction system by means of [a flexible coupling, direct drive of the non-lubricated type, manufacturer's standard, selected to provide a minimum service factor of 2.0] [sheaves and [V-belts] [chains]. To reduce the output speed, provide removable sheaves.] Cover the assembly with a suitable guard and protect from splashing.

2.3.1.3 Mounting

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

2.3.2 Low Speed Surface Aerators

Furnish and install low speed mechanical surface aerators as indicated. Ensure each supplied unit is 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. Design the aerators for continuous operation.

2.3.2.1 Impeller Shaft

Construct the shaft of [carbon steel] [_____] and size to withstand all torque loads and bending moments produced by operation of the system. Design the shaft and bearing assembly to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. Ensure the shaft is constructed so its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. Ensure the shaft supporting the impeller is removable from the drive assembly, without disassembly of the gear box. Use rolling, antifriction type bearings on the impeller shaft which have a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or

ABMA 11. Support the entire weight of the shaft and impeller by a thrust bearing integral with the gear reducer. Use a rigid coupling to connect the shaft and turbine assembly to the output shaft of the reducer. Provide bearings on the shaft that are either grease or oil lubricated, and are positively sealed against penetration of moisture, or leakage of lubricant down the shaft. Include provisions for checking the adequacy of lubrication.

2.3.2.2 Impeller

Construct the impeller of [carbon steel] [_____] and positively fasten it to the shaft with all [carbon steel] [_____] hardware. Provide means for adjustment of the impeller. If the adjustment is on the shaft, provide means to prevent the impeller from dropping off the shaft during adjustment. Impeller submergence to ensure the most efficient operation of the aeration system.

2.3.2.3 Drive System

2.3.2.3.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. Design the unit 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. Design the unit to also withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating conditions. Provide the speed reducer with lifting lugs. Vent the interior of the gear case by means of an approved breather, constructed to retard the entrance of water vapor.

2.3.2.3.2 Housing

Construct the drive housing to be waterproof and made of steel in accordance with ASTM A36/A36M or high grade cast-iron conforming to ASTM A48/A48M. Apply a protective coating that will not peel, crack or discolor at continuous operating temperatures up to 121 degrees C 250 degrees F.

2.3.2.3.3 Rating

Provide gearing with a minimum service factor of at least [2.5] [_____] times the rated brake horsepower of the drive motor. Ensure the gear reduction system is 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.

2.3.2.3.4 Bearings

Use power transmission bearings of the antifriction type which have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings are fully sealed and protected from water spray.

2.3.2.3.5 Lubrication

****

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

****

a. Provide for lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide drive with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft. Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceeds the design load. If this is not the case, then provide a proper means of cooling.

b. Ensure lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.2.3.6 Couplings

Transmit power from the motor to the gear reduction system by a non-lubricated coupling which is direct driven. Use manufacturer's standard couplings selected to provide a minimum service factor of 2.0.

2.3.2.4 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.

****

Construct a [structural bridge of steel conforming to ASTM A36/A36M] [concrete bridge] and support assembly designed to mount each aeration unit as indicated. Structurally anchor the bridge assembly to the basin walls. To ensure the most efficient operation of the aeration system, mount the aerator with the top of the impeller blades [50] [_____] mm [2] [_____] inch above the minimum water surface elevation. Ensure the blades are not submerged more than [200] [_____] mm [8] [_____] inch at the maximum water surface elevation.

2.3.2.5 Protective Covering

The manufacturer is required to supply an [ultraviolet light protected fiberglass] [_____] cover for each aeration unit. Design the cover to protect all adjacent structures from splashing caused by the unit. Mount the cover independent of the aeration equipment and be install it in accordance with the manufacturer's requirements.

2.3.3 Submerged Turbine Draft Tube Aerators

Furnish and install the submerged turbine draft tube aeration system as indicated. Provide the unit complete to include blowers, drive unit, turbine aerator unit and supports, draft tube assembly, and all appurtenances necessary for the proper operation of the equipment. Design the aerators for continuous operation.

2.3.3.1 Impeller Shaft

Construct the shaft of [carbon steel] [_____] and size it to withstand all

torque loads and bending moments produced by operation of the system. Design the shaft and bearing assembly to allow operation below 80 percent of its natural frequency without the use of stabilizing devices. Construct the shaft so that its deflection will not affect the alignment of the antifriction bearings or cause misalignment of the gearing during the mixing/aeration operation. Ensure the shaft supporting the impeller is removable from the drive assembly, without disassembly of the gear box. Use rolling, antifriction type bearings on the impeller shaft with a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11. Support the entire weight of the shaft and turbine by means of a thrust bearing installed integrally with the gear reducer. Use a rigid coupling to connect the shaft and turbine assembly to the output shaft of the reducer. Provide bearings on the shaft that are either grease or oil lubricated and are positively sealed against penetration of moisture or leakage of lubricant down the shaft. Provide means for checking the adequacy of lubrication.

2.3.3.2 Impeller

Construct the impeller of [carbon steel] [_____] and positively fasten it to the shaft with all [carbon steel] [_____] hardware. The impeller is required to be removable from the shaft. Means for adjustment of the impeller. If the adjustment is on the shaft, provide a means to prevent the impeller from dropping off the shaft during adjustment.

2.3.3.3 Drive System

2.3.3.3.1 Reducer

Construct the drive system reducer to maintain alignment of bearings and gearing while absorbing the external loads of the impeller. Design the unit 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. Design the unit to withstand all external loadings produced by torque, thrust, out-of-balance and vibration resulting from operating conditions. Provide lifting lugs with the speed reducer. Vent the interior of the gear case using an approved breather, constructed to retard the entrance of water vapor.

2.3.3.3.2 Housing

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

2.3.3.3.3 Rating

Ensure the gearing has a minimum service factor of at least [2.0] [_____] times the rated brake horsepower of the drive motor. Ensure the gear reduction system is 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.

2.3.3.3.4 Bearings

Provide power transmission bearings that are antifriction type and have a minimum L-10 life of 100,000 hours at maximum operating speed in accordance with ABMA 9 or ABMA 11. Ensure bearings used are fully sealed

and protected from water spray.

2.3.3.3.5 Lubrication

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

a. Provide lubrication by [gears running in an oil bath] [an oil slinger] [pumps]. Provide drive with an oil "dam" or other means of positive protection against lubricant leakage around the output shaft. Also provide an oil level gauge or sight glass and drain fittings. Ensure the thermal rating of the gear reducer exceed the design load or provide proper cooling.

b. Ensure all lubricating pumps are removable for maintenance without disassembly of the drive and/or removal of the motor. Provide either a low pressure or low oil level switch to shut off the unit in the event of insufficient lubrication.

2.3.3.3.6 Couplings

Transmit power from the motor to the gear reduction system by using a non-lubricated coupling, direct driven. Ensure all couplings are the manufacturer's standard and select to provide a minimum service factor of 2.0.

2.3.3.4 Draft Tube

Each draft tube consists of upper and lower sections of epoxy coated steel. The upper section consists 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 is required to be [_____] mm feet long, sufficient to carry the design flow with minimal pressure drop. Shape bottom section to carry the wastewater to a sufficient depth to dissolve the required oxygen and direct the flow forward in the channel. The draft tube is required to be [_____] mm inch in diameter with a 6 mm 1/4 inch minimum wall thickness, and equipped with grout rings as shown.

2.3.3.5 Mounting

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

2.3.3.6 Air Supply Equipment

Provide blower(s) that conform to Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.4 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.

****

Provide the jet aeration system as indicated. The system includes air-liquid jet manifolds, [vertical propeller] [submerged centrifugal] pumps, pneumatic backflush system, air blowers, and all in-basin air and

liquid piping and supports. Design the jet aeration system for continuous operation.

2.3.4.1 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 consists of [fiberglass reinforced plastic] [_____] jet nozzles, oriented in a common direction and attached to a common manifold. The manifold consists 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 is required to provide uniform distribution of mixed liquor from the inlet of the manifold to each of the jets. The jets consist of 2 nozzles and a mixing chamber constructed integrally with the manifold. The primary jet directs the mixed liquor into the mixing chamber where air is introduced and combined with the liquid. The air-liquid mixture then discharges into the secondary nozzle and, hence horizontally into the basin. Carefully mold the two nozzles to maintain proper alignment and tolerances. To reduce the likelihood of plugging, each jet nozzle has a minimum intake and discharge diameter of 40 mm 1-1/2 inches. Construct the manifold assembly of [fiberglass reinforced plastic] [epoxy coated carbon steel] [_____]. Design the manifold to withstand all normal stresses encountered in shipping, handling and operation.

2.3.4.2 Recirculation Pumps

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NOTE: Select the applicable pump from the following paragraphs:

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2.3.4.2.1 Vertical Propeller Pump

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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: Install the pumping system as indicated and ensure it is suitable for outdoor installation. Design the unit, consisting of

vertical shaft, [single] [multistage] propeller type pump and motor to operate safely in the reverse direction of rotation, due to water returning through the pump. Carry the weight of the revolving parts of the pump, including the unbalanced hydraulic thrust of the propeller, by means of a thrust bearing in the motor. Support the pump from a base plate by means of a vertical column having horizontal discharge located below the base plate.

b. Pump Characteristics: Provide pump number(s) [_____] having 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: Construct the pump supporting column of steel pipe with a minimum [6] [_____] mm [1/4] [_____] inch thickness. Use a flanged discharge opening for connection to the discharge pipe. Use long radius discharge elbows made of [welded steel] [cast-iron].

d. Base Plate: Suspend the pumping unit from a base plate of adequate structural design to support the weight of the complete unit filled with water. Fabricate the base plate of cast iron or steel and size to allow the entire pump to be removed, with the discharge flange attached. Use stainless steel base plate mounting hardware. Locate the packing box on or above the base plate to provide for easy maintenance. Mount the motor above the pump.

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

f. Propeller: Construct the pump propeller using [bronze] [_____] and balance propeller statically and dynamically to reduce vibration and

wear.

g. Propeller Shaft: Size the propeller shaft to operate without objectionable distortion or vibration in both forward and reverse rotation. Fabricate the propeller shaft using [stainless steel] [_____] and direct couple propeller shaft to the line shaft. Ensure the propeller shaft is adjustable with reference to the bowl. Construct the line shaft of [carbon steel] [_____] and extend as one unit to the motor shaft. Enclose the line shaft in a water-tight steel column.

h. Bearings: Ensure the pump is equipped with 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, also provide [bronze] [_____] intermediate shaft bearings. Install the intermediate shaft bearings inside the water-tight steel column. At the top of the line shaft, include a [bronze] [_____] tension bearing with a tension nut and tension ring. Ensure all bearings are easily replaceable and spaced to provide adequate support for the shaft and to prevent vibration. Use bearings with an L-10 life of 100,000 hours in accordance with ABMA 9 or ABMA 11.

i. Lubrication: Equip the pump with an automatic lubricating system which supplies grease lubricant to all but the lower support bearings. Grease pack the lower support bearings.

2.3.4.2.2 Submersible Centrifugal Pumps

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

2.3.4.2.3 Self-Priming Centrifugal Pumps

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

2.3.4.2.4 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.
****

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

2.3.4.2.5 Pump Suction Screens

Mount a [stainless steel] [_____] screen to the suction of the pump. Provide a screen sized to ensure nothing larger than 25 mm 1 inch in diameter to pass.

2.3.4.3 Blowers

Provide blowers in accordance with Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.5 Diffused Aeration/Slow Speed Mixer System

Furnish and install the diffused aeration/slow speed mixer system as indicated. Provide a complete system including 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 includes blowers, piping, valves, diffusers, supports and all necessary appurtenances to ensure proper operation of the equipment. The mixing units 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. Design the combined system for continuous operation.

2.3.5.1 Diffused Aeration System

Provide the diffused aeration and blower system as specified in Section 46 51 00.00 10 AIR AND GAS DIFFUSION SYSTEM.

2.3.5.2 Slow Speed Mixer (With Submersible Electric Motor)

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

Ensure all components of the mixer, including the motor, are capable of continuous underwater operation while the mixer blade is either completely submerged or partly submerged. In addition, ensure all components of the mixer, including motor, are capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.3.5.2.1 Mixer Propeller

Construct the propeller of [ASTM A167, Type 304 stainless steel] [cast-iron] [molded fiberglass] [_____] and shape so that no solids, fibrous material and other material found in normal wastewater applications collects on the blades. Dynamically balance the propeller to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and [internally key it for engagement with the shaft] [ensure it slides onto the shaft and is securely fastened with a screw washer and sleeve] [_____].

2.3.5.2.2 Drive System

Provide each mixer be direct-driven, close-coupled, completely submersible units. Use mixer motors that are squirrel-cage induction, shell type design, housed in an air-filled, watertight chamber. Insulate the stator winding with moisture-resistant Class F insulation in accordance with NEMA MG 1 and design for continuous duty. Ensure the cable entry is an integral part of the stator casing and is leakproof. In addition, machine all mating surfaces where water tight sealing is required and fit with [nitrile] [_____] rubber O-rings.

2.3.5.2.3 Shafts and Seals

Ensure the mixer motor shaft is integral with the propeller shaft and rotates on two permanently lubricated bearings. Provide ball bearings

with a minimum L-10 life of 100,000 hours as defined by ABMA 9 or ABMA 11. Provide each mixer with a tandem mechanical rotating shaft seal system on the propeller shaft. Provide lapped end face type seals and run them in an oil reservoir. The inner seal is required to contain one stationary and one positively driven rotating ceramic ring. The outer seal is required to contain one stationary and one positively driven rotating tungsten carbide ring.

2.3.5.2.4 Mounting

Configure mixer capable of being raised and lowered from the basin for ease of repair and maintenance. Mount the mixer on and guide by a sliding bracket constructed to withstand all thrust created by the mixer. Provide a lifting cable and winch mechanism to permit raising and lowering of the mixer on the sliding bracket.

2.3.5.3 Slow Speed Mixer (With Hydraulic Motors)

Each hydraulic horizontal mixer consists 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 are required to capable of continuous operation in air, completely unsubmerged, for a minimum of [2] [_____] hours.

2.3.5.3.1 Mixer Propeller

Construct the propeller of [cast-iron] [molded fiberglass] [_____] and shaped so that no solids, fibrous material and other material found in normal wastewater applications collects on the blades. Dynamically balance the propeller to [5.3] [_____] N/meter [0.03] [_____] pounds/inch and [internally key it for engagement with the shaft] [ensure it slides onto the shaft and is securely fastened with a screw washer and sleeve] [_____].

2.3.5.3.2 Drive System

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

b. Hydraulic Pump: Enclose the hydraulic pump in the hydraulic reservoir and mount directly to the electric motor adapter. Ensure the hydraulic pump has a continuous pressure rating of not less than 13.8 MPa 2000 psi. Ensure the hydraulic fluid flow control mechanism lock and is fully adjustable to allow for infinitely variable speed control.

c. Reservoir and Accessories: Construct the hydraulic reservoir of steel. Include a filler/breather assembly, and a fluid level/temperature gauge and clean-out cover. Connect the hydraulic reservoir 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.

2.3.5.3.3 Mounting

Provide mixer capable of being raised and lowered from the basin for ease of repair and maintenance. Mount the mixer on and guide by a sliding bracket constructed to withstand all thrust created by the mixer. Provide a lifting cable and winch mechanism to permit raising and lowering of the mixer on the sliding bracket.

2.3.6 Lubrication Requirements

Provide an adequate means of lubrication for all moving parts subject to wear. Except as otherwise specified, lubricate using grease or oil. Provide grease fittings for all grease-type bearings. If bearings are not easily accessible, provide grease tubing in a convenient location. Provide bearings with relief ports to prevent build-up of pressures which might damage the bearings or seals. Size oil reservoirs liberally and provide with an opening for filling, an overflow opening at the proper location to prevent overfilling, and a drain opening at the lowest point. Vent reservoirs to prevent pressure build-up.

2.3.7 Electric Motors

Utilize a squirrel-cage induction motor suitable for continuous duty. Provide motor with a non-overloading power rating for any conditions under which the driven equipment function.

2.3.7.1 Frame

Select the motor frame size in accordance with NEMA MG 1. Ensure that motors of the same rating, mounting, and characteristics are interchangeable.

2.3.7.2 Design

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

2.3.7.3 Enclosure

Provide a totally enclosed fan cooled enclosure.

2.3.7.4 Terminal Boxes

Size cast-iron terminal boxes for the space required, for the allowable bending radius and stiffness of the motor supply cables, and for terminating a grounding conductor. Provide gaskets for the terminal boxes and threaded conduit entrances or hubs. Ensure terminal boxes are 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.

2.3.7.5 Bearings

Provide grease lubricated, shielded, antifriction steel ball bearings and grease with a moisture resistant grease. Ensure all grease fittings and excess grease purge plugs are readily accessible and locate externally so that bearing lubricant can be changed without removing fan housing or dismantling the motor.

2.3.7.6 Windings

Provide nonhygroscopic, epoxy coated motor windings.

2.3.7.7 Motor Characteristics

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

2.3.7.8 Motor Controls

NEMA ICS 1.

2.3.8 Special Tools

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

2.4 MATERIALS

Ensure materials and equipment conform to the following requirements.

2.4.1 Steel Plates, Shapes and Bars

ASTM A36/A36M.

2.4.2 Pipe

Furnish and install piping as indicated and ensure it is in accordance with the applicable standard specification.

2.4.2.1 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.

2.4.2.2 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: Provide bituminous coating on all buried piping.

2.4.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings

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

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

b. Solvent Cement: ASTM D2564.

2.4.3 Pipe Hangers and Supports

MSS SP-58.

2.4.4 Valves

2.4.4.1 Gate Valves

Gate valves are required to withstand a working pressure of not less than 1.03 MPa 150 psi. Ensure valves have a clear waterway equal to the full diameter of the valve, and are opened by turning counterclockwise. On operating nut or wheel handle, provide an arrow, cast in metal, indicating the direction of opening. For valves used for buried service, provide with non-rising stem (NRS), 50 mm 2 inch square nut operated with joints applicable to the pipe or installation. Furnish buried valves with extension stems comprised of socket, extension stem and operating nut, that are long enough to bring operating nut to within 150 mm 6 inch of grade. Furnish one 1.2 m 4 foot "T" handle valve wrench for each quantity of six buried valves. For gate valves which are exposed or installed inside, provide outside screw and yoke (OS&Y), handwheel operated with flanged ends unless otherwise indicated. Flanges are not to be buried. Provide a approved pit for all flanged connections.

a. Valves smaller than 75 mm 3 inch are required to be all bronze conforming to MSS SP-80, Type 1, Class 150.

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

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

2.4.4.2 Plug Valves

Plug valves are required to be eccentric type capable of withstanding a minimum working pressure of 1.03 MPa 150 psi. Provide flange valve conforming to ASME B16.1, Class 125. Provide mechanical or push-on type rubber gasket joint ends conforming to AWWA C110/A21.10 and AWWA C111/A21.11. Ensure port area for valves is at least 80 percent of full pipe area. Valve bodies, plugs or discs, seats, shafts, shaft seals and actuators are required to conform to AWWA C504. Valves are required to open counterclockwise and the operating nut or wheel have an arrow, cast in metal, indicating the direction of opening. Ensure valves meet all performance, leakage, and hydrostatic tests 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.

2.4.4.3 Check Valves

Check valves are required to permit free flow of sewage forward and provide a positive check against backflow. Check valves are required to withstand a minimum working pressure of 1.03 MPa 150 psi or as indicated. Provide iron body check valves. Directly cast on the body the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow. Flanges are required to be the 56 kg 125 pound type complying with ASME B16.1.

a. Provide ball check valves with flanged or threaded ends and the non-slam type. Construct ball of stainless steel unless otherwise specified.

b. Ensure swing check valves comply with AWWA C508, are bronze mounted, and have flanged ends. Equip check valves with [outside lever and spring] [_____].

2.4.5 Joint Compound

For joint compound for threaded joints, use a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

2.4.6 Joint Tape

Ensure joint tape for threaded joints complies with ASTM D3308.

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 functions as a unit. Drawings are to show the proposed layout and anchorage of equipment in appurtenances and equipment relationship to other parts of the work including clearances required for maintenance and operation. Submit all submittals for this system at the same time. It is not acceptable to

piecemeal submittals.

Perform all excavation, filling, and backfilling in accordance with Section 31 00 00 EARTHWORK. Install reinforced concrete, of the size and design indicated, in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.1 Welding

Weld piping in accordance with AWS D1.1/D1.1M using welders certified to have passed tests using procedures in accordance with AWS B2.1/B2.1M or ASME BPVC SEC IX. Ensure the welder or welding operator applies the assigned personal symbol near each weld made, as a permanent record. Weld structural members 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 perform the tests at the work site if practicable.

3.2.2 Pipe and Valve Installation

Install piping with all joints tight and with no undue marring of finishes. Ensure installed piping, valves, and fittings is free from strain and excessive stresses caused by weight or misalignment.

3.2.2.1 Flanged Joints

Tighten bolts uniformly to prevent overstressing flanges and misalignment.

3.2.2.2 Screwed Joints

Make screwed joints tight with joint compound, applied to the male threads only, or with joint tape.

3.2.2.3 Push-On Joints for PVC Pipe

Bevel pipe ends to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate gaskets to prevent displacement. Exercise care 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

Weld joints in accordance with the manufacturer's written instructions.

3.2.2.5 Valves

Installed and locate valves for easy access for operation.

3.2.3 Equipment Installation

Install equipment in accordance with the manufacturer's written instructions.

3.2.4 Electrical Work

Perform electrical work in accordance with the applicable requirements of Section [_____].

3.2.5 Painting

Paint all metal surfaces, except aluminum, bronze, brass, galvanized steel, and stainless steel. Perform surface preparation and painting in the field. Finish manufactured items, such as motors and switchboards, per with the manufacturer's standard finish.

3.2.5.1 Preparation and Application

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

3.2.5.2 Coating Examination

Examine all coatings for flaws and test for thickness and holidays. Measure the thickness of coatings wet and dry using a commercial film thickness gauge. Notify the Contracting Officer in advance of any painting. Do not apply additional coats until the previous coat has been approved. Perform all repair or additional coatings at no additional cost to the government.

3.2.5.3 Coating Repair

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

3.3 FIELD QUALITY CONTROL

3.3.1 Field Tests And Inspections

Supply water required for the field tests. Give the Contracting Officer [14] [_____] days prior notice of the dates and times for acceptance tests to allow the Contracting Officer the ability to witness all field tests. Rectify any deficiencies found. All work affected by such deficiencies required to be completely retested at the Contractor's expense.

3.3.1.1 Basin Leakage Test

After completion of the installation and as soon as practical, conduct a leakage test on the CLR basin. Fill the basin with clean water and leave standing for 24 hours. Basin leakage is not allowed to exceed 25 mm 1 inch drop in water surface elevation in 24 hours. Repair leaks encountered and retest the basin. Ensure the basin is watertight prior to proceeding with the tests specified below.

3.3.1.2 Operating Tests

After completion of the installation and as soon as practical, perform an operating test of the CLR and all equipment to demonstrate that the system functions properly. Include all manufacturer's recommended tests for equipment vibration, horizontal and vertical alignment and structural integrity. Check and verify wattage horsepower [and air flow rates] against the manufacturer's design data for the specified equipment. Ensure the aerator wattage horsepower meets nameplate plus or minus five percent. After completion of all tests, adjust the system for proper operation in accordance with the manufacturer's written instructions and the operating and maintenance instructions.

3.3.1.3 Velocity Test

After completion of the basin leakage and operating tests, conduct a velocity test on the basin. Record velocity cross-sections at a distance of 3 m 10 feet upstream of the shaft centerline of each aerator. Cross-sections 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. Begin measurement points at approximately 0.6 m 2 feet from walls. The average velocity at each cross-section is not to 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.

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

After completion of the velocity test, perform an S.O.T.E. test in accordance with ASCE 2-06. The aeration system oxygenation capacity is not allowed to 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. Repeat tests in the same water until ten tests have been run or until the total dissolved solids (TDS) exceed 2000 mg/L. Plot a minimum to maximum power curve from the results. Base power input on wire power. Use a nationally recognized independent testing laboratory for all tests.

3.3.1.5 Reporting Test Results

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

3.3.2 Manufacturer's Services

3.3.2.1 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.

3.3.2.2 Field Training

Conduct a training course for the operating staff as designated by the

Contracting Officer. Provide a training period consisting of a total of [_____] hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Ensure all field instruction covers all of the items contained in the Operating and Maintenance Instructions, as well as demonstrations of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to date of proposed conduction of the training course.

3.4 CLOSEOUT ACTIVITIES

3.4.1 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, prepare in typed form 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. Frame as specified above for the wiring and control diagrams and post beside the diagrams. Post the framed instructions before acceptance testing of the systems

3.4.2 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. Permanently bind each set and include a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number. Ensure information includes, but is not necessarily 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 --