SECTION 11526

DEWATERING CENTRIFUGE EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install horizontal, solid bowl, continuous feed, scroll-type, centrifuge equipment complete and operational.
   2. Included, but not limited to, are the following components for each unit:
      a. A solid bowl centrifuge with a cylindrical section and a conical beach section.
      b. A main drive motor and backdrive system.
      c. A vibration monitor located at each centrifuge local control panel and device of the machine.
      d. All required vibration isolators.
      e. Centrate and sludge discharge chutes.
      f. All flexible connections between the centrifuge and other piping and equipment.
      g. All necessary bolts, anchor bolts and hardware for centrifuge, lube oil unit, panels and chutes.
      h. 6-Pulse Type variable frequency drives for the main drive and the scroll drive motors.
      i. A local centrifuge control panel with I/O components and PLC.
      j. All required valves, as shown on the drawings.
   3. The centrifuge Supplier shall have overall system responsibility for variable frequency drives as specified in Section 11001, Variable Frequency Drives, and shall be responsible for coordination of the overall variable frequency drive system application. This shall include coordination of the centrifuge and motors with the variable frequency drive units, as well as coordination of the drive system interfacing with electrical work and instrumentation and control functions. Overall system responsibility shall include field testing, start-up, training, calibration and overall successful operation of the equipment.
   4. All equipment provided under this Specification Section and the associated equipment as noted herein to be provided under Specification Section 11001, Variable Frequency Drives, shall be furnished by a single system Supplier who shall be responsible through the Contractor for the completeness, performance, adequacy and proper operation of the system in accordance with the requirements herein. The Contractor through the Supplier shall guarantee and

shall be the source of information for the complete system, including each piece of equipment furnished under this Section and other Sections, regardless of the manufacturing source of that equipment.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the dewatering centrifuge equipment Work.
   2. Notify other Contractors in advance of the installation of the dewatering centrifuge equipment to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the dewatering centrifuge equipment Work.

C. Related Sections:
   1. Section 03600, Grout.
   2. Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
   3. Section 09900, Painting.
   4. Section 11000, Electric Motors.
   5. Section 11001, Variable Frequency drives.
   6. Division 13, Applicable Sections on Instrumentation and Controls.
   7. Division 15, Applicable Sections on Piping, Valves and Appurtenances.
   8. Division 16, Electrical.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Suppliers Association, (ABMA).
      a. ABMA STD 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. ABMA STD 11, Load Ratings and Fatigue Life for Roller Bearings.
   2. American Gear Suppliers Association, (AGMA).
   3. American Institute of Steel Construction, (AISC).
   4. American Iron and Steel Institute, (AISI).
   5. American National Standards Institute, (ANSI).
   6. American Society of Mechanical Engineers, (ASME).
   7. American Society for Testing Materials, (ASTM).
      a. ASTM A 36/A 36M, Specification for Carbon Structural Steel.
      b. ASTM A 48/A 48M, Specification for Grey Iron Castings.
      c. ASTM G 65, Test Method for Measuring Abrasion using the Dry Sand/Rubber Wheel Apparatus.
   8. American Welding Society, (AWS).
      a. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   9. Institute of Electrical and Electronics Engineers, (IEEE).
      a. IEEE 112, Test Method for Polyphase Induction Motors and Generators.
   10. National Electrical Code, (NEC).
   11. National Electrical Suppliers Association, (NEMA).
      a. NEMA MG1, Motors and Generators.
   12. National Fire Protection Association, (NFPA).

a. NFPA 79, Electrical Standard for Industrial Machinery.

13. Occupational Safety and Health Act, (OSHA).
14. Underwriters' Laboratories, Inc., (UL).
    a. UL 674, Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.
    b. UL 1004, Electric Motors.

1.3 QUALITY ASSURANCE

A. Supplier's Qualifications:
   1. The centrifuge shall be the product of a Supplier regularly engaged in the design, fabrication, service and repair of high-speed centrifuges. The centrifuge shall be manufactured utilizing the latest manufacturing machine tool technology. The bowl, scroll and frame of each centrifuge shall be manufactured to precise tolerances and shall be readily interchangeable with those components of other identical models. The Supplier shall be certified for ISO 9001 Quality Assurance in the design, development, production, installation and servicing of machines and installations for mechanical separation. The Supplier shall have a minimum of ten years experience manufacturing decanter-type dewatering centrifuges with bowl diameters of 25-inches or larger and operating "g" force in excess of 2,500 x "g".
   2. The centrifuge Supplier shall supply qualified installation Engineers to supervise the unloading, erection, placement, adjustment, testing, start-up, commissioning, and guaranteed performance testing of the equipment specified in this Section.
   3. Provide qualifications of the technicians that the centrifuge Supplier will be providing for installation, testing and start-up, and commissioning of the centrifuge assemblies. The qualifications shall be submitted to the Engineer for approval before the installation is initiated. Welders shall have passed AWS qualification tests or equivalent tests in countries other than the United States, within the last 12 months. Evidence of compliance shall be submitted to the Engineer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component Supplier from a single dewatering centrifuge equipment Supplier.
   2. The dewatering centrifuge equipment Supplier to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the dewatering centrifuge’s equipment Supplier.

1.4 SUBMITTALS

A. Shop Drawings: Submit the following:

1. Supplier's literature, illustrations, catalog cuts, specifications and Engineering data.
2. Drawings showing fabrication methods, assembly, accessories, installation details and wiring diagrams. Drawings shall include, but not be limited to, the following:
    a. Foundation drawings providing overall equipment dimensions and anchor bolt locations.
    b. Detailed Shop Drawings for all the equipment supplied, providing dimensions, piping, gross and net weights, and minimum clearances around the equipment.
    c. G-Volume calculations.
    d. Design data for:
        1) Main drive and scroll drive electric motors.
        2) Main bearings.
        3) Lube oil unit heat exchangers.
    e. Field wiring diagrams and outline drawings showing field wiring, requirements for conduit location, stubups and physical sizing information. The physical location of the electrical devices on the centrifuge and the ancillary equipment shall be shown on these drawings that shall be made specifically for this Project. Standard, marked up drawings shall be rejected. Electrical connections shall be in accordance with NEMA and ANSI standards.
    f. Parts lists and Bills of Materials for all equipment.
    g. Results of Liquid Penetrant tests for all castings.
    h. Detailed information about shop surface preparation, shop priming and shop finish coating of the surfaces to be painted.
    i. Lubrication schedules, with lists of equipment and related lubricants.
    j. List of special tools required to disassemble, service, repair and adjust the equipment.
    k. Spare parts lists.
    l. Electrical diagrams, elementary diagrams, loop drawings, process and instrument drawings identifying centrifuge parts as well as equipment by others that interface to the centrifuge.
    m. PLC Register locations available for owner interface to plant Distributed Control System.
    n. Proposed test procedures and test reports for the following tests:
        1) Laboratory testing of the abrasion resistant materials.
        2) Shop tests of the centrifuges.
        3) Centrifuge vibration tests.
        4) Shop tests of all control panels.
        5) Field tests of the centrifuges.
        6) Performance tests of the centrifuges.
    o. For equipment or material for which specific tests are not required in this Section, the Supplier's standard Quality Control test reports shall be submitted. The tests shall have been performed not longer than three years before the date of submittal of the reports for approval. Upon request by

the Engineer, the Supplier shall certify that the supplied equipment is of the identical material and quality as the equipment used for the standard test.

p. Certificates of calibration for the shop test instruments.
q. Certificates of calibration for the field test instruments.
r. Suppliers' instructions for delivery, unloading, storage, handling and installation of all equipment.
s. Record Documents showing all modifications made by Contractor during installation, start-up, testing, and commissioning.
t. Warranties for the Work performed under this Contract and, in particular, the wear and performance guarantees.
u. Qualifications of the proposed technicians for the installation, testing and start-up and commissioning.
v. Provide information on Variable Frequency Drives as specified in Section 11001.

B. Provide Manufacturer's standard warranty for a period of 18 months from the date of Substantial Completion.

C. Shop Test Results: Contractor shall submit for approval the results of all shop tests conducted on the centrifuges within 30 days of the shop test as required by these Specifications.

D. System Operation Demonstration (SOD) Results: Contractor shall submit for approval six copies of the results of the SOD tests conducted on the installed centrifuge within 2 weeks of completion of the SOD as required by these Specifications. Refer to Section 3.4 for SOD requirements.

E. Certifications: Submit all certificates of conformance and compliance for items required in these Specifications.

F. Operation and Maintenance Manuals:
1. Submit complete Installation, Operation and Maintenance Manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operation and Maintenance Data.

G. Lubricant Specification: Furnish a lubricant specification for the type and grade necessary to meet the requirements of the equipment.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices that are to be embedded in cast-in-place concrete in ample time to prevent delay of the Work.

2. At the time of delivery, Contractor and the Supplier's factory authorized representative shall:
    a. Inspect shipment for damaged or missing pieces.
    b. Inspect shipment for erroneously shipped equipment.
    c. Prepare brief report, in writing, of the findings for delivery to Owner, Engineer, and Contractor.
    d. Initiate corrective action, as may be required.

B. Storage and Protection:
    1. Supplier shall store the centrifuge equipment until notified by Contractor to deliver the equipment. Contractor, at no additional cost to the Owner, shall replace all equipment delivered to and accepted by Contractor that is damaged or is later missing.
    2. Contractor shall install the centrifuge equipment upon receipt, provided the facilities are environmentally acceptable to the Supplier. If the centrifuges cannot be installed as received, Contractor may temporarily store the centrifuge equipment in a bonded off-Site storage facility. Off-Site storage arrangements shall be presented, in writing, to the Engineer. The minimum requirement for off-Site storage by Contractor shall be as follows:
        a. Centrifuge, motor, backdrive and control panel stored in temperature controlled environment.
        b. Maximum temperature in range of 50 to 100°F.
        c. Condensate not permitted to accumulate.
        d. Equipment not subjected to vibration.
        e. All openings maintained in sealed condition.
        f. Rotate motor shafts at least ten revolutions each month.
        g. Exercise gears each month.
        h. Measure resistance of motor windings with megger every six months:
            1) Minimum reading shall be one megohm.
            2) If below this value, drying will be required.
    3. Upon delivery to the Site, Contractor shall be responsible for protecting, rotating, lubricating, and maintaining the equipment as recommended by the Supplier. The maintenance requirements shall be shipped with the centrifuges. Supplier shall supply environmental requirements for installation of the centrifuges at Site, to Contractor and Engineer, within 30 days of Notice to Proceed.

1.6 UNIT RESPONSIBILITY

A. Centrifuge manufacturer shall have unit responsibility for the equipment specified in this section; the main drive and backdrive systems, centrifuge control panel, PLC and its programming along with ancillary equipment specified.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Design equipment to be suitable for the process and service conditions described in the Schedule of Service Conditions.
      a. Solid bowl centrifuge shall be designed for continuous 365-days, 24-hours per day, seven day per week operation.

B. Schedule of Service Conditions:
   1. Sludge Characteristics:
      a. Type of Sludge: 70 to 80 percent Waste Activated Sludge from Cannibal™ sludge reduction system and Membrane Bioreactors and 20 to 30 percent ferric sludge from phosphorus removal.
      b. Sludge Concentration:
         1) Minimum Sludge Feed Concentration: 1.0 percent.
         2) Maximum Sludge Feed Concentration: 3.0 percent.
      c. Maximum Volatile Solids: 90 percent.
      d. Maximum Capillary Suction Time: 20 seconds (Standard Methods 2710G).

   2. Minimum Required Centrifuge Feed Rates for Centrifuge Performance Criteria: Centrifuge shall be capable of meeting the Required Centrifuge Performance Criteria at all the design conditions listed below.
      a. Design Condition No. 1:
         1) Sludge Flow Rate to Centrifuge: 100 gpm/centrifuge.
         2) Solids Concentration: 1.25 percent.
         3) Dry solids feed rate: 626 dry lbs/hr/centrifuge.
      b. Design Condition No. 2:
         1) Sludge Flow Rate to Centrifuge: 75 gpm/centrifuge.
         2) Solids Concentration: 1.75 percent.
         3) Dry solids feed rate: 657 dry lbs/hr/centrifuge.
      c. Design Condition No. 3:
         1) Sludge Flow Rate to Centrifuge: 60 gpm/centrifuge.
         2) Solids Concentration: 2.25 percent.
         3) Dry solids feed rate: 676 dry lbs/hr/centrifuge.
   3. Required Centrifuge Performance Criteria:
      a. Guaranteed Minimum Cake Solids Concentration: 17.0 percent.
      b. Minimum Solids Capture: 95.0 percent.
      c. Maximum Noise Level: 86 dBA.
      d. Maximum Vibration Without Feed: 7 mm/sec.
      e. Maximum Polymer Use: 30.0 lbs/dry ton.
   4. Minimum Required Centrifuge Feed Rates: Centrifuge shall be designed to operate at the following conditions without mechanical or electrical overloading any component of the system.

a. Centrifuge shall be capable of operating at 115 gpm/centrifuge at all feed solids concentrations that will result in a solids loading rate equal to or less than 1,000 lbs/hr/centrifuge.
b. Centrifuge shall be capable of operating at 1,000 lb/hr/centrifuge at all feed solids concentrations that will result in a feed rate equal to or less than 115 gpm/centrifuge.

2.2 SUPPLIERS

A. Products and Suppliers: Provide one of the following:
1. Andritz AG, Model No. D4LL.
2. Westfalia Separator, Inc., Model No. CC458.
3. Or equal.

2.3 GENERAL REQUIREMENTS

A. The centrifuges shall be of the solid bowl type, horizontal, scroll conveyor, suitable for continuous operation modified as necessary to provide the specified features.

B. The centrifuge assemblies shall be identical in design and construction.

C. Individual parts shall be identical in design and workmanship and shall be inter-changeable between the centrifuge assemblies.

D. All components shall be designed for any stresses that may be experienced during fabrication, shipment, erection, operation and maintenance.

E. Each centrifuge assembly shall be provided complete with all equipment, accessories and appurtenances as specified in this Section and as necessary for a complete and operating installation.

F. Each centrifuge shall be provided with an accessible Type 316 stainless steel nameplate, securely fastened to the base or other conspicuous place, and clearly inscribed with the Supplier's name, year of manufacture, model number, serial number, and principal rating numbers. This nameplate shall also carry the Project identification number of the unit. The minimum size of the inscribed and stenciled characters shall be 1/2-inch. The minimum size of the nameplate shall be 6-inches by 12-inches. During the witness shop tests, the same equipment identification number shall also be stenciled on the following parts, where indicated by the witnessing Engineer.
1. Centrifuge cover.
2. Centrifuge lower casing.
3. Centrifuge base.
4. Centrifuge main bearing pillow blocks.
5. Lube oil units.

G. There shall be no rigid connections at the feed tube, solids discharge or liquid discharge on the centrifuge and any other connections in order to prevent transmission of vibration to structures, piping, conduits, etc.

H. The centrifuges shall be furnished with motors that shall not be overloaded throughout the full range of the centrifuge operation.

I. Design of all support structures, platforms and bracing shall be in accordance with AISC Standards.

J. Welding shall conform to AWS D1.1/D1.1M, and for special welding, ASME code for Boiler and Pressure Vessels.

K. All carbon steel surfaces shall be protected by a paint system specifically designed to resist chipping, cracking, and lye or acid corrosion. The paint shall consist of a two-part epoxy metal primer and a polyurethane finish coat.

L. All wetted parts of the centrifuge rotating assembly shall be made of Type 316 stainless steel except for O-rings, seals, and abrasion resistant materials. O-rings and seals shall be made of Viton rubber. The sludge feed pipe, solids discharge, and liquid discharge compartments shall be constructed of Type 316 stainless steel.

M. The centrifuge and its components shall have the following nominal dimensions:
   1. Bowl shall be a minimum of 79 inches long by a minimum of 16 inches in diameter.
   2. Maximum overall centrifuge height of 70 inches.
   3. Maximum overall centrifuge length of 152 inches.
   4. Maximum overall centrifuge width of 45 inches.

N. All the above components shall be within the lifting capacity of a 5 ton bridge crane.

2.4 MATERIALS

A. All Wetted Parts: AISI, Type 316 stainless steel, unless otherwise specified.

B. Bowl Shell: AISI, Type 316 stainless steel.

C. Bowl Wall: Cast Type 316 stainless steel bowl machine grooved along entire length.

D. Feed Port: Sintered tungsten carbide.

E. Gear Box Adapter, Pillow Blocks and Pins: High strength alloy steel.

F. Base-Frame Assembly: Cast-iron ASTM A 48/A 48M, fabricated steel ASTM A 36/A 36M, or a combination of both.

G. Feed Compartment Walls: Field replaceable stainless steel plates with Flame-Sprayed Tungsten Carbide hard surfacing.

H Feed Port: Field replaceable tungsten carbide bushings (Chemical joints, bonds, glue, etc. are not allowed) All joints are to be mechanical (Flanged, etc.)

I. Solids Discharge Port: Field replaceable Tungsten Carbide bushings (Chemical joints, bonds, etc. are not allowed) All joints are to be mechanical (Flanged, etc.)

J. Discharge Casting: Stainless Steel

K. Centrifuge Cover: Fiberglass or Stainless Steel

L. Scroll conveyor: AISI, Type 316 stainless steel.

M. All Bolts, Nuts, and Washers: AISI, Type 316 stainless steel.

N. Flexible Connections: Refer to Paragraph 2.8.B., below.

O. Structural steel shall conform to ASTM A 36/A 36M.

2.5 DETAILS OF CONSTRUCTION

A. General:
   1. The centrifuges shall be high solids, solid bowl, horizontal scroll type units suitable for continuous or intermittent operation requiring minimal maintenance at the service conditions listed.
   2. Contractor shall furnish the units with all required motors, motor starters, internal wiring, control equipment and panels, connections, anchor bolts, maintenance tools and all other appurtenances and accessories to make a complete and operational system. All external piping and external electrical wiring between the various components of the equipment supplied, unless specified otherwise, will be furnished and installed by Contractor.
   3. The centrifuge shall be able to separate at a G-force between 2900 and 3100 This shall correspond to a speed range between 3000 and 3600 rpm.

B. Bowls, Bowl Hubs and Extensions:
   1. Bowls shall be solid horizontal cylinder type with a conical beach extension in which a scroll conveyor fits concentrically. The bowl shall be a minimum of 16-inches in diameter and 79-inches in length. End hubs shall be of 316 stainless steel.
      a. Bowls shall be manufactured from centrifugal or static castings and designed to withstand all centrifugal forces encountered at the maximum design speed, with an adequate factor of safety.
      b. Bowl shall have a 40,000 hour warranty against wear and failure.
      c. Inspect all centrifugal cast material for cracks, shrinkage, porosity, or other defects, by means of a Liquid Penetrant Test. The centrifuge Supplier shall

certify that the Liquid Penetrant Test was performed and that the casting is free of defects.

d. The bowl shall be independently balanced.

2. Pool depth shall be readily adjustable through use of weir plates located at the large diameter end of the bowl.

C. Scroll Conveyor:

1. The centrifuge shall include a horizontal scroll conveyor equipped with helical flights that shall be independently mounted concentrically inside the centrifuge bowl. The scroll shall convey solids from the bowl to the solids discharge ports located at the small diameter end of the conical section. The scroll shall contain a feed compartment designed for the gradual acceleration and low velocity introduction of feed to the centrifuge bowl. Provisions shall be made for introduction of polymer inside this feed compartment to minimize shear forces and polymer consumption. The feed tube shall be Type 316 stainless steel. The scroll flights shall be protected utilizing field replaceable sintered tungsten carbide tiles over the entire length of the scroll. The scroll flights wear protection shall contain a 20,000 hour wear warranty. The Scroll Conveyor shall be dynamically independently balanced to allow for the exchange of one scroll conveyor to another.

D. Frame and Casing:

1. The frame and casing shall be a welded construction designed to act as a protective guard and provide a complete enclosure for process and odor containment. All wetted parts shall be made of Type 316 stainless steel. The casing shall contain the compartments and flanges for the solids and centrate discharge. The centrifuge frame shall be constructed of mild steel. The frame shall be painted with a lye, acid, and impact resistant two-part epoxy resin paint. The casing shall be of Type 316L stainless steel, in the case of the casing being incorporated into the centrifuge cover the entire cover shall be of Type 316L stainless steel. Manufactures utilizing separate casings and covers shall utilize fiberglass, or Type 316 stainless steel for the cover.

E. Main Bearings:

1. Each centrifuge shall be designed so the rotating assembly is supported by two cylindrical roller type main bearings with a minimum ABMA L-10 life without adjustment factors of 100,000 hours at the specified operating condition. The main bearings shall be mounted on the centrifuge frame, and shall be grease or forced oil lubricated. The centrifuge shall include temperature sensors mounted on the bearing housing to directly monitor the bearing temperature and shut down the centrifuge should excessive temperature occur. Monitoring of lubricating temperature shall not be an acceptable method of bearing temperature protection. The internal bearings for the scroll conveyor shall be grease packed and shall be designed for a minimum ABMA-L10 life of 100,000 hours. Scroll bearings shall be externally greased. “Spray or mist” oil lubricators are not allowed

F. Abrasion Protection: To minimize wear from abrasive materials in the feed, the centrifuge shall be equipped with the following features:
   1. Bowl Wall: The full length of the bowl wall shall have evenly spaced longitudinal grooves designed to trap a protective, stationary layer of sludge solids between the bowl wall and the scroll conveyor.
   2. Scroll Conveyor: The face and outer edge of the scroll conveyor flights shall be protected against abrasion over the full length of the scroll conveyor. The feed compartment and discharge ports shall be protected from wear by field replaceable flame-sprayed tungsten carbide components. The flights shall be protected from abrasion by the following method:
      a. The edge and the face of the conveyor shall be protected against abrasion over the entire length of the conveyor by a series of sintered tungsten carbide tiles.
      b. Tungsten carbide tiles shall have a volume loss of no more than 3.0 cubic millimeters at the end of the test. The test shall be conducted in accordance with ASTM G 65, Procedure A. The centrifuge Supplier shall submit test results from a qualified laboratory as part of the equipment submittal specified in Article 1.4, above.
      c. Abrasion protection for the conveyor flights shall be designed for a minimum of 20,000 hours of operation before refurbishment or replacement is required.
      d. Tiles shall be welded to the conveyor. No glued or bolted tile connections to the conveyor will be allowed.
      e. Tiles shall be weight corrected, field replaceable and not directly brazed to the scroll.
   3. Solids Discharge Ports: The solids discharge ports shall be protected by replaceable tungsten carbide inserts. The inserts shall be designed and attached in such a fashion that when localized wear is sufficient to require replacement, they can be rotated to double their useful life.
   4. Casing Discharge: The casing solids discharge shall be protected by replaceable inserts designed to protect the discharge casing from discharged solids abrasion.

2.6 DRIVE SYSTEM

A. The centrifuge shall be V-belt driven. The centrifuges shall be provided with variable frequency drives to optimize and control bowl speed. Speed adjustment will be at the control panel.

B. Main Drive System: The main drive system shall consist of the following:
   1. Variable Frequency Drive (VFD) System:
      a. The bowl drive system shall consist of an electric motor and belt drive system. The belt drive system shall consist of multiple V-belts to provide full load capacity and to withstand the full starting torque of the system, with a VFD.
      b. Provide motor meeting the requirements of Section 11000, Electric Motors, and the additional requirements below:
         1) Horsepower: 60 Hp, maximum.

2) Speed: 1800 RPM.
3) Electrical Characteristics: 460 volts, 60 Hz, 3 phase.
4) Enclosure Type: TEFC.
5) Accessories:
a) Provide motor thermal protection meeting the requirements of Section 11000.
6) Provide an inverter duty rated motor meeting the requirements of Section 11000.

c. With the motor at ambient temperature, it shall be capable of making two complete starts in succession without coasting to rest between starts. The motor shall be capable of at least one restart within one hour after any shut down.

C. Backdrive Systems: The backdrive system shall consist of one of the following:

1. Alternating Current Scroll - Backdrive System:
   a. The centrifuge backdrive motor shall consist of an alternating current/variable frequency drive system in combination with a single-stage Cyclo speed inducer.
   b. Provide motor meeting the requirements of Section 11000, Electric Motors, and the additional requirements below:
      1) Horsepower: 10 Hp, minimum.
      2) Speed: 1800 RPM, minimum.
      3) Electrical Characteristics: 460 volts, 60 Hz, 3 phase.
      4) Enclosure Type: TEFC.
      5) Provide an inverter duty rated motor meeting the requirements of Section 11000.
      6) Accessories:
         a) Provide motor thermal protection meeting the requirements of Section 11000.
   c. The backdrive motor shall be mounted directly above and in-line with the main drive motor. Designs not utilizing a vertical in-line configuration shall not be acceptable.
   d. Backdrive systems utilizing eddy current brakes, direct current or hydraulic drives are not acceptable.
2. Cyclo gear–Backdrive System:
   a. The centrifuge shall be furnished with a cyclo-gear drive system to provide control of the differential speed between the centrifuge bowl and conveyor. The drive system shall consist of an AC inverter duty rated motor mounted on the sub-frame and a torque controller mounted in the control panel. The drive system shall consist of independent cyclo-gears mounted in series. The cyclo-gears shall be forced oil lubricated by an external oil circulation system. Each cyclo-gear shall be independently balanced from the centrifuge and interchangeable. The drive shall be protected from damage due to high torque overload.
   b. The drive shall be furnished with an approved digital dual quadrant variable frequency drive with self-tuning. The drive shall have a maximum wire length to motor of 1,000 feet. Drive shall be constant torque and

factory tested for severe centrifuge duty. The electrical noise shall be in accordance with IEEE Standards. The drive shall include a DC link filter and fundamental power factor of 0.98, and IGBT inverter output, primary filter (EMI/RFI type), and output line chokes with LC filters to control line harmonics.

c. Provide motor meeting the requirements of Section 11000, Electric Motors, and the additional requirements below:
   1) Horsepower: 10 Hp, minimum.
   2) Speed: 1800 RPM.
   3) Electrical Characteristics: 460 volts, 60 Hz, 3 phase.
   4) Enclosure Type: TEFC.
   5) Provide an inverter duty rated motor meeting the requirements of Section 11000.
   6) Accessories:
      a) Provide motor winding thermal protection meeting the requirement of Section 11000, Electric Motors.

2.7 INLET MANIFOLD

A. Centrifuge Supplier shall supply the inlet manifold for each centrifuge assembly. The inlet manifold shall combine and direct into the centrifuge the sludge feed, polymer feed and washwater feed. Final arrangement of the inlet manifold shall be determined during the Shop Drawing phase. The inlet manifold shall be fabricated from Type 316 stainless steel.

2.8 VIBRATION ISOLATORS AND FLEXIBLE CONNECTIONS

A. The centrifuge and motors shall be furnished with vibration isolators that shall be capable of dampening vibration in all directions created during normal centrifuge operation. The vibration isolators shall be sized by the centrifuge Supplier. The centrifuge unit shall be mounted on not less than four Rubber or Spring type isolators. Spring isolator shall consist of not less than one steel spring provided with built-in leveling bolts and dampers to control oscillation. Isolators shall be designed for external level adjustment. After installation, isolators shall be inspected and adjusted by a qualified representative of the centrifuge Supplier. Rubber type vibration isolators shall be of the self-leveling type.

B. Flexible connections shall be provided for all liquid feed and discharge points, including sludge feed, polymer feed, centrate discharge, frame drain, flushing water feed, lube oil lines and solids chute. Due to local conditions, flexible connectors for the main drive motor and centrifuge terminal boxes shall be provided by Contractor ensuring that all local electrical codes are met.
   1. Flexible connectors shall be of black molded neoprene, two-ply fabric reinforced with polyester cord, complete with stainless steel back-up flanges and hardware. Neoprene flanges shall match the dimensions of the centrifuge casing flanges. Face-to-face flange dimension shall be not less than 12-inches.

2.9 CAKE DISCHARGE SLIDE GATE AND CHUTE

A. General:

1. Each centrifuge shall be provided with a cake discharge chute and cake discharge slide gate mounted horizontally as shown on the Drawings and specified herein. The cake discharge slide gate shall slope slightly toward the centrate bypass line.
2. The chute and slide gate shall be designed to receive dewatered sludge (25 percent total solids) discharged from the centrifuge. The chute and slide gate shall be supported independently of the centrifuge, from the floor slab and beams. The slide gate, chute and supports shall be designed to support minimum of 3 cubic feet of residuals weighing 74 pounds per cubic feet when the gate is closed.
3. The chute shall be designed and constructed with flanged fittings at top and bottom to match the centrifuge flexible discharge connection and sloped as required to match the slide gate as shown on the Drawings. Provide nozzle connections on the chute for bypass line and cake discharge flushing line. Provide removable gasketed access door on the side of the chute as shown on the Drawings.
4. The slide gate shall be provided at the discharge of the centrifuge and shall be single blade type with multi-turn actuators, meeting the following requirements:
    a. Dimensions of the slide gate shall be as indicated on the Drawings.
    b. Gate on the live bottom shall be designed to withstand the pressure transmitted by the full load of the discharge of the centrifuge including any potential sludge head load in the interconnecting chute.
    c. Slide gate shall be watertight in the Closed position.
    d. The gate shall be designed to span the width of the centrifuge discharge chute and shall not introduce a restriction in the flow of sludge to downstream equipment.
    e. The gate shall incorporate a ramping mechanism which shall be used to force the gate blade against the blade seal when in the closed position.
    f. Gate Frame:
        1) The gate frame shall be constructed of 304L stainless steel using heavy duty structural channels, plate and angles.
        2) Frame shall be designed for maximum rigidity and extend in one continuous piece to support the travel of the blade.
        3) The frame shall include a 6-inch diameter flanged drain connection to allow low solids material to be diverted to the centrate line when the gate is closed.
        4) The frame shall include a tapered transition section to the drain.
        5) The frame shall include any external mounting hardware to accommodate the electric actuator and discharge chute extension.
        6) The gate frame shall bolt to the discharge of the interconnecting chute and shall be supported by the equipment on the discharge flange. All connections shall be flanged, bolted and gasketed.
        7) Gaskets shall be neoprene, and hardware shall be 316 stainless steel.
    g. Gate Blade:

1) The gate blade (sliding member) shall be constructed of one piece of Type 304 stainless steel. Stainless steel liners over carbon steel shall not be acceptable.
2) Plate thickness shall be minimum 0.75 inch. Actual thickness to be determined by the manufacturers to limit deflection to 1/360 of the span based on the full design load on the blade.
3) The blade shall travel on and be supported by permanently sealed, type 303 stainless steel rollers with AFBMA L_{10} life of 100,000 hours under maximum load.
4) The blade end connected to the actuator shall have a ramp and seals that prevent leakage when the gate is fully closed or open. The gate seal shall consist of a one-piece molded neoprene ball seal with a minimum diameter of 2 inches. The seal shall extend around all four sides of the gate and shall be retained by Type 316 stainless steel retainer bars that shall ensure positive contact of the seal with the blade in the closed position.
5) To prevent binding of the gate during operation, the actuator shall engage with the blade in a minimum of two places. The interior longitudinal sidewalls of the gate frame shall be lined with UHMW strips to ensure easy operation and to prevent racking of the blade during operation.
6) The blade transmission mechanism shall be either rack and pinion type, or dual Acme screw and busing type. Acme screws shall be ANSI standard size only, right hand pitch, and single lead.

5. Open/Close Electric Actuator:
   a. Manufacturers:
      1) Rotork.
      2) Limitorque.
      3) Or equal.
   b. Application Criteria:
      1) Ambient Temperature Rating: -22 to +158°F.
      2) Ambient Humidity: 100 percent.
      3) Power Supply: 460 volts, 3 phase, 60 Hz.
      4) Control Voltage: 120 VAC, single phase, 60 Hz.
      5) Torques: Per gate manufacturer.
      6) Duty Cycle: 60 starts per hour, minimum.
   c. General:
      1) Conform to AWWA C540, Power-Actuating Devices for Valves and slide gates, and as specified herein.
      2) Provide actuator operable with handwheel or chain wheel even after the electric motor has been disengaged and removed.
      3) Coordinate sizing of electric actuator with the gate manufacturer who shall furnish the gate and the electric actuator as a unit.
      4) The electric actuator shall be suitable for the gate orientation as shown.
   d. Electric Motor:
      1) General:

a) Provide motor suitable for OPEN-CLOSE service, of high torque characteristics and maximum 70°C temperature rating.

2) Motor Construction:

a) Provide motor meeting the requirements of Section 11000, Electric Motors, and the additional requirements below:

1) Electrical Characteristics: 460 volts, 60 Hz, 3 phase.

2) Enclosure Type: TEFC.

e. Actuator Gearing:

1) Housing: Die-cast aluminum or cast iron.

2) Close coupled to electric motor.

3) Input Shaft Gearing: Spur, bevel, or single stage worm gear design assembly.

4) Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.

5) All gearing shall be of hardened alloy steel or a combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.

6) Lubrication: Grease or oil bath.

7) Input Shaft: Hardened alloy steel.

f. Limit Switches:

1) Four contacts shall be provided which can be selected to indicate any position of the gate with each contact externally selectable as normally open or normally closed.

a) The contacts shall be rated at 5A, 250 VAC, 30 Vdc.

b) As an alternative to providing gate position, any of the four contacts shall be selectable to signal one of the following:

(1) Gate Opening or Closing.
(2) Gate Moving (Continuous or Pulsing).
(3) Local Stop Selected.
(4) Local Selected.
(5) Remote Selected.
(6) Open or Close Interlock Active.
(7) ESD Active.
(8) Motor Tripped on Torque in Mid-Travel.
(9) Motor Tripped on Torque Going Open.
(10) Motor Tripped on Torque Going Closed.
(11) Pre-Set Torque Exceeded.
(12) Gate Jammed.
(13) Actuator Being Operated by Handwheel.
(14) Lost Main Power Phase.
(15) Customer 24 Vdc or 120 VAC Supply Lost.
(16) Internal Failure Detected.
(17) Thermostat Tripped.

c) In the event of a (main) power (supply) loss or failure, the four position contacts must be self latching to maintain interlock capabilities.

d) The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2.0 kV.

2) Provide OPEN and CLOSE limit switches geared to the drive mechanism and in step at all times, whether the unit is operated electrically or manually and whether or not the actuator is powered by the electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.

3) Provide driven mechanism totally enclosed to prevent entrance of foreign matter or loss of lubricant.

4) Switches shall be rated 10 amperes at 120 volts.

g. Torque Switches:

1) Provide adjustable torque switches with each gate actuator. The torque switches shall operate during the complete gate cycle without the use of auxiliary relays, linkages, latches or other devices.

2) It shall be possible to select the torque switches to control the OPEN and CLOSE limit positions in either direction of gate travel.

3) Provide dry contacts (10A, 120 VAC) for remote high torque alarm.

4) Torque and turns limitation to be adjustable as follows:

a) Position Setting Range: Multiturn 2.5 to 100,000 turns, with resolution to 7.5° of actuator output. 1/4 turn – 90 degrees + or – 5 degrees at each end.

b) Torque Setting: 40% to 100% rated torque.

c) Torque sensing must be affected directly electronically. Torque measurement shall be independent of variations in frequency, voltage or temperature.

d) "Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.

h. Handwheel Operation:

1) Furnish the actuator with a handwheel for manual operation, so connected that operation by the motor shall not cause the handwheel to rotate.

2) Should power be returned to the motor while the handwheel is in use, design of the unit shall prevent transmission of the motor torque to the handwheel.

3) The handwheel shall require an effort of no more than 80 pounds on the rim for seating or unseating load, or 60 pounds on running load.

4) The handwheel shall have an arrow and the word OPEN or CLOSE indicating required rotation. The handwheel shall operate in the clockwise direction to close.

i. Controls:

1) Provide the following controls in a separate compartment integral with the actuator.

2) The enclosure shall be NEMA 12.

3) Starter: Reversing magnetic starter.

4) Control Power Transformer: Provide a transformer to transform the rated three phase, 60 Hz power to 120 volts, single phase. The transformer shall be complete with a grounded and fused secondary and dual primary fuses.
5) Provide LOCAL/OFF/REMOTE selector switch. LOCAL position provides operation from OPEN/CLOSE pushbuttons. OFF position disables local and remote operation. REMOTE position enables OPEN/CLOSE control from the Dewatering Centrifuge 1 Control Panel (DWC1-CP).
6) Provide OPEN/CLOSE pushbuttons with hold-to-run or momentary contact selection.
7) OPEN/CLOSE indicating lights and 0 to 100 percent position indication on a liquid crystal display window.
8) Provide thermal overload and single phasing protection of the motor.
9) Provide a set of dry contacts to remotely indicate that the actuator is available for remote operation.
10) Actuator circuit boards shall be rated for high temperature service, minimum 55°C.
11) Provide electrical interlocks as shown on the Drawings.

j. Testing:
1) Test actuator in the shop in conformance with AWWA C540.

6. The cake discharge slide gate, cake discharge chute and centrate transition piece shall be of stainless steel construction and provided by the centrifuge manufacturer as indicated on the Drawings.
7. Provide an expansion coupling per 15120, Piping Specialties and Accessories.

B. Testing:
1. Each slide gate shall be fully assembled and shop inspected for proper seating and leak tested at the factory.
2. Conduct functional field test of each slide gate in the presence of the Engineer to demonstrate that the gates function correctly.

2.10 ANCHOR BOLTS

A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment Supplier. Provide hooked anchor bolts for direct embedment during placement of concrete. Anchor bolt materials shall be of Type 316 stainless steel conforming to the requirements of Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.

2.11 MONITORING AND CONTROL

A. Controls:
1. All controls required for the operation, monitoring, and control of the centrifuges shall be supplied as described herein and as required for proper operation. All components in the control panel shall be completely factory wired and tested.

a. Control of the centrifuge and ancillary equipment shall be accomplished by one control panel. The use of separate controllers or processors for drive control operation is not acceptable.
b. Control system programmable logic controller shall be Siemens S7-300 Series, with Ethernet and Profinet functionality. Operator interface terminals (OIT) shall be Siemens Simatic TP270, with WinCC Flexible Engineering Software.
c. Control system shall be compatible with the plant-wide Ethernet system.
d. Submit a listing of all addresses and/or register locations of all data points for monitoring and control of the centrifuge. Provide PLC program on CD for Owner.
e. All interlocks between the Dewatering Centrifuge 1 Control Panel (DWC1-CP) and peripheral equipment, including the Centrifuge Feed Pumps and Residuals Discharge Conveyor shall be through the Plant PLC via Ethernet as shown on the Drawings. It shall be the responsibility of the centrifuge supplier to coordinate with the Plant PLC programmer to provide and obtain PLC addresses and register for the control interlocks as specified herein.

2. Each centrifuge shall be supplied with one control panel.
   a. The Dewatering Centrifuge 1 Control Panel shall be a freestanding double door enclosure rated NEMA 12 and shall be suitable for installation in the Screening and Dewatering Building (SDB) Electrical Room.
      1) Main control components shall consist of but not be limited to: programmable logic controller, control relays, and terminal blocks for interconnection with ancillary equipment.
      2) A public IP address shall be made available to the manufacturer for remote diagnostics, data transfer and online analysis.
      3) Door mounted components shall consist of illuminated "CONTROL POWER" ON/OFF selector switch, mushroom head maintained emergency stop, and a color touch screen OIT for control and monitoring of complete system.
   c. The DWC1-CP, including all control panel components, shall comply with the requirements of Section 13430, Control Panels and Enclosures.
   d. The DWC1-CP shall be equipped with a main circuit breaker/disconnect.
   e. OIT and control functions on front door shall as a minimum, include:
      1) START/STOP, ON/OFF controls of:
         a) Auto Sequence.
         b) Clean In Place Sequence.
         c) Centrifuge Drives.
         d) Washwater Valves.
         e) Cake Discharge Diversion System.
         f) Polymer Systems.
         g) Centrifuge Feed Pumps.
         h) Wake Mode.
         i) Sleep Mode.
         j) Pause Mode.
         k) Residuals Discharge Conveyor.

l) Alarm Control.

2) OIT control status indications shall include the following:
   a) System Control Power Indication.
   b) Auto Start Indication.
   c) Auto Stop Indication.
   d) CIP (Clean in Place) System Engaged.
   e) Centrifuge Running.
   f) Detwatering Centrifuge 1 Washwater Solenoid Valve Open.
   g) Dewatering Centrifuge 1 Discharge Chute Solenoid Valve Open.
   h) Dewatering Centrifuge 1 Discharge Diverter Valve Open.
   i) Dewatering Centrifuge 1 WAS Feed Valve Open.
   j) Polymer Feed Unit 1 Running.
   k) Polymer Feed Unit 2 Running.
   l) Centrifuge Feed Pump Running.
   m) Residuals Discharge Conveyor Running.
   n) Bowl Speed in RPM.
   o) Backdrive Speed in RPM.
   p) Backdrive Torque in Percent.
   q) Relative Speed in RPM.
   r) Vibration in In/Sec.
   s) Polymer Feed in GPM.
   t) Sludge Feed in GPM.
3) OIT alarm indication shall include the following:
   a) Centrifuge Emergency Stop.
   b) Main Drive VFD Fault.
   c) Main Drive Motor Temperature Fault.
   d) Backdrive VFD Fault.
   e) Backdrive Motor Temperature Fault.
   f) Backdrive High Torque Indication.
   g) Backdrive High-High Torque Indication.
   h) High Vibration Indication.
   i) High-High Vibration Indication.
   j) Low Relative Speed Indication.
   k) Polymer Feed Unit 1 or 2 Fault.
   l) Centrifuge Feed Pump Fault.
4) An OIT RESET pushbutton shall be provided. Pressing the RESET pushbutton prior to eliminating the cause of the fault shall not allow the centrifuge to be restarted or the indication to go off.
5) OIT speed controls shall include the following:
   a) Bowl Speed.
   b) Scroll Relative Speed (PI Manual).
   c) Scroll Torque (PI Auto).
   d) Polymer Feed Units.
   e) Centrifuge Feed Pumps.
6) OIT shall provide selection for the following:
   a) Backdrive ON/OFF.
   b) Washwater valve AUTO/MANUAL.

c) Discharge chute valve AUTO/MANUAL.
d) Discharge diverter valve AUTO/MANUAL.
e) WAS Feed Valve AUTO/MANUAL.
f) Feed Pump Selection:
i. Centrifuge Feed Pump 1.
ii. Centrifuge Feed Pump 2.
g) Centrifuge feed pump AUTO/MANUAL.
h) Polymer Feed Unit Selection:
i. Polymer Feed Unit 1.
ii. Polymer Feed Unit 2.
i) Polymer Feed Units AUTO/MANUAL.
j) Residuals Discharge Conveyor AUTO/MANUAL.

7) All readings shall be in Engineering units.

f. All other controls, transformers, starters, and controllers shall be provided as required for a complete and operational system. A ground fault, duplex 120 VAC receptacle shall also be mounted internal to the panel.

g. The panel shall be provided with lifting eyes. The outer dimensions of the panel shall not exceed 90 inches high, 60 inches wide and 24 inches deep. All panel mounted components and panel construction shall be in conformance with the specifications in Section 13430, Control Panels and Enclosures, and Section 13440, Panel Mounted Instruments.

2.12 OPERATION SEQUENCE

A. Operation:

1. Prior to centrifuge start-up, a permissive signal shall be provided to the Plant PLC to start the transfer conveyor. The centrifuge shall be interlocked with the discharge conveyor controls at the DWC1-CP to prevent remote operation until the discharge conveyor is running as verified by the discharge conveyor zero speed switch.
2. After the discharge conveyor has started and is running, the centrifuge shall be activated by pressing the OIT centrifuge START button locally at the DWC1-CP. Pressing the OIT START button shall illuminate the centrifuge OIT START graphic.
3. The polymer feed units and centrifuge feed pumps shall be operated manually at their local control stations or remotely at the DWC1-CP. When the polymer feed units or centrifuge feed pumps are in the REMOTE mode, they shall be interlocked with the centrifuge controls and shall not run unless the centrifuge is in the RUN mode (UP-TO-SPEED).
4. During starting, the backdrive shall be automatically set to a maximum differential to provide maximum scrolling of residual solids from the bowl.
5. After a preset, timed interval, during which the bowl has reached full operating speed, the START light shall go out and the RUN light shall come on. A feed permissive from the DWC1-CP shall be provided to the Plant PLC to allow sludge feed to the centrifuge.
6. Operation of the centrifuge feed pumps and polymer feed units shall be initiated from the DWC1-CP in the REMOTE mode. The centrifuge feed pumps, and

polymer feed units shall also be started and run from the local control station in the LOCAL mode, but shall not be interlocked with the centrifuge controls.

7. When the DWC1-CP receives a signal that the selected/interlocked centrifuge feed pump is running (i.e. feeding sludge to the centrifuge), the discharge chute valve shall be opened. During this initiation of dewatering, the slide gate on the cake discharge chute shall be closed and the discharge diverter valve shall be open. The dewatered sludge shall initially flow through the bypass line into the centrate discharge.
8. As the percent solids in the dewatered sludge increases, the torque shall increase until it exceeds a setpoint that shall signal the initiation of the following sequence:
   a. First, the discharge chute valve shall CLOSE.
   b. Then the slide gate shall OPEN and discharge diverter valve shall CLOSE, simultaneously.
9. Backdrive: As process requirements vary, the backdrive speed shall be infinitely adjustable. The backdrive controller shall be capable of maintaining a set speed while the torque is allowed to vary as process parameters change.
10. Autotorque: After stable operation has been achieved, the AUTO-TORQUE mode may be selected. In this mode, the backdrive torque shall be maintained while the speed is allowed to vary, within preset limits, in order to maximize residence time of the solids. If torque begins to rise above a set point, the differential speed shall be increased to scroll solids out of the bowl at a faster rate; thereby, lowering the torque back to a set point. Conversely, if torque begins to fall below the set point, the differential speed shall be decreased; thereby, providing a longer residence time and increasing the torque back to the set point.
11. Centrifuge Shutdown: The centrifuge shall be stopped manually at the DWC1-CP. Upon stopping the centrifuge, normally or via a FAULT condition, the interlock at the DWC1-CP shall cause the interlocked centrifuge feed pump and polymer feed unit to shutdown in the REMOTE mode, thus stopping feed to the centrifuge (however, normally the feed from the centrifuge feed pump and polymer feed unit shall be shutdown manually before centrifuge shutdown). Once the centrifuge feed pump and the polymer feed unit have been shut down, the DWC1-CP shall cause the WAS feed valve to close. The backdrive shall again be automatically set to a maximum differential to provide maximum scrolling of residual solids from the bowl during coast down. The backdrive shall be automatically stopped at the end of the coast down by an adjustable shutdown timer. After the torque falls below a setpoint during shutdown, the following sequence shall occur:
    a. The cake discharge slide gate shall CLOSE and discharge diverter flush valve shall OPEN simultaneously.
    b. Then the cake discharge flush valve and washwater valve shall OPEN and stay open for an adjustable time period then CLOSE.
12. Feed Shutdown: In order to move sludge cake storage trucks or containers, a shutdown of the sludge and polymer feed shall be required to temporarily stop dewatering and the discharge of sludge cake. The centrifuge feed pumps and polymer feed units shall be stopped remotely at the DWC1-CP or locally. The

centrifuge shall continue running and the remaining solids shall be scrolled out. When torque falls below the setpoint, the following sequence shall occur:

a. The WAS feed valve shall close.
b. The cake discharge slide gate shall CLOSE and discharge diverter valve shall OPEN simultaneously.
c. Then the discharge chute valve shall OPEN and stay open for an adjustable time period.
d. If necessary, the torque setpoint may be lowered to scroll the remaining solids out of the bowl at a faster rate. When the operator is ready to resume dewatering, the torque setpoint is returned to normal (if necessary) and the centrifuge feed pumps and polymer feed units are manually restarted.

13. Emergency Shutdown: The centrifuge emergency stop shall be activated at the DWC1-CP. Upon pressing an EMERGENCY STOP pushbutton the centrifuge shall completely shutdown and the interlock at the DWC1-CP shall cause the interlocked centrifuge feed pump and polymer feed unit to shutdown in the REMOTE mode, thus stopping feed to the centrifuge.

2.13 SURFACE PREPARATION AND SHOP PAINTING

A. Machined, polished, and non-ferrous surfaces shall be coated with corrosion prevention compound.

B. Surfaces requiring painting or coating for corrosion protection shall be smooth, free from sharp edges, burrs, and projections and shall have all welds ground smooth and all edges and corners of structural members rounded. Non-conformance shall be grounds for rejection of equipment, as determined by the Engineer.

C. Equipment shall receive Supplier’s standard priming and final finish paint systems prior to delivery to the Site.

D. All metallic surfaces shall be primed with an approved shop priming system that has been certified, by letter, as being compatible with the shop finish coating systems and shall be applied in accordance with the recommendations of the paint Supplier. Submittal for equipment shall include:

1. Coating Supplier's "Cut-sheet" describing components, surface preparation requirements, recommended mill thicknesses, and application procedures for the proposed primer.

E. Surfaces of equipment, which will be inaccessible after assembly, shall be painted or otherwise protected before assembly by a method that provides protection for the life of the equipment. Contractor shall furnish equipment to replace any equipment that the Engineer determines to be damaged beyond repair by rust or mishandling, etc., while in storage or during installation by Contractor.

F. Equipment or motor data nameplates shall not be painted.

G. Machined, polished, and other ferrous and non-ferrous surfaces that are not to be painted shall be coated with rust preventative compound, Dearborn Chemical "NO-Ox-Id", Houghton "Rust Veto 344," Rust-oleum "R9," or equal. Should rust occur during shipment or storage, Contractor shall be responsible for correction, as determined by the Engineer.

H. Copper, bronze, chromium plate, nickel, stainless steel, aluminum, monel metal, lead, lead coated copper, brass, and plastic are not to be painted or finished, unless otherwise specified or recommended by the Supplier.

I. After delivery to the Site, equipment surfaces shall be inspected and evaluated by the Engineer. Touch-up may be required as determined by the Engineer based on the condition of the equipment.

J. One gallon of each type and color of finish paint shall be shipped with the equipment for touch-up purposes.

2.14 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. The centrifuge shall be provided with the following spare parts and special tools:
   1. One set of main bearings.
   2. One set of conveyor bearings.
   3. One set of thrust bearings, seals and lockwashers.
   4. One complete set of gaskets, O-rings and seals.
   5. One set lubricants.
   6. Two sets of any special tools required for normal operation and maintenance.
   7. Power fuses – one set of each type and size used in the VFDs.
   8. Control power fuses - one set of each type and size used in the VFDs.

B. The centrifuge system shall be provided with the following special tools:
   1. One set of Universal Tools.
   2. Set of spanners, set of hexagon keys, pliers, snap rings remover, screwdriver, wrenches, sockets.
   3. One set of lifting straps for lifting the machine housing.
   4. One scroll/bowl lifting device.
   5. One scroll motor lifting device.
   6. One set of straps for lifting the main motor assembly.
   7. One gear lifting device.
   8. One power assist tool (6:1).
   9. One complete set of threaded spindles and plates used for disassembling and assembling close tolerance parts.
   10. One bearing puller.
   11. One complete set of conveyor extracting tools.
   12. One complete set of pillow block lifting eyebolts.
   13. One pillow block bearing nut wrench.
   14. One tension bar nut wrench.
   15. One seal holder puller.

16. One pillow block bearing remover.
17. One pillow block dowel pin remover.
18. One dowel pin sleeve extractor.
19. One gearbox adapter removal aid kit.

C. Spare parts and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.

2.15 LUBRICANTS

A. Furnish and install oil and grease required for initial operation. Products shall be as recommended by the Supplier.

2.16 POLYMER FOR START-UP AND TESTING

A. The polymer scheduled for use at the plant shall be utilized during start up and testing. The polymer shall be provided by the Owner. All field sampling shall be requested, scheduled and coordinated by Contractor through the Engineer.

2.17 SOURCE QUALITY CONTROL

A. Shop Performance Tests:
   1. Upon completion of manufacture of the centrifuge(s) and appurtenances to be installed on this Project, conduct both wet and dry shop tests on the centrifuge(s) as described below. The test facility shall be under the control of the Supplier and be a full-service facility capable of conducting the described tests and modify the equipment based on results of the testing. The shop tests shall be conducted using the actual equipment, including motors, to be supplied on this Project. The control panels may be tested separate from the testing of the centrifuge. Each centrifuge to be supplied shall be tested. Each centrifuge shall first be tested under dry conditions and then filled with water to simulate wet operating conditions:
      a. Centrifuge Operation:
         1) Running test: Each machine and motor, through normal start, normal stop, and emergency stop cycles and a minimum of four hours of continuous operation at proposed design operating speed.
         2) Demonstrate that all equipment is capable of running, stopping, and continuous operation in a satisfactory manner without mechanical defects or operational difficulties. A maximum of 2-mils of displacement, peak to peak, measured on the centrifuge pillow blocks at operating speed will be acceptable under dry run shop test conditions and 2-mils when filled with water. Measure and record vibration.
         3) If necessary, tests shall be repeated until satisfactory results are obtained.

4) The centrifuge shall be equipped with noise suppression devices such that the noise level measured at three feet around the periphery of the complete centrifuge assembly shall not exceed 86 dBA when tested at the manufacturing facility, without feed and with the discharge openings closed and at the specified operating conditions. These devices shall not include items such as ventilated enclosures which require additional power, but shall include items such as low noise motors (main drive), and may include insulation of the equipment.

b. Centrifuge Construction: Prior to assembly all surfaces including the bowl, scroll, shafts, casing, base, supports, flanged connections shall be examined for cracks, shrinkage, porosity or other defects by means of a liquid dye penetrate test.

c. Instruments and controls on the control panel shall be checked, adjusted and certified accurate.

d. All testing facilities, lubricating oil, instruments, equipment and electrical power shall be supplied by Manufacturer at their expense.

e. Upon completion of the tests, submit six copies of the shop test results, certified by a Registered Professional Engineer, who shall sign and seal the test results, to the Engineer. Shop test results shall include vibration (displacement), noise, speed of bowl, and speed of scroll, as well as a description of the testing procedure.

f. All defects or defective equipment revealed by, or noted, during tests shall be corrected or replaced promptly and centrifuges retested.

2. In the event that the centrifuges do not meet the requirements of this Section during shop testing, the Supplier shall modify the equipment, and methods of operation, at no additional cost to the Owner. After adjustments or modifications, the centrifuges shall be re-tested. A maximum of two retests shall be allowed. If the centrifuges, after shop testing is completed, do not meet the requirements of this Section, the Owner may reject the equipment in its entirety and exercise the options available under the terms of the Contract Documents.

3. Contractor shall notify the Owner and Engineer of the test dates and test schedule at least 21 days prior to start of the testing. The test may be observed by the Owner and Engineer.

   a. If it becomes necessary to repeat specific tests at another time or testing is not ready to commence at time of Engineer and Owner visits, Contractor shall reimburse Engineer and Owner for subsequent visits to observe the specific test.

   b. Such reimbursements shall include both time and expenses.

   c. Contractor acknowledges that neither the Owner nor the Engineer has any specialized training or knowledge of centrifuges and that their presence at Manufacturer's facilities is solely for the benefit of the Owner. Any approvals or failure to detect or object to the performance or results of tests witnessed by the Owner or the Engineer shall not in any way be deemed to waive any non-conformity with the requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install in a manner and to the tolerances recommended by the equipment Supplier and the approved Shop Drawings.

B. Contractor shall install centrifuge systems and provide all electrical and piping connections at the points of interface required for system operation as specified herein.

C. All final electrical connections to the centrifuge or centrifuge local devices shall be made with flexible conduit.

D. Power, control, and instrument cables shall be installed in separate conduits and cable trays as shown.

E. Install the Supplier provided instrument cables for speed and temperature signals, as directed by the centrifuge Supplier.

3.2 FIELD QUALITY CONTROL

A. Inspection:
   1. Inspect and verify that structures or surfaces on which equipment will be installed have no defects which will adversely affect installation.
   2. Inspect all equipment prior to installation.
   3. Promptly report defects that may affect the Work to Engineer.

B. Supplier's Services:
   1. The centrifuge Supplier shall provide written guidance and on-Site advisory assistance in the installation of all equipment supplied herein.
   2. Submit detailed instructions on preparation and installation of the centrifuge assemblies.

C. Observe Contractor during unloading of the centrifuge assembly. Inform the installation Contractor in method of storage and notify the Engineer, in writing, when storage does not conform to Supplier's requirements. Provide all necessary maintenance on centrifuge assemblies during period of storage.

D. Provide technical installation assistance to Contractor.

E. Check and approve the installation before operation.

F. Field Service Technician Qualifications:
   1. The Supplier shall dispatch factory-trained technicians to service the equipment. The technicians shall be in the direct employ of the Supplier.
   2. A fully qualified field service department shall support all field service.

3. Field service shall be available 24-hours per day, seven days per week.

G. Start-up and Testing:
   1. Start-up services and SOD shall be performed by the centrifuge manufacturer as described and required to place the equipment into proper operation and demonstrate to the Owner that the equipment shall satisfactorily perform the functions and criteria specified in Part 2.
   2. Following completion of each centrifuge installation phase, including electrical and process piping and the completion of all other support systems such as centrifuge feed pumps, thickened sludge pumps and polymer system, the centrifuges shall be started and placed into operation by the centrifuge manufacturer. All signals, controls, interlocks and alarms shall be checked to assure proper operation and control.
   3. A qualified factory-trained representative shall provide the following services, as a minimum:
      a. Two (2) workdays for onsite inspection, certification of installation and for pre-start-up classroom and onsite equipment instruction and maintenance training.
      b. Five (5) workdays for start-up and performance testing and for post-start-up classroom and onsite equipment instruction, troubleshooting, and other follow-up services.
   4. Contractor shall notify the Engineer when process start-up and SOD shall take place so the Engineer and Owner can observe. A minimum of 72 hours notice shall be provided.
   5. Provide all test apparatus required at no extra cost to Owner.

H. The solids capture shall be determined based on the following equation:

$$\text{Capture} = \frac{c * (f-e) * 100}{f * (c-e)}$$

Where: c = cake solids (%TS),
f = feed solids (%TS), and
e = centrate solids (%TS).

I. Emergency Service:
   1. Provide the services of the Supplier to be present within 24-hours for on-Site emergency services of all the furnished equipment. Emergency service shall be required for failure of any major component of the centrifuge equipment.
   2. Emergency service shall be provided, at no additional cost to the Owner, throughout the one-year warranty period from the day of Owner Final Acceptance.

3.3 FIELD PAINTING

A. Field painting shall conform to the requirements of Section 09900, Painting.

3.4 SYSTEM OPERATION DEMONSTRATION (SOD)

A. General:
   1. An SOD on the centrifuge shall be conducted within the first year after Substantial Completion at a time selected by the Owner. The SOD shall not be performed until activated sludge is being wasted as part of the first test period of the residuals reduction system. Waste activated sludge is not anticipated to be available until 10 months after Substantial Completion. The SOD shall be conducted by the centrifuge Supplier using waste activated sludge.
   2. For the demonstration, the system shall be defined as including all equipment, panels, controls, instruments, wiring and miscellaneous equipment specified in this Section.
   3. Comply with Section 01752, Equipment and System Startup and Performance Testing.

B. The purpose of the SOD is to demonstrate that all equipment is operational as specified herein to the satisfaction of the Owner. All aspects of the system shall be demonstrated to meet the criteria specified in this Section. Each SOD shall consist of meeting the criteria as specified below.

C. The SOD shall be conducted on the centrifuge installed. The test shall be conducted at the performance requirements of Paragraph 2.1.B over a period of five consecutive operating days (three days optimization and two days testing). The SOD shall be conducted for a minimum of six hours per day during day shifts, Monday through Friday.

D. At minimum, one factory trained technician shall be present during the entire SOD.

E. The Owner shall be permitted at his option to witness portions or all of the SOD.

F. Successful completion of the SOD shall be required prior to Final Acceptance of the equipment. However, successful completion of the SOD does not constitute grounds for final acceptance.

G. Mechanical Criteria Segment:
   1. If total downtime exceeds 3 hours, the SOD shall not be accepted. A new SOD shall be scheduled after adjustments are made by the Contractor and/or centrifuge manufacturer.
   2. The Contractor shall be permitted to adjust operation of the centrifuge and polymer dosages during the SOD.
   3. No maintenance shall be permitted during the demonstration period except routine maintenance recommended in Supplier's Operation and Maintenance Manual. This includes only the maintenance tasks which are to be performed more than once every week.

H. Process Criteria Segment:
   1. General:
      a. Collect data during each hour of the SOD.
      b. The Owner, at his option, shall assist in data collection and determine time and location of sample collection.
      c. The Owner, at his option, shall be provided with duplicate samples by the Contractor.
      d. Data shall be tabulated for each shift.
      e. The final performance data shall be the arithmetic average of the sum of the data from the last two days testing data. The final performance data shall demonstrate that the centrifuge meets the operating conditions and performance guarantees specified in Paragraph 2.1.B of this Section.
      f. The date, time, and sampler shall be recorded for each sample taken or data point collected.
      g. Contractor shall perform the necessary laboratory analysis.
   2. Data Collection and Analysis:
      a. Feed, cake and flow stream samples shall be sampled once per hour and analyzed by the Contractor.
      b. Polymer usage shall be monitored during the SOD. Polymer usage shall be recorded at approximately the same time samples are taken of feed, cake, and centrate. Total quantity of polymer utilized per day shall be recorded. Polymer usage shall not exceed conditions specified in Paragraph 2.1.B. Polymer for the centrifuge field acceptance test shall be provided by the Contractor. The neat polymer concentration shall be 25 percent to 50 percent active solids.
      d. Sludge feed and total polymer flow shall be monitored during the SOD. These flows shall be recorded at the same time feed, centrate, and cake

sample measurements are taken. Total quantity of sludge fed per day shall be recorded.

I. Upon successful completion of the SOD, the centrifuge Supplier shall prepare a written report. This report shall be submitted to the Owner and Engineer and shall summarize pertinent details regarding the test as well as test results to demonstrate that the tested centrifuge shall comply with specified performance criteria.

3.5 SUPPLIER'S FIELD SERVICES

A. All equipment will be given running tests by Contractor at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, Contractor shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the Engineer, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.

B. A factory trained representative of the Supplier shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three visits to the Site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation, to complete field tests, and supervise initial operations. The third visit shall be to instruct the Owner's personnel in the proper care, operation, and maintenance of the equipment in accordance with Section 01821. Supplier's representative shall test operate the system in the presence of the Engineer and verify that the equipment conforms to the requirements.

C. Supplier's Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the Owner.

3.6 ONLINE TRAINING

A. Provide online training per Section 01821 for all equipment included in this section.

++ END OF SECTION ++