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USACE / NAVFAC / AFCEC **UFGS-46 43 21 (February 2020)**

Preparing Activity: NAVFAC **Superseding**
UFGS-46 43 21 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025
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SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 43 21

CIRCULAR CLARIFIER EQUIPMENT

02/20

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 ADMINISTRATIVE REQUIREMENTS
1.3.1 Pre-Installation Meetings
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 WARRANTY

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION
2.1.1 Circular Clarifier
2.1.1.1 Shop Drawings
2.1.2 Clarifier Mechanism Design Requirements
2.1.2.1 Design
2.2 EQUIPMENT
2.2.1 Sludge Collector Assembly
2.2.1.1 Scraper Arms, Blades & Squeegees
2.2.1.2 Center Drive Cage or Drum
2.2.1.3 Center Shaft
2.2.1.4 Rapid Sludge Removal System & Piping
2.2.2 Drive Assembly
2.2.2.1 Motor
2.2.2.2 Speed Reduction and Turntable Gearing
2.2.2.2.1 Gear Lubrication
2.2.2.3 Gearmotor
2.2.2.4 Turntable Bearing Assembly
2.2.2.5 Drive Assembly Bearings
2.2.2.6 Chain Drives and Belt Drives
2.2.3 Scum Removal
2.2.3.1 Skimmer Assembly
2.2.3.2 Scum Trough
2.2.3.3 Scum Removal Assembly

2.2.4 Center Column
2.2.5 Effluent Trough and Weir Assembly
2.3 MANUFACTURED UNITS
2.3.1 Access Bridge, Walkway, and Operating Platform
2.3.2 Supporting Bridge
2.3.3 Influent Well
2.3.4 Influent Skirt
2.4 COMPONENTS
2.4.1 Electrical Control System
2.4.1.1 Circuit Breakers
2.4.1.2 Motor Starter [, Contactors,] and Pushbutton Station
2.4.1.3 Overload Protection and Alarm Device
2.4.1.4 Wiring
2.4.2 Lubrication
2.4.3 Key Mounted Connections
2.4.4 Weir Plates and Scum Baffles
2.5 MATERIALS
2.5.1 Clarifier Piping Connections
2.5.1.1 Pipe and Fittings
2.5.2 Anchor and Connecting Bolts, Nuts, and Washers
2.5.3 Grout Materials
2.5.4 Materials Protection
2.6 ACCESSORIES
2.6.1 Spare Parts
2.6.2 Tools

PART 3 EXECUTION

3.1 EXAMINATION
3.1.1 General
3.2 PREPARATION
3.2.1 Surfacing of Clarifier Tank Floor
3.3 INSTALLATION
3.3.1 Piping
3.3.2 Weirs
3.4 FIELD QUALITY CONTROL
3.4.1 General
3.4.2 Tests
3.4.3 Repair Painting
3.4.4 Manufacturer Field Service
3.5 CLOSEOUT ACTIVITIES
3.5.1 System Operation

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC | **UFGS-46 43 21 (February 2020)**

Preparing Activity: NAVFAC | **Superseding UFGS-46 43 21 (February 2011)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025

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SECTION 46 43 21

CIRCULAR CLARIFIER EQUIPMENT
02/20

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This guide specification covers the requirements for circular clarifiers for use in Water Resource Recovery Facilities (WRRFs). This guide specification may be used to prepare specifications for either primary or secondary clarifiers for the treatment of domestic wastewater only. Special consideration must be given to wastewater containing industrial wastes.

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).

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NOTE: Show the following on the project drawings or provide:

1. Type of clarifier: primary or secondary

2. Dimensions of clarifier tank

3. Whether clarifier is a center feed with peripheral overflow type or a peripheral feed with center overflow type

4. Whether influent enters through side of tank or through center column when clarifier is center feed with peripheral overflow type

5. Whether rapid sludge removal system is to be used and the number and size of the sludge uptake pipes

6. Size of influent well when clarifier is a center feed with peripheral overflow type

7. Size and section of effluent trough when clarifier is a peripheral feed with center overflow type

8. Size and section of weirs and baffles; and anchorage details

9. Sizes of piping, points of connection to plant piping, and types of joints for wall castings and sleeves

This guide specification may be used to prepare specifications for either primary or secondary clarifiers.

****

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; R 2020) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
AGMA 2011	(2014B) Cylindrical Wormgearing Tolerance and Inspection Methods
AGMA 2015/915-1	(2002A) Accuracy Classification System - Tangential Measurement Tolerance Tables for Cylindrical Gears
AGMA 9002	(2014C) Bores and Keyways for Flexible Couplings (Inch Series)
AGMA ISO 10064-6	(2010A) Code of Inspection Practice - Part 6: Bevel Gear Measurement Methods
AGMA ISO 17485	(2008A; Supplement 2008) Bevel Gears - ISO System of Accuracy (Including Supplement - Tolerance Tables 2008)
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6034	(1992B; R 2010) Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)
ANSI/AGMA 9000	(2011D) Flexible Couplings - Potential Unbalance Classification

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B17.1	(1967; R 2017) Keys and Keyseats
ASME B17.2	(1967; R 2017) Woodruff Keys and Keyseats

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2023) Rubber-Gasket Joints for

	Ductile-Iron Pressure Pipe and Fittings
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2023; ERTA 1 2024; TIA 24-1) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

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 and Air Force projects.

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

****

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

SD-02 Shop Drawings

Circular Clarifier System; G, [_____]

SD-03 Product Data

Clarifier Mechanism; G, [_____]

Grout Materials; G, [_____]

Electrical Control System; G, [_____]

SD-07 Certificates

Warranty

Gears

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

SD-09 Manufacturer's Field Reports

Circular Clarifier Mechanism; G, [_____]

SD-10 Operation and Maintenance Data

Circular Clarifier, Data Package 3; G, [_____]

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

****

NOTE: Conduct a regulatory review to determine impact of new and existing permit conditions and regulations; coordinate with Environmental Services Group to determine permitting responsibility. Design separator in accordance with UFC 3-240-01. Ensure compliance with NPDES permits.

****

Coordinate with the Government for environmental concerns and permits. Ensure compliance with permits and requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Ensure that the equipment and parts are packaged for shipment to prevent breakage and damage to components. Deliver materials to the site, inspect for damage, unload and store with minimum handling. Store materials off the ground and under a weathertight covering.

1.5 WARRANTY

Provide a clarifier with a minimum [_____] [5] year warranty. Submit the manufacturer's warranty.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Circular Clarifier

****

NOTE: Construct the concrete section of the project

specification in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

When a center feed with peripheral overflow clarifier is not specified for the project, delete references to this type and the requirements for associated components, including scum removal assembly (for this type), center column used as influent pipe, influent well, and (peripheral) weirs and scum baffles.

When a peripheral feed with center overflow clarifier is not specified for the project, delete references to this type and the requirements for associated components, including scum removal assembly (for this type), influent skirt, and effluent trough and weir assembly.

****

Clarifier equipment includes a clarifier mechanism [with effluent trough and weir assembly], [weirs and baffles,] [influent skirt,] and piping. Use structural steel conforming to ASTM A36/A36M. For completely or intermittently submerged steel members use a minimum thickness of 6 mm 1/4 inch. Use cast iron conforming to ASTM A48/A48M, Class 30 minimum.

2.1.1.1 Shop Drawings

Show the complete assembly of the circular clarifier system with all components, mechanisms, and parts; each with an assigned number corresponding to the equipment manufacturer's parts list. Show details for each component of the clarifier mechanism including installation of piping, anchorage, wiring, tank, and tank floor surfacing.

2.1.2 Clarifier Mechanism Design Requirements

****

NOTE: Design clarifier in accordance with UFC 3-240-01.

Delete requirements for and references to rapid sludge removal system when this system is not included in the project.

When a center feed with peripheral overflow clarifier is larger than 11 m 35 feet in diameter or peripheral feed with center overflow clarifier is larger than 18 m 60 feet in diameter, delete requirements for and references to bridge-supported clarifier mechanisms and associated components, including support bridge, center shaft, and scraper arms of structural shapes.

Other items associated with the circular clarifier, but not covered in this section, include (when used) valves, sluice gates, and perimeter handrail. These items should be covered in the appropriate sections of the project specification.

****

The clarifier mechanism includes a sludge collector assembly [with rapid sludge removal system]; drive assembly; [supporting bridge or] center column and access bridge; operating platform and access walkway; influent [well] [skirt and effluent trough and weir assembly]; scum removal assembly; overload protection and alarm; and electrical control equipment.

The drive assembly rotates the sludge collector assembly, that [moves settled sludge to a centrally located sludge hopper] [concentrates settled sludge ahead of pipes for rapid sludge removal system]. At maximum hydraulic capacity, or no chains, sprockets, bearings (except sleeve bearing when used) or operating mechanism is below the liquid surface or in contact with the liquid. Assemble the mechanism in the shop to ensure to ensure proper fitting of parts, match-mark for erection, and disassemble for shipment.

2.1.2.1 Design

****

NOTE: Insert torque value(s) as follows:

Support Mechanism	Diameter (metersfeet)	Torque (Joulesfoot-pounds)
Bridge-supported	6-8.5 m20-28 feet	2,710 joules2,000 foot-pounds
Bridge-supported	9-12 m30-40 feet	5,420 joules4,000 foot-pounds
Bridge-supported (for peripheral feed with center overflow type only)	13-18 m42-60 feet	8,130 joules6,000 foot-pounds
Center-column-supported	Less than 16.8 mm 55 feet	27,100 joules20,000 foot-pounds
Center-column-supported	16.8 to 23 m55 to 75 feet	40,650 joules30,000 foot-pounds

This guide specification is written for one clarifier. If the project includes more than one circular clarifier, all necessary pluralizations should be made or use the word "each."

Insert peripheral speed value(s) as follows:

Peripheral Speed	
Primary Clarifier	0.04 to 0.06 meter per second8 to 12 fpm
Secondary Clarifier	0.035 to 0.05 meter per second7 to 10 fpm

Use recommended values from UFC 3-301-01, Structural Engineering, for wind load and ice load.
****

Provide a clarifier mechanism manufactured for continuous 24-hour service under design load without excessive wear, damage, or failure. Ensure that the operating stresses do not exceed those allowed in AISC 360. Ensure a minimum continuous output torque rating of [_____] joules foot-pounds [for center-column-supported units and [_____] joules foot-pounds for bridge-supported units] with the scraper arms rotating at a constant speed producing a peripheral speed of [_____] meter per second fpm.

Ensure a safety factor of 2.5, to withstand all structural and mechanical stresses brought about by the following loadings: continuous output rated torque load; dead load; wind load of [_____]; ice load of [_____] (except on scum skimmer); and a live load of 2.5 kPa 50 psf on the access bridge [or on access section of supporting bridge]. Under maximum load, deflection of access bridge must not exceed 1/240 of span[; deflection of supporting bridge must not exceed 1/360 span].

2.2 EQUIPMENT

2.2.1 Sludge Collector Assembly

****
NOTE: Delete requirements for center shaft and rapid sludge removal system when not included in this project.
****

Provide a sludge collector assembly including scraper arms, scraper blades, [and] center drive cage or drum [or center shaft] [, and rapid sludge removal system].

2.2.1.1 Scraper Arms, Blades & Squeegees

****
NOTE: Use first bracketed wording in the second sentence when rapid sludge removal system is not included in the project; use second bracketed wording in this sentence when rapid sludge removal system is included.
****

Use structural steel, using welded truss construction of triangular or box section [; or structural steel shapes or closed end pile supported either by steel guy-rods or steel tie-rods or both]. Weld or bolt steel scraper blades, with attached squeegees, to scraper arms and [move settled sludge to a centrally located sludge hopper] [concentrate settled sludge ahead of pipes for rapid sludge removal system]. Connect scraper arms to [center shaft or] center drive cage or drum by bolted or welded connections. Use scraper blades of steel plate with a minimum thickness of 6 mm 1/4 inch.

Make squeegees bronze [, fiberglass,] or stainless steel with a minimum thickness of 3 mm 1/8 inch [for metal, 6 mm 1/4 inch for fiberglass], and connect to scraper blades with bronze or stainless steel bolts and nuts with a minimum of 50 mm 2 inches. of vertical adjustment.

2.2.1.2 Center Drive Cage or Drum

Fabricate of structural steel, using a box truss or cylindrical drum construction. Connect center drive cage or drum to drive assembly with machine screws or a bolted connection.

[2.2.1.3 Center Shaft

Construct from a solid steel shaft or steel pipe conforming to ASTM A53/A53M, Schedule 40.

][2.2.1.4 Rapid Sludge Removal System & Piping

Rapid sludge removal system includes [_____] mm inch diameter sludge uptake pipes of PVC 1120 or PVC 1220 conforming to ASTM D1784, ASTM D3034, SDR 35 or ASTM D2241, SDR 26, attached to the scraper arms and arranged so that the flow from each can be observed, adjusted, and sampled in the sludge well. Uptake pipe system includes all necessary intermediate clamps and supports and terminates in a suitable fitting or flexible coupling in sludge well. Provide the discharge end of each uptake pipe with an adjustable slip tube or orifice control gate to permit flow adjustment. Sludge well must be of structural steel plate having a minimum thickness of 6 mm 1/4 inch.

]2.2.2 Drive Assembly

****
NOTE: Delete reference to chain drives when clarifier tank is more than 12 m 40 feet in diameter. Check with manufacturer.
****

Include motor, speed reduction and turntable gearing, turntable bearing assembly, drive assembly bearings, and belt drives[or chain drives, or both]. Drive assembly must permit sustained operation at the continuous output torque rating without excessive wear and develop twice the continuous output torque rating without damage to or failure of drive assembly components.

2.2.2.1 Motor

Provide a motor adequate to drive the sludge collector assembly continuously at the maximum load encountered under any operating condition without overloading or exceeding the nameplate rating of the motor. Provide the starting torque needed to move sludge collector assembly from a dead stop in a dewatered clarifier tank as well as torque needed to move it from a dead stop under the maximum loading specified without overloading.

Motor must be suitable for operation with the voltage characteristics as indicated. Protect motor against overload, low voltage, and unbalanced voltage. Use a constant speed motor, totally-enclosed, fan-cooled, suitable for outdoor service, and conforming to NEMA MG 1. Flexible coupling for connecting shafts of close-coupled motor and speed reducer

must conform to the applicable requirements of AGMA 9002, and ANSI/AGMA 9000. Motor position must be adjustable to increase or decrease belt [or chain] tension.

2.2.2.2 Speed Reduction and Turntable Gearing

****

NOTE: Delete references relating to pinion-and-spur-gear reduction unit and intermediate speed reducer when clarifier tank is less than 11 m 35 feet in diameter.

Delete reference to worm-gear reduction unit when clarifier tank is more than 11 m 35 feet in diameter.

****

Speed reduction and turntable gearing for the primary [and intermediate]speed reducer[s] must be a worm or helical or a combination thereof. Gearing for the turntable must be [a worm gear reduction unit] [a pinion-and-spur-gear reduction unit]. Ensure an AGMA service factor as recommended in the applicable AGMA Standards ANSI/AGMA 6113 ANSI/AGMA 6013, ANSI/AGMA 6034 or when drive is operating at full load motor wattage horsepower, 24 hours a day continuous running. Gearing will withstand any loadings produced by thrust, out-of-balance, and vibration resulting from operating conditions and operate from zero rpm to a speed consistent with the maximum peripheral speed. Component parts of the speed reduction and turntable gearing will operate at sustained operation at the continuous output torque rating for the life expectancy specified without excessive wear and develop twice the continuous output torque without damage to or failure of any component part.

Ensure that the gears conform to applicable requirements of the following AGMA Standards: AGMA 908, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011, ANSI/AGMA 6034, AGMA 2015/915-1. Gears for primary [and intermediate] reducer[s] must be not less than AGMA Quality 10, AGMA 2015/915-1, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011, or ANSI/AGMA 6113 ANSI/AGMA 6013. Gears for turntable must be not less than AGMA Quality 6, AGMA ISO 10064-6, AGMA ISO 17485, AGMA 2011. Certify gears as meeting the specified quality.

2.2.2.2.1 Gear Lubrication

Provide an oil or grease lubrication system for speed reduction gearing, including means to stop drive motor in event of insufficient lubrication.

2.2.2.3 Gearmotor

Gearmotor, where practicable, may be used in lieu of separate motor and primary speed reducer. Motor component of gearmotor must be as specified in paragraph MOTOR. Speed reducing component of gearmotor must conform to the applicable requirements specified in paragraph SPEED REDUCTION AND TURNTABLE GEARING, and in ANSI/AGMA 6113 ANSI/AGMA 6013 and ANSI/AGMA 6034.

2.2.2.4 Turntable Bearing Assembly

Turntable bearing assembly includes the turntable bearings upon which the turntable and attached sludge collector assembly are supported; the turntable; and the drive assembly/turntable support base. Assembly must withstand all radial and axial loads imposed by drive assembly and sludge

collector assembly. Arrange component parts for replacement of balls or rollers, or the bearing raceways, or the complete bearing unit. Bearing raceway material must have adequate strength to withstand all radial and axial loads and must have a Rockwell "C" hardness of not less than 58.

Turntable bearing assembly [for a center-column-supported clarifier mechanism] must support, where applicable, a drive assembly, turntable, spur gear, and one end of the access bridge. [A bridge-supported clarifier mechanism may incorporate a submerged split-case, water-lubricated bottom guide bearing or an intermediate steady bearing where manufacturer's design requires use of such bearing in addition to turntable bearings.] A bottom support bearing is not acceptable. Bearing must run in an oil bath or be grease-lubricated. Turntable and drive assembly/turntable base must be of cast iron, nodular cast iron, or steel; if of steel, these parts must have sufficient thickness to provide the rigidity necessary to maintain alignment of sludge collector assembly. Turntable must be cast integrally with spur gear or be fastened to the spur gear with machine screws or bolts.

2.2.2.5 Drive Assembly Bearings

Load rating and fatigue life for bearings must be based on ABMA 9 and ABMA 11, as applicable. Bearings must be either oil lubricated or grease lubricated.

[2.2.2.6 Chain Drives and Belt Drives

Belt drives[and chain drives] incorporated in drive assembly include V-belt-and-pulley[and chain-and-sprocket] arrangements, except that belt drives must not be used directly on the[center shaft or on the] center drive cage or drum. Belt drives[and chain drives] must have a minimum safety factor of 4 as applied to ultimate breaking or transmission strength of the belt[or chain] with respect to loads transmitted at twice the continuous output torque rating of the clarifier mechanism.

Key mount the pulleys[, sprockets,] and other motive power transmitting connections. Connect the [drive pulley] [drive sprocket] on the output shaft of the primary speed reducer by a shear-pin hub arrangement to protect the motor against overload[; sprocket must have a bronze bushing with grease lubrication]. Shear-pin hub arrangement must be such that it will not bind or freeze into position. Fabricate guards of steel and make weatherproof.

]2.2.3 Scum Removal

****

NOTE: Select the applicable paragraphs(s) from the following:

****

[Provide a skimmer assembly and [heated] scum trough. Skimmer assembly will continuously move surface scum to tank periphery and automatically flush the scum into the scum trough with a minimum discharge of water.

2.2.3.1 Skimmer Assembly

****

NOTE: Delete references to and requirements for

aluminum wherever a corrosion problem with aluminum may be anticipated.

****

****

When center feed with peripheral overflow type clarifier is larger than 11 m 35 feet in diameter or peripheral feed/center overflow type clarifier is larger than 18 m 60 feet in diameter, delete requirements for and references to bridge-supported clarifier mechanisms and those components peculiar thereto, including support bridge, center shaft, and scraper arms of structural shapes.

****

Skimmer assembly includes a [fixed] [hinged or pivoting] skimming blade, a hinged or pivoting plow blade with wiper blades, and support legs. Skimming blade must be of structural steel and extend from influent well to scum trough. Plow blade is [structural steel] [aluminum], and is the width of the scum trough. Securely clamp in position grease- and oil-resistant wiper blades. Ensure the plow blade and its hinged or pivoted connections have proper alignment and is in continuous contact between wiper blades, scum trough approach ramp, and scum baffle. Plow blade must have provision for field adjustment in the vertical plane. Provide means to carry plow blade smoothly over the scum trough. Use corrosion-resistant materials for moving parts within the skimming assembly. Support blades, provide bracing where necessary to maintain the rigidity of the assembly. Use structural steel for support legs.

2.2.3.2 Scum Trough

Provide a welded structural steel scum trough, minimum thickness 6 mm 1/4 inch with a flanged connection for the scum discharge pipe, supported from the tank wall. The inclined approach ramp leading to discharge section of scum trough must be shaped to contain the scum as it is moved up the incline to the trough by the plow blade.

][2.2.3.3 Scum Removal Assembly

****

NOTE: Select the applicable paragraphs(s) from the following:

When a peripheral feed with center overflow type clarifier is not specified for the project, delete references to the scum removal assembly (for this type).

In cold climates where ice build-up is a problem, require heated scum trough and hinged or pivoting skimming blades in lieu of fixed blades.

****

Scum Trough: Use an adjustable dipping weir type scum trough and include collector pipe and operator.

(1) Provide a steel collector pipe conforming to ASTM A53/A53M Schedule 20 minimum. Pipe must have a 1.05 rad 60 degree wide slot cut symmetrically

about the vertical axis, with the horizontal edges of the slot parallel to the longitudinal axis of the pipe. At maximum intervals of 750 mm 30 inches, a 50 mm 2 inch wide band of full circumference must be left for stiffness. The pipe must be plugged on the inboard end and open on the effluent end. End supports include a rolled steel collar welded to an adjustable steel end plate. Provide a grease and oil-resistant, watertight seal, so constructed that it allows smooth motion of the rotating pipe; seal must be readily renewable without removing pipe. Secure end supports to concrete tanks walls by stainless steel anchor bolts of 16 mm 5/8 inch minimum diameter.

(2) Operator: Mount a manual operating lever on the collector pipe. Lever must be steel pipe having a minimum diameter of 31 mm 1 1/4 inches and secured to collector pipe with a chain or bolted connection. Lever must extend at least 0.91 m 3 feet above the top of the tank wall and permit rotation of collector pipe at least 0.52 rad 30 degrees each side of the vertical axis.

]2.2.4 Center Column

****
NOTE: When a center feed with peripheral overflow type clarifier is not specified for the project, delete references to this type and the requirements for those components peculiar thereto, including center column used as influent pipe.
****

Use a cylindrical, structural steel, column to support the entire clarifier mechanism, including the inboard end of access bridge.[The center column also serves as the influent pipe with large openings at its upper end to direct influent flow into the influent well at a low velocity.] Provide an accurate fit between the top of the center column and the drive assembly. Attach the center column to the drive assembly with bolts or machine screws. Provide anchorage for the center column to the tank according to the manufacturer's instructions.

[2.2.5 Effluent Trough and Weir Assembly

Assembly must include effluent trough, effluent weirs, and supporting members. For effluent trough use welded structural steel. Attach weir plates to each side of the effluent trough. Weir plates must be structural steel[or fiberglass]. Bolt weir plates to effluent trough and permit horizontal and vertical adjustment of weir. Ensure proper alignment. Supporting members must be of sufficient cross section to prevent vertical movement due to the flotation forces developed with trough empty and liquid level in tank at base of weir. Supporting assembly must be capable of vertical adjustment to permit leveling of trough.

]2.3 MANUFACTURED UNITS

2.3.1 Access Bridge, Walkway, and Operating Platform

Provide an access bridge extends from tank sidewall to the center and beyond that is sufficient to support walkway and operating platform.[Where the bridge supported unit is used, the supporting bridge must be used as the access bridge.] Ensure walkway and operating platform are skidproof. Walkway and operating platform must comply with 29 CFR 1910.

Ensure maximum deflection of L/360 when both dead and live loads are applied.

[2.3.2 Supporting Bridge

Include two structural steel beams and braces of sufficient depth and thickness to support entire clarifier mechanism within the specified maximum allowable deflection.

][2.3.3 Influent Well

Provide an influent well to diffuse the liquid into the tank. The well must project below and 100 mm 4 inches above the water level at maximum hydraulic capacity and radially diffuse and dampen the influent without inhibiting the clarifier process. Provide a flanged connection for the influent pipe.

][2.3.4 Influent Skirt

****
NOTE: Delete references to and requirements for aluminum wherever a corrosion problem with aluminum may be anticipated.
****

The tangential inlet must be shaped to direct influent liquid through the influent raceway. Influent skirt is [steel sheet] [aluminum sheet, minimum thickness] 1.8 mm 14 gage, with bars or structural shapes at top and bottom for rigidity. [Aluminum must conform to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6.]Supporting assembly must be capable of horizontal and vertical adjustment for final location and leveling of influent skirt.

]2.4 COMPONENTS

2.4.1 Electrical Control System

Provide an enclosure; main and branch circuit breakers; starter, contactors, and reset buttons; pushbuttons; lockout/tagout disconnects and appurtenances and all necessary wiring. Electrical control system must be in accordance with NEMA ICS 1 and NEMA ICS 2. Design, fabrication, and installation of electrical components must be in accordance with requirements of NFPA 70. Mount electrical controls in a weatherproof enclosure.

2.4.1.1 Circuit Breakers

Circuit breakers must be thermal magnetic type and meet the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Main circuit breaker must have a maximum capacity of 150 percent of the electrical load. The main circuit breakers must be an external handle mechanism, with positive locking device, mounted outside the enclosure to permit operation of breaker from outside the enclosure. Provide branch circuit for each drive motor, control circuit, [trough heating device,] and receptacle. Ensure that the panels include spaces for two additional circuit breakers.

2.4.1.2 Motor Starter [, Contactors,] and Pushbutton Station

Provide a pushbutton actuated magnetic motor starter with overload and

undervoltage protection for the motor. Starter must have thermal overload protection in each phase and short circuit protection. Ensure overload protective devices give adequate protection to motor windings, are of thermal inverse-time-limit type, and include a manual-reset type pushbutton. Use 2-button Start-Stop pushbutton station.[Provide contactors for trough heating devices.]

2.4.1.3 Overload Protection and Alarm Device

Provide clarifier mechanism with an overload protection and alarm device to indicate load on the mechanism at all times, to sound an alarm in case of impending excessive load, and to stop the mechanism when such load is reached. Device must be of the torque-actuated or indicating-ammeter type, mounted except for alarm, in an enclosure. Include an industrial-type horn or 150 mm 6 inch bell, relay, reset button, test circuit, and an independent On-Off switch. The horn or bell must be constructed of noncorrodible material and be suitable for remote mounting.[Provide auxiliary contacts in alarm circuit for transmission of signal to existing alarm system.]

2.4.1.4 Wiring

Wire control circuits with 1.8 mm No. 14 gage stranded, 1 mm 2/64 inch insulation machine-tool wire with ring tongue compression type lugs and number tags on both ends of wires. All power circuit wiring must be minimum 2.5 mm No. 12 gage, include all terminations as necessary and be labeled with number tags. Secure wires with either plastic ties or wiring duct, or both. Wires going to components mounted on the enclosure door must be secured in a cable-like bundle and strapped to the door and the enclosure with sufficient slack to allow easy operation of the door. Terminate circuits requiring field connection on panel terminals.

2.4.2 Lubrication

Provide bearings and other moving parts subject to wear with lubrication.

2.4.3 Key Mounted Connections

Where connections between shafts and sprockets, gears, pulleys, and other component parts are specified to be key mounted, keys and keyways must conform to ASME B17.1 or ASME B17.2.

2.4.4 Weir Plates and Scum Baffles

Use [steel] [aluminum conforming to ASTM B209M ASTM B209 or ASTM B221M ASTM B221, Alloy 6061, Temper T6] [fiberglass]. Ensure weir plates and baffles or their supports permit horizontal and vertical adjustment of the weir and baffle. Seal according to manufacturer's recommendations.

2.5 MATERIALS

2.5.1 Clarifier Piping Connections

The influent connection to the clarifier will be as shown on the drawings and consist of one [_____] mm inch diameter flanged pipe connection. The effluent connection will be as shown on the drawings and consist of one [_____] mm inch diameter flanged pipe connection.

2.5.1.1 Pipe and Fittings

Use manufacturer's standard pipe and fittings.

2.5.2 Anchor and Connecting Bolts, Nuts, and Washers

Use manufacturer's standard anchor and connecting bolts, nuts, and washers. Show bolt sizes and locations on the approved shop drawings for the equipment[, except as otherwise indicated].

2.5.3 Grout Materials

Use grout conforming to ASTM C1107/C1107M.

2.5.4 Materials Protection

Except as otherwise specified, treat and paint equipment in accordance with the manufacturer's standard practice.

2.6 ACCESSORIES

2.6.1 Spare Parts

Provide manufacturer recommended spare parts that are identical and interchangeable with original parts. Protect spare parts from corrosion and furnish in clearly marked containers. Spare parts must meet standards recommended by the manufacturer in the manufacturer operation, maintenance, or instruction manual.

2.6.2 Tools

Provide special tools necessary for the proper maintenance and operation of the equipment together with a properly identified hardwood or metal box for their storage.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 General

Install clarifier equipment in accordance with the manufacturer's instructions. Correctly align equipment components.[After final positioning of center column, provide full bearing under base plate using non-shrink grout.]

3.2 PREPARATION

3.2.1 Surfacing of Clarifier Tank Floor

Perform surfacing operation in accordance with the approved recommendations of the manufacturer of the clarifier equipment, except as otherwise specified.

Immediately before the surfacing operation is begun, clean the floor of all dirt, soil, and other substances which would prevent the proper bonding of the surfacing to the concrete subfloor. Bring the grout surfacing to finish grade, as near as possible, by hand. If the manufacturer's recommended procedure calls for use of straightedges

attached to scraper arms, fasten a 50 by 150 mm 2 by 6 inches metal clad wooden straightedge to each scraper arm approximately 6 mm 1/4 inch below the scraper blade to form a suitable screed; rotate scraper arms manually to complete the surfacing operation; do not use drive unit to move the arms. Prevent grout from entering sludge cone; immediately remove any grout that falls in the sludge cone or on clarifier tank walls. Immediately after surfacing operation is complete, clean clarifier tank floor and circular clarifier equipment of deposits of excess grout.

3.3 INSTALLATION

Install clarifier in accordance with the manufacturer's installation instructions.

3.3.1 Piping

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NOTE: Delete piping applications not covered in this section. In general, piping external to the clarifier tank that is part of the water resource recovery facility interconnecting piping system should be covered in a separate piping section in the project specification.
****

Install piping in accordance with manufacturer's instructions. Make flanged joints up tight, avoid undue strain on flanges. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose is not be permitted. Install flanged pipe so that adjoining flange faces are not out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. Provide hangers and supports where necessary to support piping.[For buried piping, use push-on joints or mechanical joints, and make in accordance with AWWA C600; for mechanical joints, also follow recommendations of Appendix A to AWWA C111/A21.11].

3.3.2 Weirs

Mount weir plates in accordance with manufacturer's instructions. Use sufficient sealant to fill all voids between tank and weir plates.

3.4 FIELD QUALITY CONTROL

3.4.1 General

Perform all field tests and provide all labor, equipment, and incidentals required for tests. The Contracting Officer will witness field tests and conduct all field inspections. Provide the Contracting Officer ample notice of dates and times scheduled for tests.

3.4.2 Tests

Test circular clarifier mechanism as in operation to demonstrate correct alignment, smooth operation, proper adjustment of flow distribution, freedom from vibration, and freedom from noise and overheating of moving machinery. Include in test at least two full cycles of successful operational sequences to demonstrate that the system continues to function satisfactorily after meeting all operational requirements.

3.4.3 Repair Painting

Inspect painted surfaces for holidays, scratches, chipping, and other damage. Refinish imperfections by cleaning burrs and rough surfaces and sanding to a smooth finish, prime and repaint.

3.4.4 Manufacturer Field Service

Provide the services of the clarifier equipment manufacturer's representative or technician, experienced in installation and operation of the type of systems being provided, to supervise the erection, start-up, acceptance tests, and final inspection.

3.5 CLOSEOUT ACTIVITIES

3.5.1 System Operation

Provide Circular Clarifier, Data Package 3, including operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, providing basic data relating to the design, operation and maintenance of the circular clarifier.

-- End of Section --