SECTION 14510 - SHAFTLESS SCREW CONVEYORS

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing shaftless screw conveyors including electric motors, drives, controls, instrumentation, and other appurtenances as indicated and required to provide a complete and operable system with no spillage of sludge.

B. The WORK also requires that one manufacturer be made responsible for furnishing the WORK of this Section, but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.

C. The WORK additionally requires that the one responsible manufacturer shall manufacture the principal elements and components including, as a minimum, the shaftless screw conveyors and troughs and shall be responsible for the suitability of the equipment for the intended application.

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

1.2 RELATED SECTIONS

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

1. Section 11000 Equipment General Provisions
2. Section 16485 Local Control Panels

1.3 CODES

A. The WORK of this Section shall comply with the current editions of the following codes as adopted by the City of San Diego Municipal Code:

1. Uniform Building Code
2. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

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

1. Commercial Standards:

ASTM A 36	Specification for Structural Steel
ASTM A 283	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
AISI 8620	Alloy Steel, Hot Rolled and Cold Finished
AWS D1.1	Structural Welding Code - Steel
ANSI/ASME B15.1	Safety Standards for Mechanical Power Transmission Apparatus

ANSI/ASME B20.1 Safety Standards for Conveyors and Related Equipment

2. Manufacturer's Standards:

Conveyor Equipment Manufacturers Association (CEMA) standards

American Gear Manufacturers Association (AGMA) standards

Institute of Electrical and Electronics Engineers (IEEE) standards

National Electrical Manufacturer's Association (NEMA)

1.5 SHOP DRAWINGS AND SAMPLES

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

1. Catalogue cut sheets containing descriptive information and drawings of screw conveyors and their components.

2. Assembly and installation drawings including shaft size, seal, coupling, anchor bolt plan, parts nomenclature, material list, outline dimensions and shipping weights.

3. Manufacturer specification sheets for rupture discs.

4. Drive and motor sizes and specifications.

5. Design loadings to be transmitted to foundation or supports.

6. Design calculations showing dead, live, and dynamic loadings for normal and seismic conditions certified by a registered structural engineer in the State of California.

7. Calculations for stress in the auger corresponding to torsional rating as indicated under "Design Requirements."

8. Certifications from the manufacturer stating that the equipment complies with this Specification and the manufacturer accepts responsibility for coordination of all equipment and services required for proper installation and operation of the installed equipment.

9. Information on at least one successfully performing comparable installation designed and fabricated in the recent past by the manufacturer responsible for this WORK, along with contact names, addresses, and telephone numbers.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Technical manuals and spare parts lists.

2. Instructions for field procedures for erection, adjustments, inspection, and testing.

3. Certification that the equipment complies with requirements.

4. Structural calculations for conveyor supports as indicated in paragraph 2.8.

1.7 SERVICES OF MANUFACTURER

A. **Inspection, Startup, and Field Adjustment:** An authorized service representative of the manufacturer shall visit the site and witness the following:

1. Installation of the equipment for not less than [2] days.

2. Inspection, checking, and adjusting the equipment for not less than [2] days.

3. Startup and field testing for proper operation for not less than [2] days.

B. **Instruction of OWNER'S Personnel:** The authorized service representative shall also furnish the indicated services for instruction of the OWNER'S personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment for not less than [one] day.

1.8 QUALIFICATIONS

$# _____

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

_____ #$

A. **Manufacturer**: Company which has supplied at least one successfully performing installation of comparable size and complexity in the United States in the recent past. Equipment of comparable size and complexity shall have the following characteristics: [ ].

PART 2 -- PRODUCTS

2.1 DESIGN CRITERIA

A. **General**: The screw conveyors shall be shaftless, screw-type units designed to transfer dewatered sludge from the [centrifuges] to the [hopper]. The shaftless screw conveyors and components shall be designed and constructed in accordance with the Conveyor Equipment Manufacturer's Association (CEMA) Standard No. 350 and with the schedules at the end of this Section.

B. **Safety Requirements**: Screw conveyors shall comply with ANSI/ASME Safety Standards B15.1 and B20.1, as applicable.

C. Each conveyor shall be sized to convey the indicated design material handling rate at 60 percent of the rated capacity and 30 percent trough filling. The capacity of the drive unit shall equal the rated capacity of the conveyor.

D. Manufacturer shall demonstrate by submission of calculations that at its torsional rating, the stress in the extreme fiber of the auger flighting does not exceed 30 percent of the Fy value of the flight material. Manufacturer shall also demonstrate that at 250 percent of the motor nameplate horsepower, the drive unit cannot produce more torque that the torsional rating of the flighting.

E. **Materials**: Materials used in the fabrication of the equipment furnished under this Section shall conform to the following:

1. Steel plate and shapes - ASTM A36 or A283 Grade D

2. Spiral flights	-	AISI 8620, cold formed spring steel, minimum hardness 200 Brinell
3. Wear liner	-	Plastimeric, impregnated with molybdenum disulfide and silicone oil or stainless steel, Type 316
4. Bolts, nuts, and washers for conveyor supports and in contact with sludge	-	Type 304 stainless steel. All threads shall be with "Never Seeze" or equal

F. Conveyor Nos. [ ] shall be constructed for a design pressure of [15] psig according to ASTM Pressure Vessel Code.

G. Conveyer Nos. [ ] shall be provided with a jacket for cooling water.

H. Conveyor Nos. [ ] shall be insulated for protection of personnel. Insulation clips shall be provided on the conveyor shell for attaching the insulation jacket.

2.2 SPIRAL FLIGHTING

A. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft. The spiral flights shall be designed with the stability to prevent distortion and jumping in the trough.

Spiral flighting shall have full penetration welds at all splice connections. The flights shall be fabricated and welded on a jig to assure true alignment and shall be assembled according to the manufacturer's recommendations. The spiral flights shall be welded to the end pipe sleeve. The spiral flights shall be coupled to the end shafts by a pipe to shaft connection of sufficient strength to transmit thrust and/or torsion applicable to meet performance criteria.

2.3 END SHAFT CONNECTIONS

A. Spiral flights shall be connected to the end shafts using an end flange and a pipe sleeve to effectively transmit torque from the drive shaft to the spiral flight. The flange and pipe sleeve shall be welded to the spiral flights, with welded gusset plates used for additional reinforcing. Bushings shall be used between the pipe sleeve and the end shaft, if necessary.

2.4 TROUGHS

A. Troughs shall conform to the dimensional standards of CEMA 300 and enclosure classification IIIE. Each conveyor trough shall be fabricated from a minimum 1/4-inch steel plate. Each trough shall be equipped with filling and discharge chutes for transferring material to or from another conveyor. Each filling chute shall be flanged. The chutes shall be fabricated from a minimum 1/4-inch steel plate. Equal level transfers shall be permitted. A cleanout shall be provided at the low end of the conveyor trough. Cleanouts shall be 4-inch diameter, suitable for connection to steel drain pipe. The portion of each trough that is not covered by the filling chute shall be covered by a minimum 12 gauge steel hinged cover. Covers shall conform to CEMA Standard No. 300-24.

2.5 WEAR LINERS

A. **Plastic Liners**:

1. The wear liners shall be a plastimeric material that is impregnated with molybdenum disulfide and silicone oil capable of work hardening to a friction factor of 0.08 or less. The material shall be

attached with Type 316 stainless steel countersunk bolts after the material has been drilled to accept the fasteners. The fasteners shall be installed on maximum 12-inch centers and a maximum of 2 inches from the liner top edge.

2. Minimum liner thickness as shall be as follows:

Conveyor Size	Liner Thickness
6-inch through 12-inch	1/4-inch
14-inch through 24-inch	3/8-inch

B. **Stainless Steel Liners**:

1. The liners shall be fabricated of 10 gauge 316 stainless steel, insertable liner conforming to the inside diameter of the trough, capable of withstanding temperatures up to 250 degrees F. Liner plates shall extend not less than 3 inches above the horizontal centerline of the conveyors and shall be bolted or clamped to the conveyor troughs as required for the application.

2. Stainless steel, Type 316, rifling bars with a hardness exceeding Brinell 250 shall be stitch-welded, to the stainless steel liner plates, parallel to the conveyor centerlines. The rifling bars shall form the contact surface of the shaftless augers. Spacing between bars shall be 1-1/2 inch maximum. The bar cross section shall be 2-inch by 1/4-inch minimum. The bars shall cover a minimum of 180 degrees of the liners.

2.6 RUPTURE DISCS

A. Rupture discs shall be provided on screw conveyors as indicated. Rupture discs shall be made of stainless steel suitable for cyclic and pulsing duty. The maximum operating temperature and pressure shall be [250 degrees F] and [2 inches] of water column pressure. The rupture discs' burst pressure shall be [5] psig.

B. Rupture disc clamps shall be capable of withstanding a minimum of [5] psi more pressure than the rupture disc rating.

C. Rupture discs mounted on Conveyor Nos. [ ] shall be equipped with rupture detectors. They shall be monitored and alarmed at the Programmable Logic Controller at the Operator Console.

2.7 CONVEYOR SUPPORTS

A. Each conveyor shall be furnished complete with supports suitable for mounting as indicated and required. The supports shall be shop fabricated from structural steel shapes and plates. Structural and support design shall be based on seismic forces for Zone 4 with completely filled conveyor. All shop welding shall conform to the latest standards of the American Welding Society.

2.8 DRIVE UNITS

A. Each screw conveyor shall be driven by an electric motor connected to a gear reducer. The gear reducer shall be mounted to the trough end. The drive system shall be designed for starting the conveyor fully loaded. Drive size shall be as recommended by the manufacturer. All electric motors shall be [totally enclosed fan cooled, heavy duty]. Drive system components shall be provided such that jamming of any components do not cause damage to the equipment.

2.9 MOTION DETECTORS

A. A motion switch to detect under speed or zero speed shall be provided with each conveyor. The unit shall have a time delay to allow the selected machine to accelerate and shall have sufficient range on the calibration to be able to detect decrease in speed as an alternative to motion failure. The unit shall detect failure in the forward and reverse directions on the reversible conveyors.

[2.10 EMERGENCY STOP SWITCHES WITH CABLE OPERATORS

A. Provide conveyor with an emergency stop system consisting of pull-cord switches actuated by a cable system running the full length of both sides of the conveyor. Cables shall be orange colored, plastic-covered steel aircraft cable. Provide all cable end fittings and all intermediate cable support eyes. Provide cable support eyes every 10 feet. Provide switches in enclosures which are NEMA rated in accordance with the area designations of Section 16050. Switches shall limit the required actuating force to OSHA guidelines. The switches shall be manually set after actuation and shall provide visual indication of operation. Switches shall be single-pole, double-throw output contact, rated for inductive load of 5 amps at 120 VAC. Switches shall be normally closed and shall open when pull-cord switches are actuated. Actuator arms shall be 316 stainless steel.]

[2.11 TORQUE OVERLOAD PROTECTION

A. Torque overload protection shall be provided to protect the drive components and shaftless screws from torsional loadings exceeding the torsional rating of the shaftless auger. Current transformers shall be provided and shall sense the current draw of the motor leads. The signals shall be transmitted to the current overload protection devices, which are set as recommended by the equipment manufacturer.]

2.12 GEAR REDUCERS

A. All gear reducers shall be commercially built, AGMA Class I, single, double, or triple reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have the AFBMA L-10 life of 100,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. Low speed output shafts shall be chrome plated. Shaft seals shall be tripled lipseal with taconite packing design for service conditions.

2.13 ADJUSTABLE FREQUENCY AC DRIVES

A. The following conveyors shall be provided with adjustable frequency drives:

Conveyor Nos.: [ ], [ ], [ ], [ ], [ ], [ ]

B. Adjustable frequency PWM (Pulse Width Modulating) AC drives shall be provided to control the speed of the AC drive motor required by the conveyor speed range. Speed reducing gear boxes shall be provided as required to deliver the necessary torque and acceleration required by the conveyors.

C. **Enclosure**: The AC drives shall be installed in a NEMA 4X enclosure which shall be purged with nitrogen. The enclosure shall have a 1/2-inch NPT female connection for nitrogen purge. The enclosure shall be sized to dissipate the heat generated internally,but shall not be larger than 24 inches by 24 inches by 12 inches deep. The following items shall be mounted on the enclosure door:

1. Power disconnect handle
2. Emergency stop pushbutton
3. AC drive running status light

D. **Controls**: The AC drives shall have local and remote control modes selected by local-remote switches located in the AC drives enclosures. The normal mode of operation shall be remote by a programmable logic controller (PLC). In the remote mode, VFDs shall interface with the PLC as follows:

1. PLC provides a START/STOP contact closure command.
2. PLC provides 4-20 mA analog signal for the conveyor speed control. The 4-20 mA analog signal shall be proportional to the conveyor rpm range.
3. The AC drive provides 4-20 mA analog signal representative of conveyor speed.
4. The AC drive provides a contact closure common alarm representative of AC drive or motor malfunction.
5. The AC drive provides contact closure for indication of the local-remote switch position.

E. The microprocessor-based controls shall include the following adjustable control functions entered via the AC drive keyboard:

1. Motor/conveyor rpm
2. Minimum speed
3. Maximum speed
4. Gain adjustment
5. Acceleration
6. Deceleration
7. Current trip
8. Torque limit
9. Signal span
10. Low frequency boost
11. Volts/Hertz
12. LED/LCD status indicator programmed to display conveyor rpm

Speed indicator shall not require the use of a tachometer generator.

F. **AC Drive Controllers**: The AC drive controllers shall be all solid state inverters utilizing silicon semiconductors and transistors which shall be standard catalog items of the device manufacturer. The power circuits shall consist of a phase controlled rectifier, a filter choke, and an auto-sequential force of auxiliary communicated inverter.

The inverter output voltages shall be controlled such that they vary directly proportional to the output frequencies. The solid state AC drives shall be capable of attaining efficiencies in excess of 95 percent at full speed and in excess in 80 percent at 50 percent speed.

The AC drives shall be designed to operate at full output power over the maximum specified input voltages and frequency fluctuations, in ambient conditions indicated. No external venting or heat exchangers shall be required. The AC drives shall operate from 480 volt, 3-phase, 3-wire, 60 Hertz input power.

Normal operation shall not be affected by input power fluctuations between plus or minus 10 percent voltage and plus or minus 2 Hertz. Voltage regulations shall be plus or minus 1 percent of setpoint voltage. Speed regulation shall be 1 percent of full speed due to variables other than motor load.

The AC drives shall be equipped with a diagnostic system capable of troubleshooting problems down to a component replacement level, as well as being able to monitor inverter output, process input, and power line parameters. In addition, an indication shall be provided for each protective function to show an "actuated" status, malfunction, or trouble.

G. **Protective Devices**: The AC drives shall have transient surge protection to a minimum of 10,000 volt, 50 joules, without failure. They shall meet or exceed the Institute of Electrical and Electronic Engineers (IEEE) Surge Withstand Capability Test, IEEE Std. 472 without failure. For the purposes of this Section, failure is defined as loss of components in the AC drive, including power semiconductors, logic components, or fuses.

H. The AC drive controllers shall be furnished with the following protective functions, as applicable:

1. Short circuited output (instantaneous over-current)
2. Live to ground faults
3. Overload
4. Reverse phase sequence of input power
5. Single-phase input power
6. Power outage or dips in input power (under voltage)
7. Communication overcurrent
8. DC link overvoltage
9. Cabinet over temperature
10. Changes in volts/Hertz constant
11. Inverter fault

2.14 BEARINGS AND END SHAFTS

A. When recommended by the manufacturer, bearings shall be provided on both ends of each conveyor. End bearings shall be double pillow block and shall be mounted outside the conveyor trough. Bearings shall be completely serviceable from outside the conveyor. Intermediate bearings will not be allowed. A plate-type lipseal shall be provided around the shaft where the shaft passes through the trough ends. The bearing and seals shall be capable of supporting the applicable thrust loads by means of snap rings and shall prevent angular misalignment of the shafts. Bearings shall have an L-10 life of 100,000 hours.

2.15 HOLDDOWN PROVISIONS

A. Holddown devices shall be installed on the shaftless screw conveyors if required by the manufacturer's design or if excessive vertical movement of the spiral flights occurs during the first year of operation. Evidence of excessive vertical movement shall include wear on the trough cover plates. Holddown devices shall be of welded steel construction supported by the conveyor trough, and be designed to minimize material flow interruption. The holddown devices shall be designed by the manufacturer.

2.16 STRUCTURAL

A. The ratio of the unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for a compression member and shall not exceed 240 for any tension member (of angles about the Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the running torque of the drive motor.

2.17 SUPPORTS

A. Supports shall be provided within 2 feet of the drive units and at locations no more than 12 feet apart along the conveyor. Support loads shall be based on a completely filled trough plus dead weight of the equipment designed for Zone 4 seismic forces as per UBC.

2.18 NAMEPLATES, TOOLS AND SPARE PARTS

A. **Spare Parts**: The WORK also includes furnishing the following spare parts for each conveyor:

1. [Four] sets of shaft packing material (if used)
2. [One] packing gland follower (if used)
3. [One] gear reducer (if used)
4. [One] set of belts or chains (if used)
5. [One] bearing of each size
6. [One] safety switch (if used)

2.19 FACTORY TESTING

A. The conveyor drive system shall be assembled and given no-load running tests at the manufacturer's plant before shipment.

B. The OWNER and the CONSTRUCTION MANAGER (at the option of either) reserve the right to witness factory tests. The CONTRACTOR shall notify the CONSTRUCTION MANAGER 2 weeks in advance of the testing date.

2.20 MANUFACTURERS

A. Products shall be of the following manufacture, type or model, as indicated (or equal):

1. Shaftless screw conveyors:
Purac Engineering, Inc.

2. Gear reducers:
SEW Eurodrive
Nord Gear
Falk

3. Zero speed switches:
Magnetic Pickup: Airpax, "Part No. 70087-3040-007"
Amplifier Speed Switch: Airpax, "Part No. T77130-8-000"

4. AC drives:
Allen Bradley, "Bulletin 1336"
Eaton Dynamics, "Model AF-5000+"

5. Plastic wear liners:
Dura Ware Corporation, "Dura Slide Xylethnon"

6. Motion detectors:
Milltronics

[7. Emergency stop switches:
Conveyor Control Corporation
Crouse-Hinds]

[8. Torque overload protection devices and current transformers:
Tsubaki]

PART 3 -- EXECUTION

3.1 INSTALLATION

A. All sections and loose items shall be match-marked prior to shipping.

B. Installation shall be in accordance with the manufacturer's installation requirements.

3.2 FIELD TESTS

A. The equipment shall be field tested after installation to demonstrate satisfactory operation without causing excessive noise, vibration, and overheating of the bearings. The field testing shall be performed

by an experienced field representative of the manufacturer of each major item of equipment, who shall supervise the following tasks and shall certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

1. Start up, check, and operate the equipment over the entire speed range.

2. Bearing temperatures shall be determined by a contact-type thermometer. A running time of at least 20 minutes shall be maintained for this test without an excessive temperature rise that would be detrimental to the bearing.

3. The field testing will be witnessed by the CONSTRUCTION MANAGER. In the event any of the equipment fails to meet the above test requirements, it shall be modified and retested until it meets the requirements of these Specifications. The manufacturer shall then certify in writing that the equipment has been satisfactorily tested, and that all final adjustments thereto have been made. Certification shall include the date of the final acceptance test and a listing of all persons present during tests, and resulting test data. The costs of all work performed in this paragraph by factory-trained representative shall be borne by the CONTRACTOR. The OWNER will pay for costs of power and water.

SCHEDULE

SCREW CONVEYOR NOS. [ ], [ ]

No. of units		- [ ]
Capacity, lbs/hr		- [ ]
Screw diameter, inches	-	[ ]
Pitch, inches	-	[ ]
Length, feet-inches	-	[ ] [ ]
Incline, degrees		- [ ]
Trough	-	["U" shaped with bolted cover] [ ]
Wear liner		- [stainless steel] [plastimeric]
Hours of operation	-	[continuous 24 hrs] [ ]
Power supply	-	[3 phase, 60 Hz, 480 V]
Material conveyed	-	[dewatered sludge 45% solids] [dried sludge 90% solids] [ ]
Density, lbs/cu ft		- [ ]
Temperature, degrees F	-	[ ]
Special requirements		- [reversible conveyor] [jacketed trough for cooling water] [insulated trough for personnel protection] [ ]

** END OF SECTION **