

## SECTION 1 CENTRIFUGE DEWATERING EQUIPMENT

### Part 1 General

#### 1.01 Description

- A. Furnish centrifugal dewatering equipment and appurtenances as indicated and as specified. Installation will not be part of this contract. However, assembly of the centrifuge platform as shown on the drawings is required prior to shipment.
- B. The specifications direct attention to certain features of the equipment, but do not purport to cover all details entering into the design and construction of the equipment, controls, or appurtenances.

#### 1.02 System Description

##### A. General:

- 1. The centrifuges shall be of the solid bowl, horizontal continuous feed, scroll type, specifically designed to thicken and dewater sludge.
- 2. The centrifuge shall be designed and constructed to operate continuously.
- 3. The centrifuges shall be capable of performing in accordance with the requirements set forth in these specifications. In order to be assured of meeting the required performance, the centrifuges shall be capable of operating at a speed to produce a G force of 3000. Speed control shall be provided by a solid-state variable frequency drive (frequency inverter).

##### B. Components and Appurtenances:

- 1. All equipment shall be furnished by the manufacturer of the centrifuge dewatering units; however, all equipment need not be manufactured by a single manufacturer.
  - 2. All components, including but not limited to the following, shall be considered as part of the sludge dewatering package and become the responsibility of the sludge dewatering equipment manufacturer:
    - a. Centrifuge Assembly.
    - b. Main Drive Motor with variable frequency drive.
    - c. Hydraulic Scroll Drive System & controller.
    - d. Grease Lubrication System.
    - e. Control Panel and Wiring.
-

- f. Motor Starters and Appurtenant Enclosures.
  - g. Flexible Connectors, Thickened/Dewatered Sludge, and Centrate Chutes.
  - h. Spare Parts
  - i. Special Tools
3. All equipment, components and appurtenant items shall be furnished and installed as complete assemblies. The interconnecting wiring, conduit, piping shall be furnished by others.

1.03 Conditions Of Service

- A. Sludge dewatering equipment and appurtenances are to be installed in areas of a heated building specifically designed for these systems.
- B. The equipment and its appurtenances shall be suitable for exposure to splash and spill conditions, and 100% humidity.
- C. The equipment and its appurtenances shall be capable of receiving, conditioning and dewatering the feed sludge specified herein, and discharging the dewatered sludge into a screw conveyors for further transport. Each unit shall be capable of operating continuously and shall be suitable for thickening/dewatering the specified sludge continuously for up to 24 hours per day, 7 days per week.
- D. The feed sludge will have the following characteristics:

1. Sludge Feed Characteristics

Type of Sludge: \_\_\_\_\_

Sludge Concentration: \_\_\_\_\_ TS

Volatile Solids: \_\_\_\_\_ %

SVI: \_\_\_\_\_

Temperature: \_\_\_\_\_ F

pH: \_\_\_\_\_

2. Sludge Quantity (Excluding Polymers)

a. Dewatering \_\_\_\_\_ gpm  
up to \_\_\_\_\_ lbs/hour

1.04 Required Performance

---

A. Each centrifuge shall achieve the minimum following performance while dewatering the sludge having the characteristics listed under paragraph 1.03D above.

<u>1. Dewatering Performance</u>	<u>Requirement</u>
Hours per day of operation	___
Capacity	___ GPM
Dewatered sludge minimum solids concentration	___ % TS
Minimum centrifuge solids capture	___ %
Maximum main drive motor energy consumption	___ HP/GPM
Maximum polymer consumption	___ lbs. active polymer/dry ton of sludge dewatered

Solids capture shall be defined as:

- T = Thickened sludge total suspended solids concentration (mg/l).
- F = Feed sludge total suspended solids concentration (mg/l).
- C = Centrate total suspended solids concentration (mg/l).

1.05 Quality Assurance

A. Workmanship and Design:

1. All parts of the equipment provided to be designed and manufactured for long, continuous and uninterrupted service. All materials to be used to be of best quality and entirely suitable for service required.
2. Provisions to be made for easy lubrication, adjustment or replacement of all serviceable parts. A minimum clearance of three feet around all sides of the equipment is required for proper maintenance.
3. Centrifuge assembly shall be designed to assure easy disassembly of the unit, including removal of the rotating assembly vertically, within the space and headroom provided. End removal design of centrifuge scroll will not be allowed.
4. The corresponding parts of multiple units if applicable shall be interchangeable.

B. Services of Manufacturer's Representative:

1. Provide services of factory-trained Service Engineer, specifically trained on type of equipment specified. Submit qualifications of Service Engineer for approval. Man-day requirements listed are exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.
  - a. Installation: to assist in location of anchor bolts; setting, leveling, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections: 2 man-days.
  - b. Start-up, testing and calibration: 2 man-days.
  - c. Operation and maintenance instruction: 1 man-days.

C. Shop Test:

1. Upon completion of manufacture of centrifuge and appurtenances to be installed on this project, conduct shop tests which shall be performed and may be witnessed by the Engineer as outlined below:
  - a. Centrifuge:
    - (1) Running test, each machine, without sludge, with minimum of 4 hours of continuous operation at proposed design operating speed. Fluids required for testing supplied by manufacturer.
    - (2) Demonstrate that all equipment is capable of continuous operation in satisfactory manner without mechanical defects or operational difficulties. Measure and record vibration.
    - (3) If necessary, tests repeated until satisfactory results are obtained.
    - (4) All defects or defective equipment revealed by or noted during tests to be corrected or replaced promptly at no additional compensation.
  - b. Main Drive Motor: Each main drive motor shall be given a routine commercial test as well as additional electrical tests as outlined below. All tests shall be required to meet NEMA and ANSI standards and shall be performed in accordance with IEEE standard 112 "Test Procedure for Polyphase Induction Motors and Generators." The additional tests, beyond commercial tests, are as follows:
    - (1) Tests at full load, 3/4 load and 1/2 load to establish motor efficiencies and temperature rise.

(2) Tests to establish starting characteristics.

(3) Tests to establish noise pressure levels.

2. Upon completion of the tests, provide six copies of the certified shop test results to the Engineer.

#### 1.06 Submittals

A. Shop drawings, catalog cuts, and other materials required to completely describe and specify system and equipment shall be submitted to Engineer for review. These will include:

1. Submission of certified shop and erection drawings, including complete motor data.
2. Foundations, installations, and grouting.
3. Services of manufacturer's representative.
4. Operating and maintenance instructions and parts lists.
5. Lubricants.
6. Special tools.
7. Bolts, anchor bolts, and nuts.
8. Sleeves and inserts.
9. Electric motors.
10. Voltage rating of motors.
11. Equipment drive guards.
12. Vibration isolators.
13. Nameplates.
14. Noise level data.
15. Vibration level data.

B. Detailed shop drawings include, but not necessarily limited to:

1. Detailed drawings and specifications of all items of equipment showing all dimensions, parts, and construction details and materials, and installation details and requirements.
  2. Performance specifications of all items of equipment.
-

3. Instrument layout of control panels.
4. Complete instrumentation and control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls, and electrical components. Specifically, the following required:
  - a. Complete instrumentation and control schematics.
  - b. Complete electrical circuit schematics, including all motor control, alarms, and power to motors and accessories such as analytical instruments, etc. Schematics include termination points in various panels. Every circuit assigned circuitry number; every wire assigned wire number. In schematics, wiring identified by numbers. Also, in schematics, every termination point assigned number, and number or identifier assigned to each terminal strip. Both termination point number (including wire number) and terminal strip identifier appear on the schematics for each wiring termination shown.
  - c. Complete electrical instrumentation and control schematics of control panels and field junction boxes. (Note these are to be supplied prewired.) Schematics to provide complete information on terminal strips and panel instruments.
5. Certified shop testing results as set forth under "Quality Assurance."
6. Certified acceptance test results.

#### 1.07 Delivery, Storage And Handling

- A. Items to be shipped as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.
- B. Spare Parts:
  - 1 Packed in containers, labeled clearly with part number, designating contents, and pieces of equipment.
  2. Deliver at same time as pertinent equipment.

#### 1.08 Warranty

- A. Provide one year warranty, including on-site repair and/or replacement for all failed parts or systems by the supplier. The warranty period shall begin when the unit is started, tested, certified and put into use by the supplier and the County, or eighteen months after delivery, whichever occurs first.

### Part 2 Products

#### 2.01 General

---

- A. The Equipment specified herein furnished shall be a model CS21-4HC centrifuge manufactured by Centrisys Corporation.
- B. Like items of equipment shall be the product of one manufacturer to achieve standardization of operation, spare parts, maintenance and manufacturer's service.
- C. Manufacturer's standard equipment sizes shall be used unless otherwise specified.
- D. The equipment provided shall be complete in all respects including, but not limited to, initial lubricants, components, calibration, alignment, and adjustments as necessary to place the equipment in operation to perform its intended functions.

## 2.02 Materials of Construction

- A. Unless otherwise specified all parts of the centrifuge in contact with the sludge shall be made of 316 stainless steel or better, except o-rings, seals or abrasion resistant materials.
- B. The o-ring and seals shall be manufactured of the following:
  - 1. O-rings: Buna-N
  - 2. Lip Type Seals: Buna-N
- C. All other equipment and guards shall be constructed of stainless steel.

## 2.03 Centrifuge Assembly

- A. Bowl:
  - 1. The bowl shall consist of a horizontal cylindrical-conical assembly. Solids are discharged at the small end of the conical section. The bowl shall have a minimum inside diameter of 22 inches and an internal minimum length of 100 inches.

Centrifuges with internal bowl dimensions that do not meet the above sizing criteria will not be accepted.

The bowl shall be supported by PLC controlled automatic forced greased main bearings mounted in single piece pillow blocks. Pillow blocks shall not be attached to centrifuge casing as an integrated unit.

---

Bowls shall be centrifugally cast and shall be manufactured per ASME Pressure Vessel Code, Section 8 and shall be 100% dye penetrant inspected.

The minimum acceptable thickness for the cylindrical and conical sections of the bowl wall shall be 0.7 inches.

The centrifuge bowl shall be cast from duplex stainless steel with a minimum tensile strength of 100,000 PSI.

Fabricated or statically cast bowls will not be accepted.

2. The liquid pool depth in the bowl shall be adjustable through the use of one single set (4) of plate dams at the large diameter end of the bowl where liquid is discharged. Solids shall be discharged from the small diameter end of the bowl. The plate dams shall be manufactured from 304 stainless steel.

Externally adjustable pond depth devices such as paring discs will not be accepted.

3. The bowl wall shall be protected by, longitudinal wear strips which cause formation of a protective feed solids layer.

Bowl liners or grooved style protection will not be acceptable.

4. The Solids discharge ports shall be protected by field replaceable tungsten carbide inserts.

5. Sludge feed shall be introduced into the centrifuge feed zone by means of a minimum 2-inch diameter 316L stainless steel feed pipe. The feed shall be uniformly distributed into the centrifuge and the feed zone shall have accelerators and contact surfaces protected from abrasion by fused tungsten carbide.

## B. Scroll Conveyor

1. The centrifuge shall include a horizontal cylindrical-conical scroll conveyor supported by grease lubricated cylindrical roller bearings and grease lubricated angular contact anti-thrust ball bearings and equipped with helical flights independently mounted concentrically within the centrifuge bowl.

The conveyor hub shall be centrifugally cast of duplex stainless steel.

Conveyors that have not been manufactured with centrifugally cast hubs will not be accepted.

---

2. Conveyor bearings shall be protected by seals and shall be externally lubricated by means of a forced grease lubrication system.
3. The feed compartment within the conveyor shall be constructed of centrifugally cast duplex stainless steel. It shall be protected from abrasion by feed nozzles or ports manufactured from tungsten carbide. The feed ports shall be field replaceable.
4. The edge and face of the conveyor flights shall be protected against abrasion with field-replaceable tungsten carbide tiles, from the feed zone to the cake discharge end. The edge of the conveyor flights shall be protected with spray fused Tungsten Carbide from the feed chamber to the liquid discharge. The hard surfacing shall be guaranteed against failure for 15,000 hours of operation.

C. Case:

1. The centrifuge casing shall consist of a stainless steel lower casing and a stainless steel one piece upper casing. The purpose of the case shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard and to provide a complete enclosure for noise reduction. Design shall be such that the centrifuge bowl can be exposed for inspection and maintenance with the spring assisted opening of a single cover.

Centrifuges designed with separate solids, liquids and center casing covers will not be accepted.

For safety reasons, machines manufactured with fiberglass bowl covers will not be accepted.

Carbon steel lower casings will not be accepted.

2. The lower casing shall be a single piece constructed of stainless steel.
3. The centrifuge case shall be vented as recommended by the manufacturer. Lifting hooks shall be provided for lifting the casing.
4. To limit splashing and air leakage, the casing shall be provided with seals where the bowl hubs intersect the casing and a gasket on the machine flanges where the upper and lower casings join.

D. Pedestal:

1. The centrifuge shall be supported on a fabricated structural carbon steel pedestal with 304 stainless steel wetted parts. The pedestal shall be mounted on vibration isolators with the bottom of the centrifuge a maximum of 10" above the floor.
-

2. Machined surfaces shall be provided at all points where support loads are transferred to the pedestal. The bottom portion of the pedestal shall be provided with machined outlets for the attachment of the solids and centrate flexible connectors and chutes and other appurtenant connections.
2. Lifting hooks or solid lifting bars shall be provided for lifting the pedestal.
3. The pedestal shall consist of structural steel beams and channels amply designed to handle all imposed forces with 4 legs.
4. A minimum 6-inch steel channel frame shall extend around the periphery of each centrifuge to allow attachment of a future access platform.

E. Main Bearings:

1. The main bearing shall be pillow block ball type. The bearings shall have an L-10 life of 100,000 hours minimum at 24 hours per day service.
2. The bearings shall be lubricated by an automatic grease lubrication system which continually systematically lubricates bearings during their operation.

Manually grease lubricated main bearings shall not be accepted.

2.04 Main Drive Motor

A. The main drive motor shall be designed, manufactured and tested in accordance with the latest NEMA, IEEE and ANSI standards and have the following characteristics:

- |    |                    |                             |
|----|--------------------|-----------------------------|
| 1. | Manufacturer:      | Baldor – Premium Efficiency |
| 2. | Type:              | Squirrel-Cage, Single-Speed |
| 3. | Horsepower:        | Maximum 75                  |
| 3. | Synchronous Speed: | 3600 rpm                    |
| 4. | Service Factor:    | 1.15                        |
| 5. | NEMA Design:       | B                           |
| 6. | Insulation Class:  | F or H                      |
| 7. | Code Letter:       | G                           |
| 8. | Voltage:           | 480 volts                   |
| 9. | Phase:             | 3-phase                     |
-

- |     |                             |   |
|-----|-----------------------------|---|
| 10. | Ambient Temperature Rating: | 40 degrees C  |
| 11. | Maximum Temperature Rating: | 120 degrees C   |
| 12. | Mounting:                   | Horizontal  |
| 13. | Enclosure:                  | TEFC  |
| 14. | Duty Cycle:                 | Continuous  |
| 15. | Starting Method:            | Reduced voltage   |
| 16. | Bearing Life:               | 100,000 Hrs. as defined by AFBMA B-10 Standards.              |
| 17. | Full Load Efficiency:       | Not less than 94 percent power factor of 0.88.                |
| 18. | Sound Level:                | Maximum 80 dBA at 3 feet from outside the sound proof panels. |

- B. The motor shall be equipped with a thermal protection system to protect the motor from temperatures damaging the stator windings resulting from motor overload, frequent starting locked-rotor current and a variable frequency inverter.

## 2.05 Backdrive System

- A. A hydraulic scroll drive system shall be supplied with each centrifuge to provide speed variation between the conveyor and the bowl. The hydraulic motor shall have a minimum torque of 8,800Nm.
- B. Hydraulic Backdrive System: The differential speed between the centrifuge bowl and scroll conveyor shall be produced by a 15-HP, water cooled hydraulic system which shall independently drive the scroll conveyor.

The hydraulic scroll conveyor drive system shall be designed such that no mechanical gear reducer is used in the scroll conveyor drive train.

The hydraulic drive system shall be capable of operating in either a manual or automatic mode. In the manual mode it shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque.

In the automatic mode it shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. The hydraulic drive shall operate in a manner such that, as the reactive torque of scroll shaft increases due to an increase in solids inventory in the bowl, the scroll differential

---

speed shall gradually increase and, conversely, as the inventory of solids in the bowl and resultant reactive torque decreases, the scroll differential speed shall decrease. The net effect of this system, when operated in the automatic mode, shall be to maximize the time that cake solids are under the influence of accelerated gravitational force to ensure that the driest possible dewatered cake product is produced without plugging the centrifuge.

The system shall use a hydraulic pumping group and hydraulic motor. Torque-based adjustment shall be a function of input to the driven unit. The maximum torque input and rate of change of scroll differential speed shall be adjustable.

The system shall be designed such that automatic centrifuge shutdown is initiated in the event that excessive torque is detected. Two (2) sets of contacts shall be provided.

In the event that torque exceeds the normal operating range, the sludge feed pump shall be automatically stopped to allow the centrifuge to clear itself and shall automatically restart when the torque drops to the normal operating range. In the event that the torque approached the limit of the drive, the second set of contacts shall automatically initiate shutdown of both the feed pump and centrifuge. In this instance manual reset of the hydraulic drive is required before the centrifuge can be restarted.

Upon being energized, a cooling water solenoid will engage to allow cooling of the hydraulic oils. Should no water pressure be available, the system will not be allowed to start.

Full differential speed and maximum torque must be achievable while the centrifuge bowl is at a standstill.

Planetary or Cycloidal gears used to achieve differential speeds will not be accepted.

## 2.06 Vibration Isolators

- A. The equipment manufacturer shall furnish vibration isolators which shall be capable of dampening vibration in all directions created during normal and emergency operation of the equipment.
- B. The vibration isolators shall be provided for the centrifuge assembly.

## 2.07 Connections

- A. All piping and discharge chute connections to the centrifuge assembly, main drive motor and lubrication system, including but not limited to the feed sludge, wash water, polymer, drain, centrate, discharge, thickened sludge discharge and power and control connections, shall be equipped with flexible connections.

The flexible connections shall isolate the equipment from fixed rigid piping, chutes or other connections

---

- B. No exterior loads are to be transferred to any of the equipment.
- C. The centrate discharge chute shall be rectangular with a top flange matching the flange of the flexible liquid discharge connection. The chute shall include a 2-inch connection as a vent flange.

The chute shall maintain the shape of the centrifuge casing discharge connection and shall be 12-inches long. The chute shall be independently supported so as to impose no weight on the centrifuge casing flange. The chute is to be manufactured from 304 stainless steel.

The thickened sludge discharge chute shall be rectangular with a top flange which matches the Range of the solids flexible discharge connection. The chute is to maintain the shape of the centrifuge casing discharge connection and is to have sides as straight as possible to prevent solids from bridging or hanging up. The chute is to be independently supported so as to impose no weight on the centrifuge casing flange. The chute is to be 24-inches long and shall be manufactured of 304 stainless steel.

## 2.08 Control System

- A. The centrifuge shall have its own control panel complete with all equipment needed to operate the centrifuge and the centrifuge's associated equipment. A complete central system shall be furnished for each centrifuge system to include all controls, overloads, alarms, instrumentation and interlocks necessary for the operation of the centrifuge and all ancillary equipment including the following:

- 1) Centrifuge Main Drive (VFD)
- 2) Hydraulic Scroll Drive
- 3) Polymer feed system
- 4) Sludge discharge screw conveyor system
- 5) Sludge Feed Pump

The control system shall allow manual operation of each component and full interlocked automatic operation of all equipment upon startup and on shutdown. Control system shall include all logic, starters and VFD's as required to control necessary components listed but not limited to the above.

- B. Control Panel.

The control panel shall be free standing and have a NEMA 4X stainless steel enclosure.

The control panel shall be equipped with the following:

1. Main circuit breaker.
-

2. Provide Allen Bradley PLC for control logic, suitable for direct connection to an AB 5/04 PLC system. Provide AB 1000 Series color operator interface for display of all information. Control of all equipment shall be accessible through the operator interface.
  3. Spare module shall be included and pre-programmed with control logic for simple exchange
  4. PLC shall be protected by uninterrupted power source
  5. Viscotherm CVC scroll drive controller
  6. Variable frequency drive for the main drive motor
  7. Variable frequency drive for the sludge feed pump
  8. Controls for emulsion polymer blending system
  9. Pushbuttons and red running lights included in the operator interface for:
    - Main Drive Motor
    - Backdrive Motor
    - Polymer System
    - Sludge Feed Pump
    - Conveyors
    - Relays for Water Valves
  10. Ammeter and non-resettable hours-run meter for main drive motor to be mounted on the enclosure door.
  11. Indication on the operator interface of the following malfunctions:
    - All Alarms
    - Alarm History
    - Flow for feed pump
    - Polymer system feed rate
    - Bearing temperature
    - Vibration
    - Hour Meter
    - High main drive motor temperature.
    - High backdrive motor temperature.
    - High vibration in main bearings.
    - High backdrive torque (hydraulic pressure)
    - Backdrive low level
    - Backdrive high temperature
  9. Audible alarm with re-set.
- C. Variable Frequency Drives (specified elsewhere)
- D. Motor Starters(specified elsewhere)
-

## 2.09 Painting

Shop and field painting shall be manufacturers standard.

## 2.10 Spare Parts

The following spare parts shall be furnished with the centrifuges and back drive systems.

1 Set Bearings and Seals.

1 Set O-Rings and Seals.

1 Set Matched Drive Belts.

Grease (6 tubes)

Filters for one year operation

Spare memory card for PLC which is pre programmed and ready for direct replacement

## 2.11 Special Tools

One set of the following tools will be furnished.

- 1 Set Wrenches.
- 1 Bowl Lifter
- 1 Bearing Puller
- 1 Scroll lifter
- 1 Bowl Cart

## Part 3 Execution

### 3.01 Service

The centrifuge manufacturer shall furnish the services of an authorized representative to inspect the equipment installation, check out the equipment mechanically, and instruct plant operating personnel in the operation, optimization and maintenance of the equipment. This service shall be for a period of five 8-hour days per centrifuge and shall be completed within two consecutive weeks. The cost of this service shall be included in the centrifuge manufacturer's proposal.

---