SECTION 11231 - CIRCULAR, CENTER-FEED CLARIFIER

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing circular center-feed clarifiers consisting of sludge collector and skimming equipment, complete and operable.

B. The equipment provided for each clarifier mechanism shall include the walkway bridge with handrails, center assembly with drive unit, drive control, stationary influent column with upper inlet openings, influent feedwell, center cage, sludge removal arms with blades and squeegees, center RAS withdrawal pipe, scum skimmer, scum box, weirs, baffles, and anchor bolts, and all other appurtenances required or indicated.

C. The WORK also includes coordination of design, assembly, testing and installation.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 05521 Aluminum Railings
2. Section 06610 Glass Fiber and Resin Fabricaitons, General
3. Section 11000 Equipment General Provisions

1.3 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. AISC M011	Manual of Steel Construction, 8th Edition
2. ASTM E18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
3. AGMA 908-B	Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
4. AGMA 2001-B	Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
5. AGMA 6034-A	Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

6. AWS D1.1 Structural Welding Code--Steel

7. NEMA 250 Enclosures for Electrical Equipment

8. AFBMA 9 Load Rating and Fatigue Life for Ball Bearings

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Manufacturer's product data including catalogue cuts.

2. Complete certified equipment drawings, showing all dimensions, weights, materials of construction, structural members, sludge collection members, welds, torque ratings, and gears.

3. Foundation, installation, and grouting plans.

4. Anchor bolt placement measured from construction joints in the concrete structure. Anchor bolt details shall include projections from concrete.

5. Type and size of structural details, sludge drawoff pipes, including method of return sludge flow control, and all pipe connection details.

6. Walkway construction details and dead load deflection computations.

7. Skimming device details.

8. Specifications, detail drawings and information on type, input and output speeds, exact gear ratios, service factor (24-hour continuous service), capacity, and efficiency of gear reducer units and drive assembly. Diameter of ball race.

9. Equipment drive and drive guard details.

10. Size, make, and type designation of electric motor, including mounting details.

11. Details and description of the overload protection assembly. Details submitted shall clearly demonstrate the adequacy of the overload protection provided by the assembly proposed. Overload alarm contact shall be provided as shown on the control diagram.

12. Wiring to oil bath heaters, where applicable.

13. List of spare parts to be furnished.

14. List of special tools to be furnished.

15. Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past, including contact name, telephone number, and address.

16. Calculations substantiating the output torque rating of the drive selected, including gears and pinions. The calculations shall clearly specify the values used for the following design parameters for surface durability and strength ratings:

    Number of Pinions
    Actual Face Width
    Tooth Geometry Factor (I and J Factors)
    Load Distribution Factor
    Allowable Contact Stress
    Allowable Bending Stress
    Pinion Pitch Diameter
    Tooth Diametral Pitch
    Hardness Ratio Factor
    Elastic Coefficient
    Life Factor

B. The load distribution factor shall be determined as described in the referenced AGMA standards. The net face width for surface durability calculations shall not exceed 90 percent of the actual face width of the narrowest of the two mating gears. For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatments used.

C. **Certification:** A certificate of design, signed by a Registered Professional Engineer, shall be submitted to the CONSTRUCTION MANAGER, prior to the manufacture of the equipment. The certificate shall include the following information:

1. Codes and Specifications followed in the design.

2. Type and strength of materials for members.

3. Loading conditions used for the design.

4. Certification that equipment is designed to withstand maximum continuous running torque and momentary peak (stalled) torque specified.

1.5 SERVICES OF THE MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** An authorized service representative of the manufacturer shall visit the site for not less than [ ] days to furnish the indicated services.

B. **Instruction of OWNER's Personnel:** The authorized service representative shall also furnish the indicated services for instruction of OWNER'S personnel for not less than [ ] days.

1.6 QUALIFICATIONS

$# _____

NTS: In the paragraph below, define the terms "comparable size and complexity" for the equipment or system specified. Requiring experience of more than one successful project requires sound justification and prior written approval from the City Project Manager.

_____ #$

A. **Manufacturer:** Company specializing in circular, center-feed clarifier equipment comparable to the complexity and size indicated with at least one successful installation in the recent past. Equipment of comparable size and complexity shall have the following characteristics: [ ].

PART 2 -- PRODUCTS

2.1 GENERAL

A. **General:** Only products certified as complying with the indicated requirements shall be provided. Equipment furnished under this Section shall be suitable for installation in circular secondary sedimentation tanks. The equipment shall have an energy dissipating center feedwell supplied from the center column and hydraulic type sludge collectors.

B. [The] [Each] clarifier mechanism shall be of the center-drive type, supported on a stationary influent column, with the flow entering the influent column. The clarifier shall be designed to remove the sludge uniformly from the bottom of the tank through the sludge withdrawal system, to the outlet manifold and sludge withdrawal conduit. The allowable head loss as measured from tank water surface to the hydraulic gradient at the end of the sludge withdrawal pipes, approximately [12] inches from the clarifier center column, shall be no less than 6 inches, nor more than [20] inches water column, when sludge is withdrawn at the maximum rate.

C. Each item of equipment shall be provided complete with all supports, electric drive units, sludge collector, mechanical equipment, electrical work and appurtenances ready for operation. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Guards shall be provided for all exposed moving shafts, drives, or parts as required by the applicable safety codes. All main drive assemblies shall be provided by the equipment manufacturer.

D. The central influent pier and column assembly shall be designed to support the drive mechanism, the sludge collection mechanism, scum collection arms, utility piping, access bridge beams and walkway. No vertical thrust load shall be placed on any underwater bearing. All drive gears shall be located above water level and

all gearing shall be completely enclosed and oil lubricated. The drive cage, sludge collector arms, and associated supports shall be designed to withstand application of 200 percent of the maximum continuous operating torque at the AISC allowable stresses.

E. **Workmanship:** Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence. Welds on submerged surfaces and edges shall be of the continuous type.

2.2 DESIGN CRITERIA

Identification Number	-[	]
Service	-	Secondary
Maximum inlet flow, mgd (peak flow with maximum return sludge return)	-[	]
Minimum inlet flow, mgd (minimum flow with minimum return sludge return)	-[	]
Maximum return sludge flow (mgd)	-[	]
Minimum return sludge flow (mgd)	-[	]
Maximum overflow, mgd	-[	]
Minimum overflow, mgd	-[	]
Maximum velocity through sludge collection header at maximum return sludge flow, feet per second.	-	4
Minimum velocity through sludge collection header at maximum return sludge flow, feet per second.	-	0.5
Mixed liquor suspended solids concentration range (mg/l)	-[	]
Maximum sludge collector peripheral speed, feet per	-	8

minute.

Sludge viscosity, N-sec/m^2	-	.001 - .01
Internal Tank Diameter (ft)	-[	]
Side Water Depth (ft)	-[	]
Depth at Center Column (ft)	-[	]
Freeboard at maximum flow (in)	-[	]
Bottom slope (in/ft)	-	1/16:1
Walkway, width (ft)	-	3
Influent, dia (in)	-[	]
Effluent, dia (in)	-[	]
Sludge Outlet, dia (in)	-[	]
Tank Drain, dia (in)	-[	]
Scum drain, dia (in)	-[	]
Influent Column, dia (ft)	-[	]
Influent Distribution Tub	-[	]
Diameter (ft)	-[	]
Depth (ft)	-[	]
Diffusion gates, min number	-[	]
Secondary Baffle	-[	]
Diameter (ft)	-[	]
Depth below water surface (ft)	-[	]
Sludge collection arms, number	-[	]
Weir depth (in)	-[	]
Motor, minimum (hp)	-[	]
Motor (rpm)	-[	]
Drive speed, max (rpm)	-[	]

Max continuous running
torque (ft-lb) -[ ]

Momentary peak (stalled)
torque (ft-lb) -[ ]

Minimum ball race, dia (in) -[ ]

2.3 MATERIALS

A. **General:** All materials used shall be suitable for service in a moist, corrosive environment, as encountered in water and wastewater treatment plants.

B. Plates **and Structural Members:** Except where otherwise indicated, all plates and structural members designed for submerged service shall have a minimum thickness of 1/4-inch.

C. **Bolts and Nuts:** All bolts, nuts, anchor bolts, and washers shall be of stainless steel, as indicated for submerged service; they shall be of high strength and sized for the intended purpose. Stainless steel split lockwashers or locknuts shall be used on all bolted connections. All bolt heads and nuts shall be hexagonal. Anchor bolts shall be cast-in-place in new concrete.

2.4 DRIVE MECHANISM

A. **General**: The drive assembly shall include an electric gear motor, worm gear and worm gear reducer, pinion gear, turntable type main ring gear, drive base, shear pin hub coupling, steel roller drive chain, and torque overload protection system. The worm gears shall be designed in accordance with AGMA 6034-A, for a service factor of 1.25, applied to the continuous operating torque.

B. **Design Parameters:** The gear teeth shall not be stressed to more than 80 percent of the yield strength at a load equivalent to a value of the momentary peak (stalled) torque. The entire mechanism shall be capable of withstanding an impact load of the momentary peak (stalled) torque, without sustaining damage or permanent deformation. The 20-year maximum continuous running torque shall be a computed value according to AGMA 908-B and 2001-B.

The drivehead shall be designed for the torque values indicated. It shall turn the mechanism at a speed of approximately [ ] to [ ] rpm. The drivehead bearings shall be designed for the total rotating weight with a minimum L-10 life of 20 years, or 175,000 hours, for continuous operation, if renewable liners are used. If no renewable liners are used, this value shall be increased to 50 years or 450,000 hours. The drivehead shall be capable to produce and withstand the above listed momentary peak (stalled) torque, while starting. The drivehead gear shall be designed to a minimum AGMA 5 rating when rated in accordance with AGMA 908-B and 2001-B. The maximum continuous running torque rating of the drive shall be based on the smaller of the two values determined from AGMA 908-B and 2001-B.

C. **Physical Characteristics:** The drive mechanism shall be mounted on the influent column with the top of the ring gear housing capable of supporting the total access bridge load by means of equally loaded, removable bridge supports. The drivehead shall consist of a split internal ring gear, pinion, secondary worm gear set, support base, and drivehead bearing. The ring internal gear shall be fabricated of alloy hardened steel or nodular iron. The ring gear shall have a face depth to diameter ratio of 0.15 or greater. The pinion shall be heat treated alloy steel and forged integral with the shaft, or shall be alloyed nodular iron. The worm gear shall be of hardened alloy steel, meehanite, or centrifugally cast bronze. All gears shall be fully enclosed and running in oil. Support base for the drive shall be of cast iron, meehanite, or welded steel, to assure rigidity. Oil and dust shields shall be provided. Seals shall contact a machined surface. The drivehead bearing shall include a hardened replaceable raceway, or it shall be a forged steel precision gear/bearing set, with fully contoured raceways. Raceway liners, if used, shall be either temperature drawn or bearing quality steel, heat-treated to minimum 60 Rc. An oil sight glass shall be provided for the upper and lower oil reservoirs. Readily accessible lubricant fill and drain pipes with necessary fittings shall be provided.

D. **Overload Protection:** The overload device shall be provided in a cast aluminum or stainless steel, NEMA 4 weatherproof enclosure. The device shall be actuated by thrust from the worm shaft or rotation of the secondary gear reducer, which shall operate 2 switches (the alarm switch at 85 percent of maximum continuous running torque and the motor cutout switch at 100 percent of maximum continuous running torque). These 2 switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque dial indication shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 100 percent of maximum continuous running torque.

A backup shear pin shall be provided in a shear pin hub mounted on the output shaft of the gear motors. The shear pin shall be selected to break when the load on the mechanism achieves 140 percent of the maximum continuous operating torque specified. A NEMA 4X limit switch shall be provided to activate when the shear pin breaks.

E. **Turntable:** The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection of 0.024 inches with an allowable modulus of elasticity of 25×10^6 psi. The center cage and sludge collection arms shall be fastened to and hung from the gear casing. Ball bearings shall be of the finest quality high carbon, chrome alloy steel balls running in renewable heat-treated alloy steel races mounted in the turntable base and in the gear casting, or in fully contoured races, as part of a precision gear bearing set. The balls shall run in an oil bath which shall be protected by a felt seal, or they shall be grease-lubricated. The oil baths shall be provided with a fill pipe, plug, sight gauge indicator, and drain plug.

F. **Speed Reducing Unit:** The worm gear shall in turn be driven by a vertical chain drive or direct connection from a gear motor or worm or helical gear speed reducing unit made to AGMA standards and bearing the AGMA nameplate. The speed reducing unit shall have a service factor of 1.25. There shall be no overhung

pinions without lower bearings. The lower pinion bearing shall not be located at an elevation below the turntable base.

G. **Motor:** Power supply to the equipment shall be [480-volt, 60 Hz, 3-phase], unless otherwise indicated. The motor shall be a l800 rpm synchronous speed, squirrel cage, induction type, totally enclosed, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a service factor of 1.0. The motor shall be not less than [one] hp and the connected load shall not exceed 85 percent of the motor nameplate horsepower rating under any anticipated operating condition. The gear motor drive shall be provided with output sprockets and chain to allow operation of the collector mechanism at 33, 66, 80 and 100 percent of the speed indicated above.

H. **Transmission:** Power transmission between the gear motor and a special, single-reduction worm gear reducer shall be made through a roller chain and sprocket drive assembly. The chain drive shall be enclosed by a removable chain guard, constructed of a minimum 10-gauge hot-dip galvanized steel.

I. **Worm Gear**: The special worm assembly shall consist of a through hardened and ground alloy steel worm and a centrifugally cast bronze worm gear. The worm gear assembly shall be self-contained and enclosed in a cast iron gear case and provided complete with oil fill, level, and drain fittings and a sight gauge. The drain shall be at the lowest point of the oil reservoir and shall be accessible.

The worm shall be integral with the worm shaft. The worm gear torque capacity shall be determined according to AGMA 6034-A for service factor of 1.25 applied to the maximum continuous operating torque.

J. **Pinion Gear**: The pinion and pinion shaft which drive the internal spur gear shall be made as an integral unit from heat treated forged alloy steel hardened to a minimum 475 Brinell. The pinion shall be rigidly supported by bearings located above and below the pinion gear. Overhung pinions shall not be acceptable.

K. **Ring Gear Assembly**: The ring gear shall be AGMA Quality 5 and shall be designed and rated in accordance with AGMA 908-B and 2001-B. The ring gear shall be of a split gear design with the two halves furnished with precision mating surfaces with self-registering and indexed fits.

The ring gear housing shall be made of cast iron. A felt or neoprene seal and dust shield shall be included with each spur gear housing in two locations; a lower seal located between the stationary drive base and main gear and an upper seal located between the main gear and stationary drive cover. The gear case shall be complete with an oil fill and drain with plugs, as well as an oil level indicator pipe. The spur gear housing shall be designed to allow submergence of the gear face in the oil bath sufficient to provide complete lubrication of the gear assembly. The drain line, suitable for removing condensate, shall be located at the lowest point in the oil reservoir and shall be accessible.

The drive assembly shall be firmly mounted to a cast iron turntable base with a minimum wall thickness of 1/2 inch. The drive base shall be mounted on the

center column and be provided with a positive leveling feature. The drive base shall be suitable for supporting the entire load of the drive mechanism and access bridge. To permit inspection and maintenance of the interior of the center column, each assembly shall have an access opening of not less than 22 inches in diameter. Cover plate with lifting holes securely attached shall be provided for the opening.

2.5 WALKWAY AND PLATFORM

A. **Access Walkway:** The clarifier shall be provided with a walkway consisting of rigidly interlaced structural steel beam members or of structural truss construction, connecting the drive platform to the access stairs. The [-foot] wide walkway shall be fabricated of aluminum safety grating. Aluminum handrails with the top rail 42 inches above the walkway shall be installed on both sides of the walkway and around the center drive platform. Walkway and handrails shall meet applicable OSHA standards. A 4-inch by 1/4-inch aluminum toe board shall be provided. If a structural truss system is supplied, additional rails may be required to meet safety codes. Access walkway flooring and stairs shall be 1-1/4-inch aluminum T-bar grating, attached between the channels, including aluminum stringers and stainless steel bolts.

B. Walkway **Support:** The walkway shall be supported by the exterior wall and the drivehead casing which, in turn, shall be supported by the center column. The walkway shall be designed to safely withstand a live load of 100 pounds per square foot, with a deflection of not more than 1/360th of the span. Maximum dead load deflection shall be 0.5 inches. Necessary provisions shall be made for expansion and contraction of the walkway. The support system shall be designed to provide support to the scum spray system.

C. **Center Drive Platform:** A center drive platform shall provide access to the center assembly and drive control. It shall consist of 1-1/4-inch aluminum grating, or 3/16-inch checkered floorplate with necessary stiffeners and supports, resting on the center assembly, and provided with connections to the walkway. The entire platform shall be surrounded by handrails. The center platform shall provide not less than 2 feet of working clearance around the drive unit.

2.6 INFLUENT

A. **Influent Structure**: The tank influent structure shall consist of the center column and the influent diffusing well. The center column shall be a hollow steel cylinder with its base flanged for fixing to the concrete floor of the tank. Its top shall also be flanged and stiffened for supporting the sludge collection mechanism, the drive mechanism, and the access bridge beams. Ports shall be provided for discharging the mixed liquor from the center column into the influent diffusion well. The influent diffusion well shall be designed to provide even distribution of flow into the tank and shall consist of an inner distribution tub and an outer concentric secondary baffle. The distribution tub and the secondary baffle shall be fabricated of minimum 1/4-inch thick steel plate.

The distribution tub shall be fitted with adjustable multiple steel diffuser gates, all directing the flow to move in the same tangential direction to provide for energy

control of the inflow. The distribution tub shall be supported from the drive cage and shall rotate therewith. A neoprene seal shall be provided at the bottom of the tub between the rotating bottom and the stationary center column to prevent the passage of mixed liquor into the sedimentation tank at this location. The top of the ports in the influent pier and the top of the gates in the distribution tub shall be above the tank's maximum water surface elevation.

The secondary baffle shall be supported from the drive cage and shall rotate therewith. At least two removable shallow gates shall be provided on the secondary baffle extending above the maximum water surface elevation to allow scum removal. The gates shall be designed to be manually operated from the bridge.

B. **Drive Cage**: Torque shall be transmitted from the drive unit to the sludge collection arms and scum skimmers by a drive cage. The drive cage shall encompass the center column and shall be fabricated of structural steel shapes of sufficient strength to transmit and/or carry all loads and stresses associated with 200 percent of the maximum continuous operating torque. Calculations shall be provided showing the related stresses developed in the drive cage at that torque.

2.7 HYDRAULIC SLUDGE COLLECTION SYSTEM

A. **General:** Each clarifier sludge collection system shall consist of a rotating fabricated steel center outlet manifold, with two fabricated steel headers located parallel to the tank bottom. They shall be complete with a series of inlet orifices and squeegees designed to sweep the entire tank bottom clean every one half revolution. The squeegees shall be adequately braced to the steel headers and shall extend to the bottom of the tank. The mechanism shall collect the sludge from the tank bottom and carry it through the headers to the outlet manifold and to the opening of the sludge withdrawal conduit. The complete sludge collection mechanism shall be capable of handling the return sludge as indicated in the Design Criteria.

The collectors shall be supported from the drive cage by steel truss arms with turnbuckles, clevises, and locknuts to hold the headers in alignment in a vertical and horizontal plane. The truss arms shall be of box truss construction, fabricated from rolled structural steel angles or sections having a minimum thickness of 1/4 inch. Calculations shall be provided showing the related stresses developed in the sludge collection arms at 200 percent of the maximum continuous operating torque.

To trap the lower sludge layer and minimize agitation, the longitudinal cross-sectional axis of rectangular headers shall be mounted at an angle of 45 degrees with the tank bottom. The leading edge of each rectangular header shall extend forward and down 2 inches at an angle of 45 degrees to provide an equalizing vane as an integral part of the header and to direct the sludge into the orifice's area of influence . A neoprene squeegee with a steel backing plate shall be attached to the vane. The squeegee shall have slotted holes for 1-inch vertical adjustment. Inlet orifices shall vary in size from a minimum near the tank center to a maximum at the outer end and shall be accurately drilled in each header. A flange shall be

provided at the inner end of each header for connecting to the fabricated steel center outlet manifold.

B. **Sludge Collection Arms:** The mechanism shall include 2 sludge removal arms. Sludge collectors shall be designed to operate continuously or intermittently. To provide for uniform sludge drawoff velocities throughout, the removal arms shall be tapered steel tubes, rectangular in section, varying in size from a maximum near the tank center to a minimum at the outer end. The headers shall be fabricated of minimum 1/4-inch thick steel plate and hot-dip galvanized following fabrication. Standard or fabricated incremental pipe sizes will not be acceptable for use in the sludge withdrawal tubes.

C. **Center Outlet Manifold**: The fabricated steel center outlet manifold shall encompass the center column. The manifold shall be rigidly attached to the drive cage and be provided with seals to prevent passage of liquid between the tank and the outlet manifold. The inside bottom of the manifold shall be open and completely cover the opening into the sludge withdrawal conduit at all times.

2.8 SKIMMER

A. **General:** A skimming device shall be provided for each mechanism. It shall be arranged to effectively sweep the surface of the clarifier, automatically removing scum and floating material into a scum box at the periphery of the tank.

B. **Skimmer Construction:** Each rotating skimmer shall consist of a vertical steel plate supported and extending from the feedwell to a recessed adjustable pivoted scum scraper with neoprene wipers at the tank periphery.

C. **Scum Box:** The scum box shall be of ample size, supported from the tank wall and connected to the scum sump through a minimum 6-inch diameter scum pipe. It shall be made of welded steel plate, to serve as an integral section of the tank's scum baffle. The assembly shall have a scum trough, vertical steel sides and a sloping ramp. The ramp shall extend sufficiently to allow the skimmer to smoothly enter the scum box. A flexible connector shall be provided for connection to the scum outlet piping in the tank wall. The scum box shall be a minimum of 5 feet in width and 6 feet in length.

D. **Scum Scraper:** The spring-loaded scum scraper shall maintain contact with the scum baffle as it travels around the tank periphery. Upon approaching the scum box ramp it shall trap the scum in an enclosure consisting of the scum box ramp as the bottom and the baffle and scum scraper as 3 sides. The trapped scum shall be carried up the ramp and into the scum trough. The spring tensioned scum scraper shall maintain close contact with the scum box ramp and shall return to its normal operational position after traveling over the scum box.

2.9 WEIRS AND BAFFLES

A. **General**: Weir and baffle plates shall conform to the requirements of Section 06610.

B. **Baffles:** The baffles shall consist of curved sections of 1/4-inch thick by [ ]-inch deep fiberglass plate attached to the tank wall by fiberglass brackets, stainless steel anchor bolts and hex nuts, to enable 1-inch vertical and sufficient radial adjustment to keep baffles round and always in contact with the scum skimmer.

C. **Weirs:** The weirs shall consist of 1/4-inch thick by [ ]-inch deep fiberglass plate sections with [ ]-inch deep 90 degree V-notches at [ ]-inch intervals. The weir sections shall be curved and fastened to the tank wall with washers, clamps, stainless steel anchor bolts and hex nuts to allow vertical adjustment.

2.10 APPURTENANCES

A. **Scum Spray:** The CONTRACTOR shall furnish and install a spray system mounted as indicated. The spray system shall consist of galvanized steel pipe with [eight] spray nozzles, with strainer and gate valve.

2.11 SPARE PARTS

A. **Spare Parts:** Spare parts shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

The WORK includes the following:

1. 1 set - all bearings and bearing seal rings for drive unit, except the main turntable bearing
2. 1 set - all gaskets for drive unit
3. 1 set - spur gear seal and replaceable bearing races
4. 1 set - neoprene seal rings for sludge withdrawal manifold
5. 1 set - shear pins
6. 1 set - any special tools required to assemble, disassemble, or maintain the equipment
7. Lubricants for one year's operation.

2.12 MANUFACTURERS

A. **Clarifier Mechanisms:** Products, of the type indicated, shall be manufactured by one of the following (or equal):

1. Envirotech (EIMCO)
2. Envirex (Rexnord Co.)
3. Walker Process Corp.

B. **Scum Spray Nozzles**: Nozzles shall be as manufactured by one of the following (or equal):

1. EnviroQuip Corp, model FS-500
2. Spraying Systems Co., model 22561

PART 3 -- EXECUTION

3.1 INSTALLATION

A. **General:** Products and equipment shall be installed in accordance with the manufacturer's written installation instructions.

B. The equipment shall be fabricated, erected, assembled, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

C. All units shall be lubricated in strict accordance with the manufacturer's instructions.

3.2 GROUTING THE TANK FLOOR

A. After the equipment has been erected, a 2-inch layer of grout shall be applied to the tank floor, using screeds installed on the mechanism rake arms to form the finished surface. Grouting shall not be done until the mechanism has been inspected by the Manufacturer. Preparation of the base slab surface shall be accepted by the CONSTRUCTION MANAGER prior to grouting. Grouting procedure and the grout mix shall be as recommended by the manufacturer. The grout mix shall be sand and cement, and in no event shall the mix contain aggregate.

3.3 FIELD TESTS

A. The clarifier mechanism and the alarm system shall be field torque tested to 100 percent of the indicated maximum continuous running torque. Each arm shall be tested in the presence of the CONSTRUCTION MANAGER and manufacturer by applying the load evenly to both arms, before the mechanism is accepted and placed into operation.

B. The test shall be a dynamic test and shall be performed on the clarifier mechanism to verify accurate torque indication and adequacy of the mechanism to safely withstand the specified torque. The test shall accurately depict actual operation

of the mechanism and shall not apply impact loading, jerky loading, or abnormal conditions which may reduce the life of the equipment.

C. A torque test device in the form of a weighted dolly with a braking mechanism shall be attached near the outer end of each rake arm. The device shall allow load to be gradually applied uniformly to each arm as the arm rotates. Readings of the load applied at the arm versus the torque indicator reading shall be taken at 100 pound increments until the specified maximum continuous running torque is achieved. This load shall be applied over not less than one half revolution of the mechanism.

D. Actual torque versus indicated torque shall be accurately indicated within 7 percent of full scale at all torque readings.

E. There shall be no permanent deformation of any component. If deformation does occur, or correct torque is not achieved, the defective parts shall be replaced by the CONTRACTOR and then retested at no cost to the OWNER.

F. After installation of the equipment and after completion of the services of the manufacturer's representative, and when plant influent is available, the CONTRACTOR shall operate each unit to demonstrate its ability to operate continuously without vibration, jamming, or overheating and to perform its indicated functions satisfactorily. Any defects shall be corrected promptly, or defective equipment replaced.

** END OF SECTION **