1. GENERAL

1.1 Summary

.1 This Section specifies the general requirements for all equipment supplied in Divisions 11, 14, 15 and 16. Requirements additional to those specified in this Section are specified in the Sections in Divisions 11, 14, 15 and 16.

1.2 Standards

.1 ANSI:

.1 ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).

.2 ANSI B1.20.1 - Pipe Threads, General Purpose (Inch).

.3 ANSI B15 - Ball Bearing, Load Ratings and Fatigue Life.

.4 ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250).

.5 ANSI B18.2.1 - Square and Hex Bolts and Screws (Inch Series).

.6 ANSI B18.2.2 - Square and Hex Nuts (Inch Series).

.7 ANSI: S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

.8 ANSI S2.19 - Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications.

.2 ASME:

.1 ASME Section IX – Boiler and Pressure Vessel Code Welding and Brazing Qualifications.

.2 ASTM A36 – Standard Specification for Carbon Structural Steel.

.3 ASTM A48, Gray Iron Castings.

.4 ASTM A240 – Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.5 ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes.

.6 ASTM A278, Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 650°F.

.7 ASTM A312 – Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

.8 ASTM A322, Steel Bars, Alloy, Standard Grades.

.9 ASTM A380 – Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

.10 ASTM A567, Steel Bars, Carbon, Hot Wrought, Special Quality.

.11 ASTM A666 – Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

.12 ASTM A743/743M, Corrosion-Resistant, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application.

.13 ASTM: D2240 Standard Test Method for Rubber Property – Durometer Hardness.

.14 ASTM D4020 – Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

.3 American Welding Society (AWS):

.1 AWS B2.1 D1.6– Welding Procedure and Performance Qualification.

.4 SSPC.

1.3 Administrative Requirements

.1 Refer to the Technical Requirements and Section 01450 for classified areas, exposure designations and environmental classifications.

.2 Provide all equipment of each type from the same manufacturer.

1.4 Submittals

.1 Provide submittals in accordance with Section 01300 in addition to the following items:

.1 Bearing life and design data, certified by equipment Manufacturer. Provide bearing temperature operating range for the service conditions specified.

.2 Provide a list of recommended materials for the specified service. Provide documentation showing material compatibility with process fluid and service specified.

.3 All quality assurance and quality control procedures, records, certifications, standard forms, samples, testing results, reports, and personnel and firm qualifications and references.

.4 Completed Factory Acceptance Testing, installation, performance and commissioning testing and inspection forms.

.5 Extended warranty documentation where required.

1.5 Quality Assurance

.1 Provide materials and equipment that are new and of a quality equal to that specified or reviewed. Mechanical equipment to be the products of manufacturers of established good

reputations regularly engaged in the fabrication of such equipment. Provide workmanship, materials and methods of construction that conform to the best practice and highest standard of the industry.

.2 Design and proportion all parts to meet the strength, stability, stiffness and conditions of service required for the Final Design.

.3 Submit required calculations, sketches, design notes, and drawings for any related redesign or design changes for review prior to the execution of any re-work or modifications of the equipment.

2. PRODUCTS

2.1 Configuration, Components and Features

.1 Flanges and Pipe Threads:

.1 Flanges: ANSI B16.1, Class 125 on cast iron equipment and ANSI B16.5, Class 150 on steel equipment and appurtenances. Use higher pressure class where required by the equipment pressure rating.

.2 Pipe threads: ANSI B1.1, coarse thread series, Class 2 fit.

.3 Provide flange assembly bolts that are heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2.

.4 Provide threaded flanges with standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified in the individual equipment specification, provide flat faced flanges.

.2 Bearings:

.1 Unless otherwise specified in the individual equipment specification, provide oil- or grease-lubricated ball- or roller-type equipment bearings designed to withstand the stresses of the service specified.

.2 Provide equipment bearings with a minimum L-10 rating life of 10,000,000 revolutions, unless otherwise specified and shall be in keeping with equipment with low maintenance requirements.

.3 Bearing Life

.1 Bearing life rated in accordance with the latest revisions of American Bearing Manufacturers Association (ABMA) Methods of Evaluating Load Ratings of Ball and Roller Bearings.

.2 Except where specified to be factory sealed and lubricated, fit grease-lubricated bearings with easily accessible grease supply, flush, drain and relief fittings. Provide extension tubes where necessary. Provide standard hydraulic alemite type grease supply fittings.

.3 Equip oil-lubricated bearings with either a pressure lubricating system or a separate oil reservoir system. Provide oil lubrication system sized to withstand the heat normally generated in the bearing under a maximum ambient temperature of 60°C. Provide filler pipe and an external level indicator gauge.

.4 For bearings located within 2.0 m measured vertically from floor or working level, or within 0.4 m measured horizontally, from stairways, ramps, fixed ladders or other access structures (accessible to touch), maintain surface temperature at or below 65°C for continuous operation at bearing rated load and a 50°C ambient temperature, or provide appropriate shielding to prevent inadvertent human contact.

.4 V-Belt Assemblies:

.1 Unless otherwise specified in the individual equipment specification, provide Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings or Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings or approved equivalent.

.2 Provide drives with a minimum of two (2) belts and use banded belts where multiple belt drives are required.

.3 Provide V-belt drives in standard sections 3V, 5V, or 8V, in accordance with the standard specifications of the Rubber Manufacturing Association (RMA) and the Mechanical Power Transmission Association (MPTA).

.4 Select belts rated for not less than 150 percent of rated driver motor power. Where two (2) sheaves sizes are specified, provide belts capable of operating with either set of sheaves. Provide antistatic belts where explosion-proof equipment is specified. Provide multiple belts in matched sets.

.5 Provide statically balanced sheaves and bushings. Provide dynamically balanced sheaves and bushings when the peripheral operating speed exceeds 1700 m/min. Mount sheaves separately on their bushings by means of three (3) pull-up grub or cap tightening screws. Key seat bushings to the drive shaft.

.6 Provide sheaves that are fixed diameter with taper-lock bushings for all applications. Adjustable sheaves are not permitted.

.7 Design shaft protrusion with 6.35 mm minimum.

.8 Guard for V-belt drives to include access to all belts at mid-point between sheaves for tension measurement and strobe light.

.5 Chain Drives:

.1 Provide roller chain drives for slow-speed applications in accordance with ANSI standard roller chain requirements.

.2 Provide drip lubrication as a minimum and provide oil bath lubrication on higher-speed applications.

.3 All oil and weather-tight guards shall include filler and drain connections, an oil gauge, and double-shaft seals.

.4 Provide removable output shaft seals at shear-pin hubs that are large enough to permit access to the shear pin.

.6 Gear Reducers:

.1 Size reducers for continuous duty, 24 hours per day, 365 days per year, and conform to the standards of the American Gear Manufacturers Association (AGMA) Class II minimum.

.2 Provide gear reducers with a thermal power rating in excess of motor power.

.3 Provide shaft-mounted cooling fans and equip with anti-friction bearings where cooling is required.

.4 Provide slide rails for systems using belt or chain final drives.

.7 Couplings:

.1 Unless otherwise specified in the individual equipment specification, for equipment with a driver greater than 0.375 kW, where the input shaft of a driven unit is directly connected to the output shaft of the driver, connect the shafts using a flexible coupling which accommodates angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations.

.2 Provide flexible couplings consisting of a tire with synthetic tension members bonded together in rubber. Attach flexible member to flanges by means of clamping rings and cap screws. Attach flanges to the stub shaft by means of taper lock bushings to provide the equivalent of a shrunk-on fit. Metal-to-metal contact between the driver and the driven unit is not permitted.

.3 Provide coupling per recommendations of the coupling manufacturer for the specific application, considering power, speed of rotation, and type of service.

.4 Where torque or power ratings exceed the capacity of the couplings specified above provide grid type coupling. Acceptable grid type couplings include Falk Steel Flex and Thomas-Rex sized in accordance with the equipment manufacturer's recommendation.

.5 Configure coupling guards so as not to interrupt air circulation around or through motor drives, particularly in the case of TEFC motors.

.6 Install shaft couplings in accordance with the coupling Manufacturer’s recommendations.

.8 Shaft Connections:

.1 Apply anti-seize compound as recommended by the equipment Manufacturer prior to assembly of keys, keyways, collets, retaining bolts, couplings, and other shaft attachment assemblies used to attach impellers, fan blades, sheaves, couplings, or other rotating elements to drive shafts and driver shafts.

.2 Provide anti-seize or anti-galling compound as recommended by the Manufacturer.

.3 Acceptable Products:

.1 Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO.

.2 Or approved equivalent.

.9 Guards:

.1 Fit guards over exposed moving parts.

.2 Provide guards that are Canadian Center for Occupational Health and Safety (CCOHS) approved and compliant with the Manitoba Workplace Safety and Health Act.

.3 Fabricate guards from 14-gauge Type 316L stainless steel 1/2-13-15 expanded metal screen to allow inspection of moving parts without removal of the guard.

.4 Design guards to be easily removed to allow maintenance of moving parts. Provide reinforced bolt holes. Extend lube fittings through guards.

.5 Where possible provide maintenance hatches to allow access to required items without removing the entire guard.

.10 Nameplates:

.1 Provide nameplates on each item of equipment or instrumentation for which an equipment number or instrument tag number is listed. Include the equipment name or abbreviation and equipment number.

.2 Provide nameplates in accordance with Section 01080.

.11 Lubricants:

.1 For each mechanical equipment component, provide a supply of the required lubricant adequate to last through the Warranty Period.

.2 Provide lubricants recommended by the equipment manufacturer that are readily available locally.

.3 Consolidate various lubricants, with the equipment manufacturers' approval, into the fewest number of different types. Provide a consolidated list showing the lubricants required for each mechanical equipment component and the estimated lubricant quantities needed for one full year of continuous operation.

.12 Gauge Taps and Test Plugs:

.1 Refer to Section 15050 and Section 17911 for general requirements.

.2 Provide gauge taps on the suction and discharge sides of all pumps, blowers and compressors.

.3 Tap and install plugs at locations as required for the Final Design and as required to practically complete testing of piping and equipment.

2.2 Assembly and Fabrication

.1 Assembly: The equipment to be factory assembled, to the greatest extent possible, complete with all specified components.

.2 Fabrication: the specified equipment to be fabricated by certified technicians using the specified materials in accordance with the Manufacturer's standard procedures. The equipment must be fabricated in a workmanlike manner with state-of-the-art technology. Materials and equipment must conform to the latest edition of applicable standards at the time of the Proposal Submission Date. The fabrication must be subject to and pass the Manufacturer's QA/QC requirements.

2.3 Equipment and System Controls

.1 Equipment is controlled through the PCS. Associated instruments are connected directly to PCS I/O points or a fieldbus network.

.2 Refer to Division 16 and Division 17 Specifications for control panel, indicating lights and instrumentation requirements.

2.4 Finishes

.1 Comply with procedures of Section 09900.

.2 Prime Coat: Shop applied, coating material in accordance with Section 09905.

.3 Finish Coat: Shop applied, coating material in accordance with Section 09905.

.4 Provide additional finish for field-applied touch-up painting.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

3.2 Equipment Checkout

.1 Testing:

.1 Factory Acceptance Tests to be conducted on equipment and motor assembly, where specified. Submit copies of all shop test data and interpreted results. Provide notification prior to factory tests to facilitate attendance by the designer and the City.

.2 Alignment:

.1 Set all rotating equipment and align in accordance with the more stringent requirements of either the equipment manufacturer or the requirements of Section 11005.

.3 Equipment must be installed with sufficient clearance to provide ready access for maintenance and repairs including sufficient laydown areas for removal and replacement and as recommended by the Manufacturers.

.4 Equipment must be installed with allowances of space for hoisting equipment and travel paths to allow the equipment to be removed and replaced.

.5 Upon completion of the installation of the equipment and all connecting appurtenances and completion of all equipment checks, inspections, and testing, confirm acceptance as per the Equipment Checkout Completion requirements in the Technical Requirements.

.6 Demonstrate and verify the equipment meets the requirements of Section 11005 and 11020.

.7 Upon completion of the Functional Testing of the equipment and all connecting appurtenances, confirm acceptance as per the Functional Performance Completion requirements in the Technical Requirements.

END OF SECTION

RIGID EQUIPMENT MOUNTS

1. GENERAL

1.1 Summary

.1 This Section specifies minimum requirements for rigid equipment mounts. Completed equipment mounts consist of equipment pads, anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.

.2 Requirements for non-rigid equipment mounts (vibration isolation systems) are specified in the individual equipment specifications.

1.2 Standards

.1 ANSI/HI:

.1 ANSI/HI 1.4 - Centrifugal Pumps – Installation, Operation and Maintenance.

.2 ANSI/HI 2.4 - Vertical Pumps – Installation, Operation and Maintenance.

.2 API:

.1 API Recommended Practice 686 - Recommended Practices for Machinery Installation and Installation Design.

.3 ASTM:

.1 ASTM E329 - Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.

.2 ASTM F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.

.3 ASTM F1554 - Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength.

.4 CSA A23.3 - Design of Concrete Structures, Annex D, Anchorage.

.5 MIL-PRF-907E - Anti-Seize Thread Compound, High Temperature.

.6 SSPC - Society for Protective Coatings Specifications, Vol. 2.

1.3 Definitions

.1 Baseplate: A mounting plate with a cavity above the horizontal plane at the bottom edge of the mounting plate. Bent form bases are not permitted.

.2 Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside, excepting shear lugs and keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes).

.3 Fabricated Steel Frame: An equipment mounting plate constructed of rolled steel shapes and plates welded into a frame.

.4 Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.

.5 Mounting Pads: Milled or machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.

.6 Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for leveling baseplates, soleplates, or fabricated steel frames prior to grouting.

.7 Shims: Thin Type 316 stainless steel plates of uniform thickness used for fine level adjustment. Shims are placed on top of leveling blocks for mounting plate leveling or between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.

.8 Wedges: Pairs of uniformly tapered metal blocks stacked with the tapered surfaces reversed relative to each other so that the top and bottom surfaces of the wedges are flat and parallel. Wedges are used between equipment pads and baseplates, soleplates, or fabricated steel frames for leveling mounting plates.

.9 Mounting Stud: Threaded rod or bolt anchored to baseplates, soleplates, or fabricated steel frames for mounting equipment or ancillary devices to baseplates, soleplates, or fabricated steel frames.

.10 Reinforcement Dowels and Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for transferring loads or forces across the joint.

.11 Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for leveling baseplates, soleplates, and fabricated steel frames prior to grouting.

.12 Grout Manufacturer: the Manufacturer of the grout product used for installation of rigid equipment mounts.

.13 Grout Manufacturer’s Representative(s): the representative(s) of the Grout Manufacturer.

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 in addition to the following items:

.1 Manufacturer's descriptive literature for materials.

.2 Name, employer and certificates or other documents showing compliance with the journeyman qualifications requirements for millwrights installing rigid equipment mounts, as specified in this Section.

.3 Certificates or other documents issued by the epoxy grout Manufacturer demonstrating that the grout Manufacturer’s representative has been factory trained on installation of epoxy grout for equipment mounts.

.4 Shop Drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame details. Shop Drawings depict sizes and locations of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; sizes and locations of electrical conduits; and any other equipment mounting features embedded in equipment pads. Number or mark (Specification number and equipment number) Shop Drawings for equipment pads, equipment anchors, and baseplate, soleplate, or fabricated steel frames for inclusion (filing) with the associated equipment submittal requirements.

.5 Equipment anchor calculations demonstrating compliance with this Section.

.6 Results of grout strength tests, as specified in this Section.

.7 Forms indicating completed inspection of the rigid equipment mount installation.

.8 List of equipment installation staff that has completed epoxy grout Manufacturer's grout installation training.

1.5 Quality Assurance

.1 Except where union rules require installation by another trade, all machinery shall be mounted and leveled by journeyman millwrights.

.2 Epoxy grout installation shall be installed by employees that have completed the epoxy grout Manufacturer's grout installation training specified in this Section.

2. PRODUCTS

2.1 Performance Criteria

.1 Mount all equipment in accordance with recommendations by the Manufacturer and good engineering design, including requirements for mounting plate leveling tolerance, anchor bolt sizing, anchor sleeve lengths and grout.

2.2 Materials

.1 Equipment Anchor Materials:

.1 Indoor, dry: carbon steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod.

.2 Indoor, wet: galvanized carbon steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod.

.3 Outdoor: Type 304 stainless steel, ASTM F593, Cond. CW.

.4 Submerged, immersed: Type 316 stainless steel, ASTM F593, Cond. CW.

.5 Process corrosive: Type 316 stainless steel, ASTM F593, Cond. CW.

.6 Chemical corrosive: Type 316 stainless steel, ASTM F593, Cond. CW.

.7 Materials selected according to Section 01450.

.8 Service life according to the Technical Requirements.

2.3 Configuration, Components, and Features

.1 General:

.1 Provide reinforced concrete equipment pads as required for the Final Design.

.2 Minimum dimensions for equipment pads shall be in accordance with the Technical Requirements where the equipment pad is required to provide a minimum mass for vibration dampening.

.2 Equipment Pad Drainage:

.1 Furnish minimum 50 mm drains.

.2 Place equipment pad drains at drainage outlets from equipment or mounting plates.

.3 Route equipment drainage outlets or mounting plate drainage outlets to equipment pad drains.

.4 Route equipment pad drains to the floor drainage collection system.

.5 Route drainage piping for equipment pads below the finished floor elevation.

.6 Exposed drain lines mounted on the floor are not permitted.

.3 Equipment Anchors:

.1 Conform to the equipment anchor materials specified for the area exposure condition where the equipment is installed. Section 01450 specifies area exposure conditions. Bolt length as required for the specified embedment and sleeve length. Reduce equipment anchor sleeve length as necessary to fit within finished height of equipment pad if equipment pad height is insufficient to provide specified equipment anchor sleeve length. Unified Coarse Thread Series per ANSI/ASME B1.1.

.1 Cast-in-place and grouted equipment anchors: Hex or heavy hex headed bolts.

.2 Drilled anchors (wedge, sleeve, undercut, expansion, and adhesive): conform to Section 05501.

.3 Adjustable canister anchors consist of cast-in-place pre-manufactured adjustable anchor inserts. Adjustable canister anchors provide a minimum of 150 mm of vertical height adjustment and lateral adjustment of the anchor while maintaining the anchor in a true vertical orientation.

.1 Adjustable anchors Acceptable Manufacturers and Acceptable Products:

.1 Jakebolts:

.1 Unisorb.

.2 Or approved equivalent.

.2 Heavey Duty Adjustable Anchors:

.1 Deco or Rowan Adjustable Canister Anchor Bolt.

.2 Or approved equivalent.

.4 Equipment Anchor Design:

.1 The diameter of anchors for clamping and fastening mounting plates to equipment pads shall be as specified by the equipment manufacturer.

.2 Comply with the Technical Requirements for equipment anchor size, embedment, and edge distance. Provide equipment anchors sufficient to resist the maximum lateral and vertical forces.

.3 Furnish equipment anchor calculations for all equipment, unless one of the following exceptions applies:

.1 The importance factor, IE, is equal to 1.0 and flexible connections are provided for all electrical and mechanical connections to the equipment and equipment is mounted less than 1.2 m above the floor and weighs less than 180 kg.

.2 The importance factor, IE, is equal to 1.0 and flexible connections are provided for all electrical and mechanical connections to the equipment and components weigh less than 10 kg or less than 8 kg/m for distribution systems.

.4 Provide equipment anchor calculations with equipment submittals. Equipment anchor calculations shall be sealed by a qualified professional.

.5 Design resistance to lateral (horizontal) loads using the static friction between the mounting plate and its supporting grout pad. Include the clamping force applied by equipment anchors and the weight of the equipment for calculating static friction resistance to lateral loads. Do not include lateral loading on equipment anchors or adhesion between mounting plates and supporting grout in lateral loading calculations.

.5 Equipment Anchor Tension:

.1 Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, tighten equipment anchors to provide a final clamping force that produces a tensile stress of 100 MPa in each equipment anchor. Tighten adjustable canister anchors to the Manufacturer's maximum safe working load. Tighten equipment anchors consisting of drilled anchors to Manufacturer's recommendation.

.2 Bolt torques required to produce the specified bolt tension based on well lubricated plain finish national coarse thread bolts are presented in the following table. Revise bolt torques in accordance with equipment Manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

Bolt Φ mm (in.)	10 (3/8)	13 (1/2)	16 (5/8)	20 (3/4)	23 (7/8)	25 (1)	29 (1-1/8)	33 (1-1/4)	38 (1-1/2)
Final bolt torque for 100 MPa bolt stress (N*m)	11	20	40	70	110	170	250	340	540

.6 Anchor Sleeves:

.1 Equipment anchors shall be fitted with sleeves as specified in the Equipment Mounting Schedule. Design Builder to provide Equipment Mounting Schedule based on the Final Design.

.2 Anchor sleeves consist of flexible polyurethane foam, steel cylinder or tubes, or ribbed plastic sleeves.

.7 Fill steel cylinders, tubes and ribbed plastic sleeves with a flexible room-temperature vulcanizing (RTV) sealant prior to embedment and installation.

.1 Mounting plates.

.8 General:

.1 Round edges of all baseplates, soleplates, and fabricated steel frame surfaces bearing on grout. Round to a radius of not less than 6 mm.

.2 Round perimeter corners of baseplates, soleplates, or fabricated steel frames to a radius of not less than 50 mm to avoid producing stress risers on the grouted foundation.

.3 Excepting pre-grouted baseplates, furnish all baseplates and soleplates with grout pouring holes and grout relief and air release vent holes. Grout pouring holes and grout relief and air release vent holes may be omitted from pre-grouted baseplates.

.4 Provide 100 mm minimum diameter grout-pouring holes in baseplates and soleplates that will be set in epoxy grout. Provide 65 mm minimum diameter grout-pouring holes in baseplates and soleplates that will be set in cementitious grout.

.5 Provide 25 mm minimum diameter grout relief and air release vent holes in baseplates and soleplates.

.6 Drill holes for equipment anchors through baseplates, soleplates, and fabricated steel frames.

.7 Do not burn out holes or provide open slots for equipment anchors.

.8 Make connections to baseplates and soleplates using acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease.

.9 Fasteners terminating only into the baseplate, soleplate, or fabricated steel frame are not permitted.

.10 Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, tap jackscrew threads in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

.11 Mill mounting pads and/or mounting surfaces for baseplates, soleplates, and fabricated steel frames flat after all welding and stress relieving. Provide mounting pads milled shall be coplanar within 0.004 mm/m in all directions. Pre-grout baseplates prior to milling.

.12 Baseplates, soleplates, and fabricated steel frames to provide common support for the equipment and driver (and flywheel, if practical).

.13 Provide transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates, soleplates, and fabricated steel frames for equipment with drivers 15 kW and greater.

.14 Provide alignment and positioning jackscrews in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. Provide additional jackscrews for transverse alignment of the flywheel, if a flywheel is specified.

.15 Where specified in individual equipment specifications fit baseplates, soleplates, and fabricated steel frames with RK Fixators as manufactured by Unisorb.

.16 Install fixators at mounting surfaces for drivers.

.17 Fixators consist of a three-piece wedge leveling adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface.

.9 Fabricated Steel Frames:

.1 Fabricated steel frames consist of plate or fabricated structural steel mounting plates with thickened steel mounting pads for bolting equipment to the baseplate.

.2 Excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be “T” or “L” shaped fabricated steel frames to accommodate the equipment driver and accessories, provide rectangular fabricated steel frames.

.3 Include supports for suction and discharge elbows, if required by the specified configuration.

.4 Provide I-beam or C-channel perimeter members with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 350 mm provided that the deflection and misalignment is within acceptable limits as determined by the Manufacturer.

.5 Weld mounting pads to the fabricated steel frame.

.6 Sandblast surfaces of fabricated steel frames in contact with grout to white metal per SSPC SP-6.

.7 Apply a high-strength epoxy primer as specified in this Section within eight (8) hours of sandblasting to the sandblasted part of the fabricated steel frame.

.10 Baseplates:

.1 Provide welded steel or cast iron baseplates with thickened mounting pads for bolting equipment to the baseplate.

.2 Provide internal stiffeners on all cast and fabricated baseplates. Design baseplates to allow free flow of grout between sections divided by internal stiffeners.

.3 The minimum acceptable opening in cross bracing and stiffeners is 50 mm high by 150 mm wide.

.4 All welds shall be continuous and free from skips, blowholes, laps, and pockets.

.5 Pre-grout baseplates at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate.

.6 Sandblast the underside of baseplates to white metal per SSPC SP-6 prior to pre-grouting.

.7 Complete pre-grouting within eight hours of sandblasting.

.8 Fill the underside of the baseplate to the bottom edges of the baseplate.

.9 Apply a high-strength epoxy primer as specified in this Section within eight (8) hours of sandblasting if baseplates are not pre-grouted at the factory. Apply epoxy primer to the underside of baseplates.

.10 Seal exposed surfaces of cast iron baseplates in accordance with the requirements for bleeding surfaces specified in Section 09900 prior to shipment to the site.

.11 Plate Steel Soleplates:

.1 Provide plate-steel soleplates not less than 25 mm thick for equipment with drivers greater than 22.5 kW.

.2 Furnish plate steel soleplates with grout keys and lugs or stiffeners on the underside of the soleplate.

.3 Excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes) provide a flat uniform horizontal surface on the underside of plate steel soleplates.

.4 Scribe the underside of plate steel soleplates with the words “THIS SIDE DOWN” using welding rod material prior to milling the mounting pads for equipment or mounting surfaces.

.5 Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 450 mm.

.6 Prior to shipment to the site, sandblast surfaces of plate steel soleplates in contact with grout to white metal per SSPC-SP-6.

.7 Apply a high-strength epoxy primer as specified in this Section within eight (8) hours of sandblasting the underside of plate steel soleplates.

.8 Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom suction pumps, the equipment may be supported on individual concrete piers or equipment pads instead of mounting on a common equipment pad and soleplate. In such instances, support equipment at the feet or mounting surfaces on individual plate steel soleplates that have been leveled and grouted into place on the individual piers or equipment pads as specified in this Section. Install multiple soleplates to be coplanar within 0.015 mm/m or closer if required by the Manufacturer.

.12 Polymer Concrete Soleplates:

.1 Polymer concrete soleplates consist of pre-cast polymer concrete soleplates with stainless steel inserts for equipment mounting.

.2 Make mounting surfaces on polymer concrete soleplates coplanar within 0.015 mm/m.

.3 Excepting grout keys, grout pour holes and vent holes. Provide the underside of polymer concrete soleplates with a flat uniform horizontal surface.

.13 Corrosion-Resistant FRP Baseplates:

.1 Corrosion-resistant FRP baseplates consist of pre-formed fiber reinforced plastic.

.2 Corrosion-resistant FRP baseplates and the equipment that is mounted on the baseplate to be furnished by the same Manufacturer.

2.4 Grout for Equipment Pads

.1 Epoxy Grout for Equipment Mounting: Where epoxy grout is specified in the equipment mounting schedule, set bearing surfaces of baseplates, soleplates, and fabricated steel frames on equipment pads with epoxy grout for equipment mounting as specified in Section 03600. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it means epoxy grout for equipment mounting as specified in Section 03600.

.2 Cementitious Non-shrink Grout: Where non-shrink grout is specified in the equipment mounting schedule, cementitious non-shrink grout, specified in Section 03600, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it means cementitious non-shrink grout as specified in Section 03600. Training and quality control by the grout manufacturer’s representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.5 Epoxy Primer

.1 Epoxy primer: High strength, lead free, chrome free, and rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. Provide epoxy primer with a bond strength to sandblasted metal that is not less than 10 MPa.

.2 Acceptable Products:

.1 Phillybond Phillyclad 1000 Series.

.2 Or approved equivalent.

2.6 Anti-Seize/Anti-Galling Compound

.1 Provide anti-seize or anti-galling compound with a molybdenum disulfide and graphite combination in aluminium complex base grease; conform to MIL-PRF-907E.

.2 Acceptable Products:

.1 Jet Lube 550 by Jet Lube, Inc.

.2 E-Z Break by LA-CO.

.3 Or approved equivalent.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 For equipment mounted with epoxy grout, provide quality control services for epoxy grout installation in rigid equipment mounts. The epoxy grout Manufacturer's representative shall be on site to inspect and verify that the installation personnel have successfully performed surface preparation, epoxy grout application, and quality control inspection in accordance with this Section for a representative portion of the epoxy grout installation work.

.4 The epoxy grout Manufacturer's representative performs the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:

.1 Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout Manufacturer's requirements.

.2 Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.

.3 Inspect the surface preparation of the metallic substrates onto which the epoxy primer are to be applied.

.4 Inspect the epoxy-primed metallic substrate for coverage and adhesion.

.5 Inspect preparation and application of epoxy grout form work for conformance to the specifications.

.6 Inspect and record that the “pot life” of epoxy grout materials is not exceeded during installation.

.7 Inspect epoxy grout for cure.

.8 Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.

.9 Conduct a final review of completed epoxy grout installation for conformance to these Specifications.

.10 Attest to conformance of the work in writing.

END OF SECTION

MACHINE ALIGNMENT

1. GENERAL

1.1 Summary

.1 This Section covers alignment requirements for direct coupled mechanical equipment with drives greater than 10 kW, with all mounting systems. 10 kW or less drives directly coupled to equipment, and belt or chain driven machinery, are exempted from the requirements of this Section.

1.2 Standards

.1 Shaft Alignment Handbook - Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Upon completion of all alignment work or appropriate portion thereof, and prior to Substantial Completion, submit alignment records for all machine alignment work performed, in both hard copy and in electronic format. Submit the hard copy with an original signature, signed and dated by the technician performing the alignment work.

2. PRODUCTS

2.1 Performance Criteria

.1 Alignment:

.1 Use laser alignment tools to align equipment shafts to the tolerances specified by the Manufacturer or the criteria specified in the table below, whichever is more stringent.

Maximum Tolerable Misalignment				
	Speed, rpm, maximum	**Short Couplings (Distance between flex planes ≤ 100 mm)**		**Spacer Shafts angle at each flex plane in micron/mm or projected offset in micron/mm of spacer length**
		Offset (micron)	**Angularity (micron/mm)**	
(1)	600 and less	125	1.0	1.8
(2)	900	75	0.7	1.2
(3)	1200	65	0.5	0.9
(4)	1800	50	0.3	0.6
(5)	3600	25	0.2	0.3
(6)	7200	13	0.1	0.15

.2 Soft foot (machine frame distortion) in excess of 20 microns is not permitted for any speed.

.3 Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and levelled as specified in this section.

.4 Employ laser alignment techniques to achieve the specified tolerances. Use computer based equipment with software compatible with current Windows® based spreadsheets and databases. Utilize equipment with a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. Link field measurement components and the computer through cable, infrared, or wireless transmission.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

VIBRATION AND CRITICAL SPEED LIMITATIONS

1. GENERAL

1.1 Summary

.1 This Section specifies vibration and critical speed limitations for rotating mechanical equipment. Where individual equipment specifications specify more stringent requirements, the more stringent requirements shall apply.

.2 Perform vibration testing and measurements where specified in the individual equipment sections for both factory tests and functional testing in field and in accordance with the Technical Requirements.

1.2 Standards

.1 International Organization for Standardization (ISO):

.1 ISO 1940-1, Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state.

.2 ISO 7919-1, Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria.

.3 ISO 21940-32, Mechanical vibration — Rotor balancing — Part 32: Shaft and fitment key convention.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration testing plan:

.1 Test data sheets consisting of vibration spectrum graphs for each test point and each axis listing vibration amplitude verses frequency for each of the frequency ranges specified.

.2 Vibration testing equipment identification (make and model), performance specifications, and calibration certificates.

.3 Qualifications of the personnel performing vibration testing.

.3 Test report sheets showing mounting location of vibration transducers, machine operating speed during test, and operating parameters showing machine load.

.4 Test report sheets documenting vibration for the machine’s rotation rate throughout the specified operating speed range for each of the three axes at each of the machines bearing caps in units of r.m.s velocity (mm/s) and peak-to-peak displacement (micrometres).

.1 Plot vibration amplitudes as velocity units plotted on a logarithmic scale. Plot vibration amplitudes against a linear frequency scale in units of cycles per second (Hz) or multiples of rotation rate.

.2 Annotate vibration spectrum to indicate the fundamental train frequency, ball pass frequency for the inner and outer race of ball bearings, and ball spin frequency for bearings. Annotate vibration spectrum to indicate vane passing frequency for rotodynamic pumps.

.3 Annotate vibration spectrum to indicate any critical speeds that occur within 120 percent of the maximum operating speed for each piece of equipment. It is not necessary to determine critical speeds exceeding 120 percent of the maximum operating speed.

2. PRODUCTS

2.1 Performance Criteria

.1 When the vibration testing requirements in an equipment specification reference this Section, measure vibration as specified in this Section to demonstrate that machine vibrations comply with the following limits.

.2 Rotodynamic Pumps:

.1 Unless the equipment specification specifies different vibration limits, the vibration velocity of non-rotating parts of rotodynamic pumps must not exceed the limits below. When vibration limits are specified in an individual equipment specification, the vibration of non-rotating parts of rotodynamic pumps must not exceed the limits specified in the equipment specification.

.2 Allowable operating range and preferred operating range are as defined by the rotodynamic pump manufacturer for the specific pump.

Test		**Vibration velocity limit r.m.s. (mm/s)**	
		< 187 kW	**> 187 kW**
In Situ Test	Preferred operating range	2.5	3.5
	Allowable operating range	3.4	4.4
Factory Test	Preferred operating range	3.3	4.3
	Allowable operating range	4.0	5.0
In Situ and Factory Test	Vane-passing frequency and rotational frequency in the preferred operating range	2.0	2.0

.3 Rotodynamic pumps operating at speeds below 600 RPM are further subject to the following maximum vibration displacement units.

Test		**Vibration displacement limit peak-to-peak (micrometres)**
In Situ Test	Preferred operating range	50
	Allowable operating range	65
Factory Test	Preferred operating range	65

	Allowable operating range	80

.4 Industrial Machines:

.1 Industrial machines include rotary compressors, generators, electric motors, blowers, and fans.

.2 Unless the equipment specification specifies different vibration limits, vibration limits on non-rotating parts of industrial machines must not exceed the limits below at any point within the specified range of operating speeds. When vibration limits are specified in an individual equipment specification, vibration of non-rotating parts of industrial machines must not exceed the limits specified in the equipment specification.

.1 Vibration displacement limit, RMS: 22 µm.

.2 Vibration velocity limit, RMS: 1.4 mm/s.

.3 Critical Speed Requirements:

.1 Rotating mechanical equipment that exhibits a critical speed that is less than 120 percent of the maximum specified operating speed is not permitted. Modify equipment installations so that any critical speed is at least 20 percent above the maximum specified operating speed. This applies to both VFD's and pulley installations.

2.2 Balance Quality

.1 Unless specified otherwise in the equipment specification, balance rotors and impellers to Balance Quality Grade G 2.5, as specified in ISO 1940-1.

.2 Unless specified otherwise in the equipment specification, balance mechanical shafts per the requirements for Zone B classification as specified in ISO 7919-1. Balance all equipment using the Half Key Convention as specified by ISO 21940-32.

2.3 Bearing Faults

.1 Detectable bearing faults shall not be acceptable.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory Vibration Tests and Inspections:

.1 Measure vibration at the factory following completion of fabrication.

.2 Measure vibration on the shaft bearing housing in three (3) orthogonal directions (three perpendicular axes).

.3 For machines with a horizontal shaft, orient one (1) measurement axis with a vertical orientation, and another in a horizontal orientation, as close to the shaft's corresponding vertical and horizontal centrelines as is practical. Orient the third measurement parallel to the machine shaft's axis of rotation, at locations that have good mechanical coupling or linkage with the thrust load on the machines rotating components.

.4 Arrange orthogonal measurements for machines with a vertical shaft with the two (2) horizontal measurements perpendicular and aligned as radials to the shaft's axis of rotation. If a machine has a horizontal discharge, align one of the horizontal measurement axes parallel with axis of the discharge.

.5 Mechanically attach vibration measurement transducers to the machine's bearing housing. Affix transducer mounting pads to the machine with an adhesive such as a cyanocrilate or dental adhesive. Magnetic transducer attachment shall not be permitted. Leave mounting pads in place for future testing.

.6 Translate vibration measurement data from the time domain to the frequency domain or vibration spectra (range of frequencies). Report vibration measurements over a minimum of two (2) frequency ranges, one (1) spanning from 5 to 500 Hz to show the machine's rotation rate and the first 10 multiples of rotation rate, and another spanning from 5 Hz to 5000 Hz. Provide vibration spectra with a minimum frequency resolution of 400 lines over each frequency range. Collect measurements over a sufficient time span to produce linear averaged amplitude values consisting of a minimum of eight (8) individual amplitude values for each frequency across the entire spectrum.

3.2 Functional Testing

.1 General:

.1 Measure vibration after Functional Testing.

.2 Record vibration measurements while equipment operates within the specified speed range, with a normal system load, and at a stable operating temperature.

.3 Vibration analysis technician shall have minimum five (5) years of experience.

.2 Field or Site Tests and Inspections:

.1 Measure vibration on the shaft bearing housing in three (3) perpendicular axes.

.2 For machines with a horizontal shaft, orient one (1) measurement axis with a vertical orientation, and another in a horizontal orientation, as close to the shaft's corresponding vertical and horizontal centrelines as is practical. Orient the third measurement parallel to the machine shaft's axis of rotation, at locations that have good mechanical coupling/linkage with the thrust load on the machines rotating components.

.3 Arrange orthogonal measurements for machines with a vertical shaft with the two (2) horizontal measurements perpendicular and aligned radially to the shaft's axis of rotation. If a machine has a horizontal discharge, align one (1) of the horizontal measurement axes parallel with axis of the discharge.

.4 Mechanically attach vibration measurement transducers to the machine's bearing housing. Affix transducer mounting pads to the machine with an adhesive such as a cyanoacrylate or dental adhesive. Magnetic transducer attachment is not permitted.

.5 Transform vibration measurement data from the time domain to the frequency domain or vibration spectra (range of frequencies). Report vibration measurements over a minimum of two frequency ranges, one spanning from 5 to 500 Hz to show the machine's rotation rate and the first 10 multiples of rotation rate, and another spanning from 5 Hz to 5000 Hz. Provide vibration spectra with a minimum frequency resolution of 400 lines over each frequency range. Collect measurements over a sufficient duration to produce linear averaged amplitude values consisting of a minimum of eight (8) individual amplitude values for each frequency across the entire spectrum.

END OF SECTION

TELESCOPIC GATE VALVES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of telescopic gate valves complete with operators, operating stems, bails, slip tubes, slip tube seals, and slip tube seal retaining flanges. Telescopic gate valves are used for skimming stray floatables from the water surface.

1.2 Standards

.1 ASTM A707, Flanges, Forged, Carbon and Alloy Steel for Low Temperature Service.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Shop Drawings showing the assembled telescopic gate valves. Include equipment numbers for each gate valve.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Whipps, Inc.

.2 Waterman Industries.

.3 Latanik.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Telescopic gate valves skim stray floatables from the water surface.

.2 At the start of skimming, the slip tube lowers to the water surface to allow drainage of the surface into the slip tube opening.

.3 Slip tubes shall be capable of being easily raised and lowered by means of an accessible handwheel lift operator and stand.

.4 Provide slip tube seals which prevent leakage of water into the pipe connected to the gate when the top of the slip tube is raised above the water surface.

.5 Identify the telescopic gate valves by their equipment number.

.6 Each telescoping gate valves shall connect to 150 mm diameter pipe flange.

.7 Telescopic gate valves to be fully operable 12 months per year at all weather conditions without condensation or freezing if installed outdoors.

2.3 Materials

.1 Slip Tube and Bail: Stainless Steel, Type 316L, ASTM A240.

.2 Stem: Stainless Steel, Type 316, ASTM 276.

.3 Fasteners, Nuts and Bolts: Stainless Steel, Type 316, ASTM A276.

.4 Seal: Urethane or Neoprene.

.5 Lift Nut: Bronze ASTM B584.

.6 Pedestals and Wall Brackets: Stainless Steel, Type 316L, ASTM A276.

.7 Operator Housing: Cast aluminum.

.8 Materials selected according to section 01450.

.9 Service life according to the Technical Requirements.

2.4 Configuration, Components and Features

.1 Slip tube and bail:

.1 The slip tube shall be constructed of Schedule 10S minimum thickness stainless steel pipe. Provide V-notched weirs, U-notched weirs, scum baffles and funnel tops as required for the Final Design.

.2 Construct bail of stainless steel, bolt to the stem and weld to the slip tube.

.2 Seal:

.1 The telescoping gate valve shall be provided with a self-adjusting seal system to restrict leakage between the slip tube and the receiving pipe.

.2 The seal shall be a one-piece molded urethane with an upper lip type seal and an integral companion flange.

.3 If a neoprene seal and separate companion flange is provided, the neoprene seal to have a minimum thickness of 12.8 mm and the companion flange shall be 316L stainless steel and to have a minimum thickness of 9.5 mm.

.4 The companion flange shall be provided with a bolt pattern suitable for attachment to the flange on the receiving pipe.

.3 Stem:

.1 A threaded operating stem shall connect the operating mechanism to the bail which in turn is attached to the slip tube. On rising stem valves, the threaded portion shall engage the operating nut in the manual operator or motor actuator. On non-rising stem valves, the threaded portion shall engage the nut attached to the bail. Rising and non-rising stem configurations shall be selected as required to optimize operability, resistance and clog free operation.

.2 The threaded portion of the stem shall have a minimum outside diameter of 38 mm. Stem extension pipes are not permitted.

.3 The stem shall be constructed of solid stainless steel bar for the entire length, the metal shall have a tensile strength of not less than 620 MPa.

.4 Maximum L/R ratio for the unsupported part of the stem shall not exceed 200.

.5 In compression, the stem shall be designed for a critical buckling load caused by an 176 N effort on the crank or handwheel with a safety factor of 2, using the Euler column formula.

.6 The stem shall be designed to withstand the tension load caused by the application of a 176 N effort on the crank or handwheel without exceeding 1/5 of the ultimate tensile strength of the stem material.

.7 The threaded portion of the stem to have machine rolled double lead threads of the full Acme type with a 406 micrometer finish or better. Stub threads are not permitted.

.8 Stems of more than one (1) section shall be joined by stainless steel or bronze couplings. The coupling shall be pinned and bolted to the stems.

.9 Stems on manually operated valves shall be provided with adjustable stop collars to prevent over travel.

.4 Manual operators:

.1 Use electric actuators as required to optimize operability.

.2 Unless otherwise required, gate valves shall be operated by a manual handwheel or a manual crank-operated gearbox. The operator shall be mounted on a pedestal.

.3 The gate valve manufacturer to select the proper gear ratio to ensure that the valve can be operated with no more than a 176 N effort.

.4 An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the valve.

.5 Pedestals shall be constructed of stainless steel. Aluminum pedestals are not permitted.

.6 The pedestal height shall be such that the handwheel or pinion shaft on the crank-operated gearbox is located approximately 914 mm above the operating floor.

.7 Handwheel operators:

.1 Fully enclosed and to have a cast aluminum housing.

.2 Provided with a threaded cast bronze lift nut to engage the operating stems.

.3 Equipped with roller bearings above and below the operating nut.

.4 Positive mechanical seals shall be provided above and below the operating nut to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.

.5 The handwheel shall be removable and to have a minimum diameter of 380 mm or larger so that it can be operable by a single person.

.8 Crank operators:

.1 Fully enclosed and to have a cast aluminum housing.

.2 Gearboxes shall have either single or double gear reduction depending upon the lifting capacity required.

.3 Gearboxes shall be provided with a threaded cast bronze lift nut to engage the operating stem.

.4 Bearings shall be provided above and below the flange on the operating nut to support both opening and closing thrusts.

.5 Gears shall be steel with machined cut teeth designed for smooth operation.

.6 The pinion shaft shall be stainless steel and supported on ball or tapered roller bearings.

.7 Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.

.8 The crank shall be cast aluminum with a revolving nylon grip.

.9 The crank shall be removable.

2.5 Spare Parts

.1 Provide the following spare parts:

.1 One (1) crank operator.

.2 Two (2) mechanic seats for the operating hut.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Following installation of each gate as part of Functional Testing, test each gate by operating the gate through at least five (5) complete open-close cycles under the Final Design heads conditions.

END OF SECTION

STOP PLATES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of stainless steel stop plates for wastewater containing suspended solids consisting of organic and inorganic materials, rocks, grit, rags, petroleum products and grease.

1.2 Standards

.1 ASTM:

.1 ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.2 ASTM B26 – Standard Specification for Aluminum-Alloy Sand Castings.

.3 ASTM B221 – Aluminum and Aluminum-Alloy Extruded Bar, Rods, Wire, Shapes, and Tubes.

.4 ASTM B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.

.5 ASTM D1056 – Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

.6 ASTM D2000 – Standard Classification system for Rubber Products in Automotive Applications.

.7 ASTM D6098 – Standard Specification for Extruded and Compression Molded Shapes Made from Polycarbonate.

.8 ASTM A240 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

.9 ASTM A240 – Standard Specification for Stainless Steel Nuts.

.2 AWS D1.6 – Specification for Welding Procedure and Performance Qualification.

.3 AWWA C561 – Fabricated Stainless Steel Slide Gates.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Provide design calculations confirming stress and deflection of the plate. Include calculations of breakaway lift and thrust forces, clearly showing weight of plate, coefficient of friction, and seating and unseating head.

.3 Provide details of plate assembly, accessories and part lists.

1.4 Quality Assurance

.1 The Manufacturer's shop welds, welding procedures and welders shall be certified in accordance with the requirements of the latest edition of AWS D1.6.

.2 Stop plates shall be Manufacturer's standard cataloged product and modified to provide compliance with the Final Design.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Whipps, Inc.

.2 RW Gates.

.3 Waterman Industries.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Provide stop plates and guides to stop flow in a channel with removable gate plate components.

.2 Area Exposure: Per Section 01450.

.3 Plates to be operable in all weather conditions including potential freezing conditions.

.4 Use stop plates where leakage is appropriate to the application.

.5 The design requirements and operating conditions including product dimensions, product features and installation details shall conform to the Final Design.

2.3 Materials

.1 Frame, slides, stiffeners and handles: ASTM A420 or A276 Type 316 stainless steel.

.2 Anchor bolts and fasteners: ASTM A276, Type 316 stainless steel.

.3 Guide bars: ASTM D-4020, ultra-high-molecular-weight polyethylene (UHMWPE).

.4 Seals and gaskets: ASTM D-4020 UHMWPE.

2.4 Configuration, Components and Features

.1 General:

.1 Design slides and frames with a safety factor of 5 with regard to tensile, compressive and shear strength.

.2 Design the plates to withstand the maximum design heads.

.3 When the plate is in motion, the operating forces shall be based on the sum of all operating loads on the plate.

.4 Leakage not to exceed 0.6 L/min per linear m of sealing perimeter, per AWWA C561.

.5 Provide calculation for breakaway forces.

.2 Slide: Flat plate reinforced with formed plates or structural members to limit its deflection to less than 1/720 of the plate's span under the design head.

.3 Frame:

.1 Structural members of formed plate.

.2 Provide frame suitable for mounting on a concrete wall.

.3 Provide a U-shaped form frame to act as a guide for the slide.

.4 Provide a flush bottom invert member across the bottom of the guides.

.5 Frame mounted seals are not permitted.

.4 Handles: Surface weld the handles to the plate. Extended the handles so that the top of the handles are 150 mm below the operating floor.

.5 Seals: Provide all plates with a self-adjusting seal system to restrict leakage in accordance with the requirements of the Final Design.

.1 Equip all plates with UHMWPE seat or seals to restrict leakage and to prevent metal to metal contact between the frame and slide.

.2 Provide all stop plates with a continuous resilient seal to seal the bottom and both sides of the plate. Attach the seal to the invert of the slide and hold it in place with stainless steel attachment hardware.

.3 The seal system shall be durable and to accommodate frequent operation without loosening or suffering damage.

.4 All seals must be bolted or otherwise mechanically fastened to the frame or slide. Arrangement with seals that are force fit or held in place with adhesives are unacceptable.

.5 Mount the seals so as not to obstruct the water way opening.

.6 Anchor bolts: Minimum 13 mm diameter.

.7 Stop plate lifter:

.1 Provide one (1) stop plate lifter for each different stop plate (guide frame) width.

.2 The lifter shall be constructed of aluminum or Type 304L stainless steel and fitted with UHMW guide bars and stainless steel fastener.

.3 Provide the lifter with lifting hooks designed to engage the slots in the top of the stop plates.

.4 Provide a lanyard release.

.5 Provide the lifter capable of installing and removing all stop plates of the same width whether they are installed or at the operating floor level.

.6 The maximum lift for the operator shall not exceed 23 kg.

.7 Stop plates in isolated locations shall be provided with a dedicated lifter.

.8 Storage Racks:

.1 Provide storage racks to house stop plates while they are not in use.

.9 Provide storage racks constructed of aluminum and configured and mounted.

2.5 Fabrication

.1 Fabricate in accordance with American Water Works Association (AWWA) C561.

.2 All weld burn and slag on stainless steel shall be mechanically removed and passivated in accordance with ASTM A380.

.3 Where dissimilar metals meet, isolate mating surfaces, bolts, nuts, washers, and rivets to protect against galvanic corrosion.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Field Leakage Test:

.1 The test forms part of Functional Testing.

.2 The purpose of the leakage test is to establish acceptable performance of the installed equipment in accordance with the requirements of the Final Design.

.3 Prepare and submit written test plan in accordance with AWWA C561 for review and approval prior to commencing test. Testing prior to approval is not acceptable.

.4 Provide written summary of test results.

.5 Test leakage for each stop plate under specified seating and unseating head conditions.

.6 The test must demonstrate that all plates meet or exceed the design leakage criteria.

.7 Leakage testing is completed once performance and testing documentation has been completed.

END OF SECTION

SLIDE GATES

1. GENERAL

1.1 Summary

.1 This Section covers the supply, and equipment specific installation of fabricated slide gates.

1.2 Standards

.1 ASTM:

.1 ASTM B26 – Aluminium-Alloy Sand Castings.

.2 ASTM B221 – Aluminium and Aluminium-Alloy Extruded Bar, Rods, Wire, Shapes, and Tubes.

.3 ASTM B584 – Copper Alloy Sand Castings for General Applications.

.4 ASTM D1056 –Flexible Cellular Materials—Sponge or Expanded Rubber.

.5 ASTM D2000 – Standard Classification system for Rubber Products in Automotive Applications.

.6 ASTM D6098 – Extruded and Compression Molded Shapes Made from Polycarbonate.

.7 ASTM F593 A276– Stainless Steel Bolts, Hex Cap Screws, and Studs.

.8 ASTM F594 A276– Stainless Steel Nuts.

.2 AWWA C561-12 – Fabricated Stainless Steel Slide Gates.

.3 ANSI/AWWA C540 – Power Actuating Devices for Valves and Slide Gates.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Design calculations confirming stress and deflection of the slide, yoke and stem. Include calculations of breakaway lift and thrust forces, clearly showing weight of gate, weight of stem or cylinder rod, coefficient of friction, and seating and unseating head.

.3 Details of gate actuator assembly, gate assembly, stem supports, accessories and part lists.

.4 Stamped and sealed design data from a registered Professional Engineer in the Province of Manitoba certifying that the design and installation of slide gates meets the requirements of Applicable Law and the requirements of the Design and Construction Specifications.

1.4 Quality Assurance

.1 Certifications:

.1 Shop welding to be completed by welders certified in accordance with AWS B2.1 D1.6, ASME Section IX, or CWB.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Whipps, Inc.

.2 RW Gates.

.3 Waterman Industries.

.4 Golden Harvest.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Provide slide gates and guide to stop flow in a channel with removable slide gate components.

.2 Area Exposure: Per Section 01450.

.3 Slide gates to be operable in all weather conditions including potential freezing conditions.

.4 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid Temperature.

.2 Fluid Type/Commodity

.5 The design requirements and operating conditions including product dimensions, product features and installation details shall conform to the Final Design.

2.3 Materials

Component	Material
Thimble, frame, guides, slide, yoke and stem guides	ASTM A240, A276, or A666 Type 316L stainless steel
Actuator pedestal and gear housing	ASTM A312 or A276 Type 316L stainless steel
Thrust nuts	Bronze
Stem couplings	ASTM A276, Type 316 stainless steel
Seats	ASTM D4020, UHMW polyethylene

Component	Material
Seals	ASTM D4020, UHMW polyethylene
Stem guide bushings	ASTM D4020, UHMW polyethylene
Stems	ASTM A276, Type 316 stainless steel
Stem covers	ASTM B221, aluminium with plexiglass, alloy 6061-T6 with ASTM D6098 polycarbonate
Anchor bolts and fasteners	ASTM A276, Type 316 stainless steel
Flush bottom seal	ASTM D2000, Neoprene
Lift nut	Manganese bronze, ASTM B584, UNS-C86500
Gearbox	Cast aluminium or ductile iron
Square nut operator	ASTM A276, Type 316 stainless steel
T-handle gate wrench	ASTM A276, Type 316 stainless steel

2.4 Configuration, Components and Features

.1 General:

.1 Design slides and frames with a safety factor of five with regard to tensile, compressive and shear strength, and with the requirement that all gates to comply with field leakage tests specified in AWWA C561 as modified herein.

.2 Operating forces used for determining the strength of gate components (yokes, frames, slides, stems, slide nut pockets, and other load-bearing members) to be based on the sum of the guide friction force and the weight of slide and stem without allowance for buoyancy.

.3 Leakage is not to exceed 0.60 litre per minute per linear metre of sealing perimeter.

.4 Each slide to be stamped or otherwise permanently indicate the pressure rating of the installed equipment.

.2 Slide:

.1 Fabricate slide from shapes and/or plate with a minimum thickness of not less than 6.4 mm. Reinforce slide with Type 316 stainless steel structural shapes. Provide even stress distribution with horizontal stiffeners welded to vertical stiffeners running the height of the gate.

.2 Maximum deflection for each disk is 1/1000 of the span, after inclusion of comprehensive safety factor calculations accounting for bending moments, buckling stress, and bonding stress with thermal expansion factors. Calculate safety factors for the slide under the maximum specified head, and shear at the slide/seal interface.

.3 Frame:

.1 Gate frames extending above operating floors or slabs to be self-contained and sufficiently strong so that no further support or reinforcement is required.

.1 Frames for self-contained gates to be designed for maximum loads from gate operators in a stalled condition.

.2 Where manual crank or manual hand wheel operators are specified for gates with self-contained frames, operator to be mounted 1075 to 1400 mm above the floor or deck that provides pedestrian access.

.3 Provide covers for gate openings where gate frames extend above operating floors of covered decks. Maximum gap at gate frame and gate shaft not to exceed 6 mm. Split cover at gate shaft to allow for installation and removal of cover.

.2 Wall-mounted frames to be flat back flanged type.

.3 Embedded frames to be installed in block-out recesses formed in the channel walls and floor. Frame to be embedded with non-shrink grout per Section 03600.

.4 Channel wall-mounted frames to be mounted to the channel walls perpendicular to the plane of the gate. Fill any spacing between the frame and wall with non-shrink grout per Section 03600.

.5 Provide a unitized frame guide consisting of a single plate material. Guide designs with two (2) more bolted structural members are not permitted.

.6 Thimble-mounted gates to be drilled to match the pipe flange or wall thimble. Wall thimbles to conform to AWWA C561.

.4 Seals:

.1 Provide a self-adjusting seal system suitable for the leakage, frequent cycling and velocities specified herein, and mounted such that there is no obstruction to the specified gate opening size.

.2 Provide gates equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.

.3 Extend the seat/seals to accommodate the 1.50 x the slide height with the gate in the fully open or fully closed position.

.4 Provide all upward opening gates with a resilient flush bottom seal for sealing the invert of the gate.

.5 Provide all downward opening weir gates with self-adjusting UHMW seat/seals across the invert member.

.6 Provide all seals mechanically fastened to the frame or slide, force fit seals or seals attached with adhesive are not permitted.

.7 Provide all seats and seals to be field replaceable without the need to remove grout or concrete and without the need to remove the frame from the wall or wall thimble.

.8 Gates using J" or "P" seals are not permitted.

.9 The sealing system to be as follows:

.1 The flush bottom seal to be mounted on the frame invert. With the slide open, the invert of the gate frame to be flush with the channel or opening bottom, with no pockets or cavities for the accumulation of solids.

.2 Gates to achieve the leakage rates specified and provide sealing system as follows:

.3 Upward opening gates for submerged service: Invert seal to be mounted on the slide or frame invert. Side and top seals to be frame mounted with self-adjusting or P-bulb design.

.4 Downward opening gates: Side and bottom seals to be frame mounted with self-adjusting or P-bulb design.

.10 Guides and seating of the gate to be field adjustable.

.11 All moving contact surface materials to be selected for smooth operation without any sticking or jamming. Metal-to-metal contact between the slide and frame are not permitted.

.12 Top and side seals to be replaceable without removing the gate from the concrete or wall thimble.

.5 Stems:

.1 Minimum Diameter: 32 mm.

.2 Thread Pattern: 29-degree ACME threads.

.3 Provide stem covers constructed of aluminum tubing with integral transparent sight glass. Provide durable markings indicating gate position.

.4 Stem couplings, where required, to be of the stem material. Stem guides to be of the split, adjustable type.

.5 Stem guides to be provided at intervals of 1800 mm minimum, and at sufficient intervals to prevent the L/R ratio of the unsupported stem length (L) from exceeding 200, where R is the radius of gyration of the stem.

.6 Except where otherwise specified, provide single rising stems for gates having width to height ratios of 2.0:1 or less. Provide dual rising stems for gates having width to height ratios of 2.0:1 or more. Mechanically link to a common actuator. Synchronize gate travel on both stems. Provide removable shroud covering on interconnecting shaft for all gates with dual stems and interconnected gearboxes.

.7 For gates with electric actuators, stems to be designed to withstand a compressive thrust force equal to at least 1.25 times the rated output of the hoisting mechanism with the motor in the stalled condition.

.8 For gates with manual actuators, design stems to withstand a compressive thrust force equal to at least 2.5 times the hoisting mechanism's rated output with a 178 N effort applied to the auxiliary hand wheel or crank.

.6 Operators:

.1 Furnish operator type as assigned in the Final Design. Furnish manual operators for slide gates specified manual handwheels manual cranks, right angle gear drive with manual handwheels, right angle gear drives with removable manual handwheels and square nut operators. Furnish electric actuators for slide gates as required by the Final Design.

.2 All hand operated valves shall be capable of operating with a hand drill or suitably sized portable operating system.

.3 Install pedestal mount operators on a high-strength pedestal base.

.4 Operating nut: Internally threaded with 29-degree ACME threads corresponding to stem threading.

.5 Tapered roller bearings or ball bearings: Locate above and below the operating nut to support the output thrust of the operator.

.6 Pinion shaft: Mount on tapered roller bearings to resist axial and radial thrust.

.7 Mechanical seals: Provide around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and prevent moisture from entering the sealed housing.

.8 Slide gates with manual type operators to be furnished with stop nuts or stop collars. Install stop nuts/collars at manufacturer's recommended closed position. Where position switches are specified for gates, stop nuts/collars to be configured to activate position switches.

.9 Manual Handwheel:

.1 Maximum effort of 178 N on handwheel perimeter to operate the gate under the specified operating conditions.

.2 Manual, direct drive hand wheel without reduction gearing.

.10 Manual Crank:

.1 Manual, right-angle gear reduction type.

.2 Removable and self-locking at any position of stem travel.

.3 Crank arm 380 mm long or 760 mm diameter wheel crank.

.4 Gear box: Enclose gears and bearings in a weatherproof housing with bronze operating nut, and provide pressure type fittings for grease lubrication of the bearings and gears.

.5 A maximum effort of 178 N pull on the crank to operate the gate under the specified operating conditions.

.6 Reduction gear case: Precision machined and equipped with tapered roller or needle bearings and sealed about the reduction shafts.

.7 Fit input shaft with an AWWA standard 50 mm square nut.

.11 Externally Powered Actuator:

.1 Comply with the requirements of Division 15, Division 16, and Division 17.

.2 Configure the actuator and gear box to provide 150 percent of the opening force required to open the slide gate against the maximum seating or unseating head as required by the Final Design, whichever results in the greater force.

.3 Configure actuator with heater to prevent condensation build-up while actuator is de-energized.

.12 Right Angle Gear Driven Manual Handwheel:

.1 Maximum effort of 178 N on handwheel perimeter to operate the gate under the specified operating conditions.

.2 Manual, hand wheel mounted on horizontal shaft of right angle gear drive.

.3 Provide removable hand wheel for selected slide gates.

.13 Square Nut Operator:

.1 Standard AWWA 50 mm square nut.

.2 Furnish T-handle gate wrench for operation at deck level.

.14 Provide integral features required to lockout and render gates inoperable on all operator types.

2.5 Fabrication

.1 Fabrication: in accordance with AWWA C561 and as specified.

.2 All weld burn and slag on stainless steel to be mechanically removed and passivated in accordance with ASTM A380.

.1 Passivate in an environmentally controlled shop with at least five (5) years of experience in nitric-hydroflouric acid solution pickling in compliance with all federal and provincial regulations.

.3 Where dissimilar metals meet isolate mating surfaces, bolts, nuts, washers, and rivets to protect against galvanic corrosion.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

3.2 Equipment Checkout

.1 Complete the following testing during Equipment Checkout phase:

.1 Factory Testing:

.1 Assemble each gate and inspect for proper seating.

.2 Check clearance between frame and disk seating surfaces.

.3 Fully open and close each gate in guide system to ensure gates operate freely.

.4 Conduct shop leakage test at the design unseating head on each gate and confirm leakage.

.5 Correct or replace any defects and repeat tests until specified results are obtained.

.6 Quality control per AWWA C561.

.7 Valve to be free of excessive torque at the most stringent conditions for a minimum of five (5) maneuvers.

END OF SECTION

CONSTANT UPSTREAM LEVEL GATES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and testing of the constant upstream level control gates as specified herein.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Design calculations confirming stress and deflection of the components. Include calculations of breakaway lift and thrust forces.

.3 Certification by a qualified professional that the installed equipment meets the operating and design requirements of this Section.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Golden Harvest.

.2 Waterman.

.3 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Gates shall be capable of operation in sewage with potential for rag, ropes, suspended solids and debris.

.2 Design to allow for easy maintenance.

.3 Where the application has potential for coarse gravel or debris the gate shall be designed for it.

.4 The service conditions for the following parameters shall conform to the Final Design:

.1 Maximum discharge head.

.2 Minimum differential head.

.3 Maximum Flow.

.4 Channel width.

.5 Channel depth.

2.3 Materials

.1 Type 316 stainless steel.

2.4 Configuration, Components and Features

.1 Automatic level control gate to maintain a constant upstream water level.

.2 Gate is completely self-operating with an integrated float ballast design.

.3 Uses force balance principle to control flow.

.4 Hydraulic force of the water flow against the gates to be counterbalanced by buoyant chamber and ballast chambers.

.5 Radial shaped faceplate suitably reinforced.

.6 Trapezoidal sluiceway.

.7 Frame, including the float and ballasting compartments.

2.5 Spare Parts

.1 Provide spare parts in accordance with the Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

BUTTERFLY GATES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of rectangular butterfly gates to control and isolate flow.

1.2 Standards

.1 ASTM A36 – Standard Specification for Carbon Structural Steel.

.2 ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

.3 ASTM A564 – Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

.4 ASTM B26 – Standard Specification for Aluminium-Alloy Sand Castings.

.5 ASTM B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.

.6 ASTM D2000 – Standard Classification system for Rubber Products in Automotive Applications.

.7 ASTM D4969 – Standard Specification for Polytetrafluoroethylene (PTFE) Coated Glass Fabric.

1.3 Definitions

.1 Drip-tight: No detectable leakage.

1.4 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Certification by a qualified professional that the furnished equipment meets the operating and design requirements of this Section.

.3 Design data or calculations showing head loss across the gates under design head and flow conditions.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Henry Pratt.

.2 VAG/Rodney Hunt.

.3 Waterman Industries.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Leakage of the butterfly gate valve to meet the requirements of the application as provided by the manufacturer.

.2 Area Exposure per Section 01450.

.3 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid Type/Commodity.

.2 Fluid Temperature.

.4 Gates to be suitable for operation in sewage with potential for rags, ropes and debris.

.5 The design requirements and operating conditions including product dimensions, product features and installation details shall conform to the Final Design.

2.3 Materials

.1 Body: ASTM A276 or A666 Type 316 stainless steel.

.2 Thimble: ASTM A276 or A666 Type 316 stainless steel.

.3 Disk: ASTM A276 or A666 Type 316 stainless steel.

.4 Seating edge: ASTM A276, Type 316 stainless steel.

.5 Seat: ASTM D2000, Neoprene.

.6 Shaft: ASTM A564, Type 17-4 PH stainless steel.

.7 Taper pins: ASTM A276, Type 316 stainless steel.

.8 Upper and lower shaft bearings: ASTM D4969, Teflon, fibreglass-backed.

.9 Handwheel: ASTM B26.

.10 Anchor bolts and connecting hardware: ASTM A276, Type 316 stainless steel.

.11 Retaining clamps: ASTM A276, Type 316 stainless steel.

2.4 Configuration, Components and Features

.1 General:

.1 Each gate to be stamped or otherwise permanently marked, in a location visible during normal operation, to indicate the pressure rating of the installed equipment.

.2 Provide integral features required to lock out and render gates inoperable.

.3 Mark direction of flow on gate.

.2 Body:

.1 Provide a flanged body suitable for field-mounting to a wall thimble.

.2 Provide integral hubs for housing shaft bearings and seals.

.3 Provide body with channel ribs to prevent deflection.

.3 Thimble:

.1 Provide a fabricated Type 316 stainless steel double-flange thimble (C-channel thimble with one (1) flange embedded in concrete a minimum of 50 mm and the body bolted to the other flange). External flange to extend from the wall not less than 75 mm.

.2 Provide a neoprene gasket or coat front flange with a mastic for bubble-tight fit between thimble and body.

.3 Drill holes to match the drilling pattern of the body. Use thru-bolts with nuts. Bolts tapped into the thimble are not permitted.

.4 Indicate the vertical centre lines at the top and bottom of the machined face by means of a permanent mark.

.5 Mark the word “top” near the top centre line of the thimble.

.6 The surface to be cast into concrete shall be free of paint, oil and grease.

.4 Seat:

.1 Provide a resilient seat secured to the gate body and a ground, polished and contoured seating edge around the periphery of the disk. Alternatively, incorporate the metal seating edge into the gate frame with the resilient seat recessed and secured to the periphery of the disk.

.2 Provide the seating edge to be a minimum of 50 percent in contact with the seat.

.3 Design the seat to permit field adjustment of not less than 5 mm.

.4 Provide the seat fully field adjustable and replaceable without dismantling the actuator, disk or shaft.

.5 Secure the seat with a series of adjustable retaining clamps.

.5 Valve Disk:

.1 Type 316 stainless steel disk and seating edge. Provide ground, polished and contoured seating edge.

.2 Provide streamlined disk design to prevent turbulence in full open position, minimize pressure drop across valve and provide good throttling characteristics.

.3 Provide the disk totally enclosed without external transverse or lateral ribs.

.4 Minimum Thickness: 6 mm.

.6 Shaft:

.1 Provide stub-type shafts extending into the disk a minimum distance of 1.5 times the shaft diameter.

.2 Securely lock the shaft to the disk by means of taper pins.

.7 Bearings:

.1 Provide self-lubricated sleeve type main shaft bearing fitted into the gate body trunnion bore.

.2 Provide each gate with a two-way thrust bearing assembly designed to hold the disk centred in the valve seat at all times.

.3 Secure the thrust bearing by a locking device, easily accessible for field adjustment from the operator end of the gate.

.8 Valve Operators:

.1 Select valve operations based on the application.

.9 Right Angle Gear Drive:

.1 Provide self-contained enclosed torque tube between right angle gear drive and gate shaft.

.2 Manual Gear Operator:

.1 Maximum effort of 176 N on manual hand wheel perimeter to operate the gate under the specified operating conditions.

.2 Mount hand wheel (manual hand wheel or electric actuator hand wheel) on horizontal shaft of right angle gear drive, 1200 mm above deck surface. Torque tube length to provide specified hand wheel height.

.3 Electric Actuators:

.1 Comply with requirements in Division 16.

.4 Allow for operation with portable electric drill.

.5 Provide integral features required to lock out and render gates inoperable on all operator types.

2.5 Spare Parts

.1 Provide spare parts in accordance with the Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Leakage Test:

.1 The test forms part of Functional Testing.

.2 The purpose of the leakage test is to establish acceptable performance of the installed equipment in accordance with the requirements of the Final Design.

.3 Prepare written summary of test results.

.4 Leakage testing is completed once performance and testing documentation has been completed to comply with the requirements of this Section.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the design, installation, testing and commissioning of bulkhead gates and stop logs, and associated frames, guides, seals, sills, storage racks, and appurtenances required for the isolation of open channels.

1.2 Standards

.1 ASTM:

.1 ASTM A167 – Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip.

.2 ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

.3 ASTM A380 – Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and systems.

.4 ASTM D2000 – Standard Classification system for Rubber Products in Automotive Applications.

.5 ASTM D4020 – Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

.6 ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

.7 ASTM F594 – Standard Specification for Stainless Steel Nuts.

.8 AWS B2.1 – Specification for Welding Procedure and Performance Qualification.

.2 AWS:

.1 AWS D1.1 – Structural Welding Code – Steel.

.2 AWS D1.6 – Structural Welding Code – Stainless Steel.

.3 AWWA C561 – Fabricated Stainless Steel Slide Gates.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Maximum bending stress and deflection of the stop logs under design head specified and as required for the Final Design.

.3 The latest ISO 9001 series certification or quality system plan.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Whipps.

.2 RW Gate.

.3 Steel-Fab, Inc.

.4 Golden Harvest.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Gate will be capable of operation in sewage with potential for rags, ropes, suspended solids and debris.

.2 Design to allow for ease of maintenance.

.3 Area Exposure: Per Section 01450.

.4 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid Temperature.

.2 Fluid Types/Commodities.

.5 The design requirements and operating conditions including product dimensions, product features and installation details shall conform to the Final Design.

.6 Design Requirements:

.1 Seat and seal using only the weight of the gate and the hydrostatic pressure against the gate.

.2 Allowable leakage: 0.6 L/min per linear m of wetted perimeter, with any seating or unseating head pressure from 0 mm to full design head.

.3 Invert sill: Rolled steel tube or C-channel set in grout as required for the Final Design.

.4 Guide frame: Provide seating surfaces on upstream and downstream faces.

.5 Gate deflection: Equal to or less than 1/360 of the clear width span under design load.

.6 Orientation: Gate shall be installed facing either direction.

2.3 Materials

.1 Gate skin plate and stiffeners: ASTM A167, Type 316L stainless steel.

.2 Guide frame: ASTM A276, Type 316L stainless steel.

.3 Invert sill: ASTM A276, Type 316L stainless steel.

.4 Resilient seals: ASTM D4020, UHMWPE.

.5 Guide bumpers: ASTM D4020, UHMWPE.

.6 Retainer bars and fasteners for seals: ASTM A276, Type 316L stainless steel.

.7 Studs, anchors, assembly bolts and fasteners: ASTM F593 and ASTM F594, Type 316 stainless steel.

.8 Lifting system: ASTM A276, Type 316L stainless steel.

.9 Storage rack: ASTM A276, Type 316L stainless steel.

2.4 Configuration, Components and Features

.1 General:

.1 Each gate shall be stamped or otherwise permanently indicate the seating and unseating head rating of the installed equipment.

.2 Gates shall be interchangeable among guide frames where they have the same dimensions and materials of construction.

.2 Gate:

.1 Fabricate gate from stiffeners and plate with a minimum thickness of not less than 6 mm.

.2 Reinforce skin with stiffeners.

.3 Provide even stress distribution with horizontal stiffeners welded to vertical stiffeners running the height of the gate.

.4 Provide weld on stainless steel passivated in accordance with ASTM A380 to remove weld burn and scale.

.5 Provide stop logs designed to prevent buoyance and to allow drainage.

.6 Provide all welds performed by welders with ASME Section IX certification for stainless steel.

.3 Guide Frame:

.1 Provide prefabricated stainless steel guide frames matching the full height of the channel as specified.

.2 For embedded frames, the bulkhead and stop log gate manufacturer shall specify suitable blockout dimensions for the frame.

.3 For wall-mounted frames, Manufacturer shall coordinate anchor bolt sizes and locations; mount the frame approximately 12 mm from the wall and grout in to achieve Manufacturer's required plumb, level, and coplanar tolerances.

.4 All bottom sealing sills shall be flush-bottom.

.4 Stop logs:

.1 Provide stop logs constructed with a minimum thickness of 6 mm or as required for the maximum operating head.

.2 Maximum Bending Stress: provide a factor of safety of 3.0 for allowable material design bending stress.

.3 Calculate lift requirements to remove and install the gate under full head lift requirements exceed allowable lift given in Schedule 18, provide mechanical lifting and placing device.

.4 Provide stop logs designed to prevent buoyance and to allow drainage.

.5 Provide a minimum of two (2) slots in the top of each stop log for removal and installation by means of the specified stop log lifter.

.6 Provide each stop log with a welded identification tag indicating the following:

.1 Manufacturer and model number.

.2 Width of the opening.

.3 Design head.

.4 Seal material.

.5 Seals:

.1 Provide self-adjusting resilient seal mounted along the bottom and both sides.

.2 Gates that use adjustable wedges or wedging devices shall not be permitted.

.3 Seals shall be removable and replaceable.

.4 Stop logs using rubber "J" or "P" seals shall not be permitted.

.6 Guide Bumpers:

.1 All moving contact surface materials (guide bumpers) to be selected for smooth operation without any sticking or jamming.

.2 Metal-to-metal contact between the slide and frame is not permitted.

.7 Labels:

.1 Provide the following information on each gate. Use lettering at least 75 mm high.

.1 Maximum differential liquid level at time of lifting.

.2 Order of stop logs (e.g. bottom, middle, top), if applicable.

.8 Lifting system:

.1 Provide complete lifting system(s) suitable for crane operation for each gate size and configuration in each.

.2 Placement and retrieval of the gates shall be by crane and personnel working at deck elevation above the gate(s).

.3 Lifting systems that require entry below the deck shall not be permitted.

.4 Lifting system(s) shall allow the gate sections to be installed and removed without interfering with overhead piping (if applicable).

.5 Provide dedicated lifting system in difficult to reach locations.

.9 Storage Racks:

.1 Design storage racks to store gates vertically, with slots for each gate such that any one gate can be removed and replaced without moving other gates. Design the storage racks to be open such that water cannot accumulate in the storage areas.

.2 Construct storage racks using structural sections welded together, of sufficient strength that the racks are not damaged from repeated use. Anchor the racks to equipment pads in accordance with Section 11002.

2.5 Fabrication

.1 Seals: Mechanically fasten seals and seal faces to slide. Force-fit seals or adhesives are prohibited. Locate square butt type joints between corners and side seals a minimum of 300 mm from corners.

.2 Finish vertical surface of the gate that engages the guide frame to be within Manufacturer's submitted tolerances.

.3 Welding and welding equipment shall conform to the applicable provisions of AWS D1.1 and AWS D1.6. Only continuous welds shall be used. Structural stepped ribs shall not be permitted. The electrode and flux combination of grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used.

.4 All stainless steel materials shall be cleaned, descaled and passivated in accordance with methods defined in ASTM A380.

.1 Passivate in an environmentally controlled shop with at least five (5) years of experience performing nitric-hydroflouric acid solution pickling in compliance with all provincial and national laws.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

3.2 Spare Parts

.1 Provide the following spare parts

.1 Two (2) resilient seals for each size of stopping log.

END OF SECTION

FLAP GATES

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of the flap gates and appurtenances specified and required by the Final Design.

1.2 Standards

.1 ASTM:

.1 ASTM A112C, Standard Specification for Gray Iron Castings.

.2 ASTM A126, Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.3 ASTM A276, Stainless Steel and Heat Resisting Steel Bars and Shapes.

.4 ASTM D2000, Standard Classification system for Rubber Products in Automotive Applications.

.2 AWWA C501, AWWA Standard for Cast-Iron Sluice Gates.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Rodney Hunt.

.2 Armtec.

.3 Waterman.

.4 Golden Harvest.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Flap gates to be capable of operation in sewage with potential for rags, ropes, suspended solids or debris.

.2 Design to allow for ease of maintenance.

.3 Flap gate fitting leakage shall not exceed Manufacturer's recommendations and shall be installed in appropriate areas.

.4 The design requirements and operating conditions including product dimensions, product features and installation details shall conform to the Final Design.

2.3 Materials

.1 Flap gate and thimbles: Cast iron ASTM A126 Grade B.

.2 Seating faces: Bronze ASTM B21-C464, with neoprene rubber seats, ASTM D2000.

.3 Fasteners, hinge pins, bushings and anchor bolts: Stainless steel Type 316, ASTM A276.

2.4 Configuration, Components and Features

.1 Flap gate:

.1 Design gate to prevent cover from wedging into gate opening.

.2 Heavy duty, one-piece casting, double-hinge type cover complete with lifting eye.

.3 Resilient neoprene rubber seat securely mounted and fastened in machined dove-tail groove around the periphery of the gate cover without screws or mechanical fasteners.

.4 Neoprene seats to be replaceable in situ, without removing the gate.

.5 When flap gates are not easily isolated and accessed for maintenance, seats must be bronze.

.6 Provide cover frame flanged, machined, and drilled to match thimble.

.7 Provide upper pivots adjustable for gate sensitivity, cover pivots which allow alignment of the cover, and lubrication fittings for each pivot.

.2 Thimble:

.1 Provide minimum 2.5 degree seating angle for positive seating.

.2 One (1) piece thimble shall be minimum 200 mm deep F-Section, flat back, flanged and drilled to match cover frame.

.3 Anchor bolts:

.1 Provide equipment anchor bolts in accordance with Section 05501.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

3.2 Spare Parts

.1 Provide the following spare parts:

.1 One (1) flap for each size and orientation of gate.

.2 One (1) neoprene gasket for each size and orientation of gate.

END OF SECTION

PERFORATED PLATE SCREENS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of the perforated plate mechanically-cleaned screening equipment and appurtenances.

1.2 Standards

.1 ANSI:

.1 S1.11: Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

.2 ASTM:

.1 A48: Specification for Gray Iron Castings.

.2 A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.3 NEMA:

.1 MG1: Motors and Generators.

1.3 Submittals

.1 Provide submittals in accordance with Section 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Hydraulic calculations verifying compliance to the design criteria.

.3 Strength calculation verifying compliance to the specified criteria.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single Manufacturer.

.2 Perforated plate screen Manufacturer to be the same as the washer-compactor Manufacturer.

.3 Acceptable Manufacturer:

.1 FSM.

.2 Huber Technology.

.3 JWC Environmental.

.4 Veolia Water Technologies.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Provide the screening system to meet the capacities and operating data that are set out in the Technical Requirements.

.2 Equipment shall be designed to permit easy disassembly and reassembly of any pieces which must be removed to service the system. Such disassembly and reassembly shall not require any special tools.

.3 All materials of construction shall be suitable for continuous operation in contact with corrosive and abrasive wastewater and screenings, as well as corrosive gases associated with septic raw sewage.

.4 Provide abrasion-resistant components and linings in high wear areas and moving parts.

.5 Design of screens shall ensure that repair or replacement of damaged or worn parts, including screen panels, drive chain, drive mechanism, and rotating brush, can be carried out with screen installed in channel, and that all routine maintenance can be carried out from the operating floor level.

.6 Remove solids from wastewater that cannot pass through a 6 mm hole.

.7 Operation and alternate cleaning of the screens shall not be negatively impacted by the presence of fats, oils, grease or grit in the wastewater.

.8 Screens shall automatically clean themselves without requiring manual removal of screenings under all operating scenarios

.9 Area Exposure: per Section 01450 for all components.

.10 Provide sufficient local controls for effective performance of all required operational and maintenance activities.

.11 The design criteria for the following parameters shall conform to the Final Design:

.1 Number of duty and standby screens.

.2 Screen capacities for each screen.

.3 System capacity.

.4 Screen opening diameter: no greater than 6 mm.

.5 Screen setting angle.

.6 Channel width.

.7 Channel depth.

.8 Screen depth, (channel invert to operating level).

.9 Screening discharge height (above operating level).

.10 Screening discharge height (above channel invert).

.11 Water depth upstream of screen.

.12 Clean screen headloss.

.13 Washwater flow rate.

.14 Washwater pressure.

.15 Motor power.

.16 Motor speed.

2.3 Materials

.1 All components of the in-channel traveling belt screen, with the exception of the hardened carbon steel drive sprocket and chain assembly: Type 316L stainless steel.

.2 Fabricate all frame parts and assemblies from sheets and plates of Type 316L stainless steel with a 2B finish conforming to ASTM A240.

.3 Factory Welding: Shielded arc, inert gas, metal inert gas (MIG) or tungsten inert gas (TIG) method.

.1 Add filler wire Type 316 stainless steel to all welds to provide for a cross section equal to or greater than the parent metal.

.2 Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of the joint.

.3 Finish all welds including the following as a minimum:

.1 Remove all pointed protrusions from underside and face of welds and remove all weld splatter.

.2 Field welding of stainless steel is not permitted.

.4 Bolts, nuts and washers: Type 316 stainless steel.

.5 Lifting Attachments: Type 316 stainless steel.

.6 All anchorage and fastening hardware: Type 316L stainless steel. Provide all bolts with self-locking nuts with nylon inserts, or reusable locknuts to prevent accidental loosening of the nuts. Lock washers are not permitted.

.7 Iron castings: ASTM A-48 Class 30.

.8 Inspection window: Plexiglass.

2.4 Configuration, Components and Features

.1 Frame:

.1 Constructed of minimum 5 mm thick Type 316L stainless steel.

.2 The frame width and height shall be customized to fit the specified channel width, depth and desired discharge height.

.3 Provide continuous side channel seals of Type 316L stainless steel strip and brackets and polyurethane insert.

.4 The head section shall be rigidly attached to the main frame so that the entire screen may be removed as a unit.

.5 Provide method of lifting, removing and replacing screen and path to building exterior for equipment replacement.

.6 The screen frame to be supplied in single piece requiring no field assembly.

.7 The screen to be equipped with a pivot stand and designed to be pivoted out of the channel.

.8 Screen shall be designed, configured and installed such that it is possible to clean, resolve plugging and jamming issues, and of replace all wear parts, micro switches and controls without the erection of personnel fall protection equipment

.9 The top of the screen above the screen channel operating floor shall be fully enclosed with flanged vent connection. The sides of the top cover to be bent over to overlap the side frames.

.2 Screen:

.1 Provide the screen plates constructed of minimum 3 mm thick Type 316L stainless steel.

.2 Screen plate hole size: no greater than 6 mm.

.3 Attach the screen segments to the drive chain with Type 316 ANSI stainless steel bolts with lock washers.

.4 Provide bolted and hinged Type 316L stainless steel covers to allow access to the screen segments and chain extending above the channel.

.5 Provide polyester bristle brushes and polyurethane strip as debris seals for the bottom of the traveling belt.

.3 Screen Drive Chain:

.1 Screen chain: Stainless steel link chain with Type 403 SST rollers, bushings, and pins.

.1 Chains not using stainless steel link chain with Type 403 stainless steel roller, bushing and pin assemblies for wear resistance shall not be permitted.

.2 Type 403 stainless steel parts manufactured using powdered metal construction shall not be permitted.

.3 Breaking load of the chain shall be a minimum of 6000 N.

.4 Unit weight of the chain shall be a minimum of 9 kg/m.

.2 Chain Links:

.1 Chain links section: Not less than 64 mm width. Chain to have a minimum width of 64 mm and all sections shall be minimum of 4 mm thick.

.3 Rollers:

.1 Material: Solid Type 403 stainless steel bar stock machined to roller dimensions as specified herein.

.2 Through-hardened to a hardness rating of RC38 or better.

.3 Outside diameter: Not less than 75 mm.

.4 Provide a sufficient diameter edge to maintain accurate tracking.

.5 Rollers shall be made from solid Type 403 stainless steel bar stock.

.4 Bushings:

.1 Material: Type 403 stainless steel.

.2 Provide bushings with an outside diameter of at least 50 mm.

.3 Through-hardened to a hardness rating of RC38 or better.

.5 Pins:

.1 Material: Type 403 stainless steel.

.6 Circular bottom chain guide rails: Products incorporating submerged bearings or bushings shall not be permitted.

.7 Upper guide rails: 8620 carbon steel with Type 316 stainless contact strip. Guide rails constructed of wood, plastics, or other non-metallic materials shall not be permitted.

.8 Drive-chain sprockets: Epoxy-coated hardened carbon steel with a minimum thickness of 20 mm.

.9 Drive shaft: 8620 carbon steel with a minimum diameter of 90 mm in the centre and supported at each end by greaseable 60 mm diameter ball bearings.

.10 Provide external locking collars for drive and idler sprockets to set position of sprockets and restrict the lateral movement on the shaft. Provide means of lubrication.

.4 Chain Tensioning:

.1 Provide chain tensioning mechanism with access adjustment from the operating level.

.5 Discharge Chutes:

.1 Provide discharge chutes for receiving and discharging materials, having the dimensions to suit the mechanically cleaned screens and screenings washer compactors specified in Section 11192.

.2 Chutes: Minimum 3 mm Type 316L stainless steel, reinforced to prevent bending and to provide support and cover the full width of the screen.

.3 Provide the chute to fully enclose the discharge of the machine and provide with inspection hatches.

.4 Provide all required supports and stiffeners.

.6 Inspection Window/Door:

.1 Provide an inspection window to allow for inspection of the screen plates and chain without removing any access doors or covers, at approximately 1500 mm above the access floor.

.2 Provide an inspection door for increased visibility and inspection of the screen interior.

.7 Screen Cleaning System:

.1 Screen elements cleaned by a motorized polypropylene bristle brush and spray water.

.2 Provide the brush with an adjustment such that as the brush wears during use and can be manually or automatically adjusted to increase cleaning efficiency.

.3 Provide the brush driven independently.

.4 Following the brush, provide the screen plates cleaned by a bi-directional spray wash constructed of Type 316 stainless steel with brass nozzles. Provide hot or cold wash water as recommended by the Manufacturer.

.5 Provide a sufficient number of unions for removal of all valves and in line devices.

.6 Provide electrically operated solenoid valves to control spray water.

.7 Provide Type 316L stainless steel piping in accordance with Section 15050 and stainless steel valves in accordance with Section 15100.

.8 Overload Protection:

.1 Provide an overcurrent protection device using torque sensors or current transformer input to stop the screen and alarm.

.2 Shear pins for overload protection are not permitted.

.9 Screen Drive Systems:

.1 Motor:

.1 Power rating of motors: Not less than maximum shaft power requirements of equipment under any condition of operation specified and indicated without operating in the motor service factor.

.2 Operate without overheating at the speeds specified and indicated.

.3 Service Factor: 1.15, with 1.0 inverter duty rating for screens equipped with variable frequency motor controllers.

.4 Provide capacity sufficient to start and operate screen at up to 100 percent blinded without exceeding nameplate ratings for current and power and without operating in the service factor. At 100 percent blending the screen will not be passing the design flow.

.10 Gear Reducer:

.1 Provide parallel shaft arrangement classified for continuous, AGMA Class II, twenty-four (24) hour duty.

.2 Gears: Case-hardened alloy steel forgings with precision-ground gear teeth minimum AGMA quality 12.

.3 Design reducer to match output speed requirements of screens.

.4 Match torque-rating of driven equipment.

.5 Minimum gear reducer service factor 1.50 minimum, based on motor power rating.

2.5 Equipment and System Controls

.1 Provide a HAND-OFF-REMOTE switch, and an emergency stop local to the equipment.

.2 All devices including local switches, control switch and buttons, motors and sensors to be factory wired to meet the area classification for electrical.

.3 Provide programming to incorporate screen operation, monitoring and control into the plant automation system.

.4 The automation system for the screens shall be configured such that the failure of any single PLC module or automation component shall not affect more than one component.

.5 The screen operation logic shall be controlled by a PLC. Control logic implemented via hardwired timers and relays shall not be permitted.

.6 All settings to be operator adjustable.

.7 In the OFF position, the screen to be inoperative.

.8 In the REMOTE position, the screens are operated by differential level and repeat cycle timer through the automation system. Provide additional operating logic, provided by the Manufacturer, to create a reliable system.

.9 Provide system to automatically switch to the continuous operating mode if there is a signal loss in the ultrasonic transmitters.

.10 Provide ultrasonic level sensors to sense water level upstream and downstream of each screen.

.11 The level to be input to the automation system.

.12 The screen will start based on a high differential level between upstream and downstream ultrasonics. The screen is to stop after a predetermined run time. The ultrasonic level elements and transmitters specified in Division 17.

.13 Provide the following signals for remote monitoring by the PCS of the screens:

.1 Screens on-off status.

.2 Screen failure (overload).

.3 Screen failure (over torque).

.4 Loss of signal, transmitters.

.5 Running time.

.6 Upstream and downstream levels for each screen.

.7 Adjust run time for screens once activated.

.8 Other signals that would allow full monitoring of the screen area.

.14 Provide safety switches and interlocks with the screen controls for protection of the operator.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 One (1) rotating brush

.2 One (1) set of all special tools required.

.3 One (1) perforated plate panel per screen.

.4 Two (2) sets of screen mounting bolts.

.5 Two (2) sets of screen panel side seals (complete set)

.6 Two (2) rebuild kits for rotating brush.

.7 One (1) set of screen shaft end bearings.

.8 Two (2) inspection window replacements

.9 Two (2) complete chain replacements.

3. EXECUTION

3.1 Functional Testing

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.1 Dry Testing:

.1 Conduct an overload torque test to preset the torque overload device provided by the screen Manufacturer. Test to operate and stop the screen at a loading condition equal to half the ultimate breaking strength of the primary drive.

.2 Function over torque alarm.

.3 Make all necessary adjustments and settings to the overload device at the time of the test to stop the screens, switch off the drive motor, and sound an alarm when a predetermined overload condition occurs.

.4 Dry test each screen to demonstrate the correct alignment, smooth operation, proper and equal spacing of screen bars freedom from vibration, excessive noise and overheating of the moving parts and bearings.

END OF SECTION

SCREENINGS WASHER-COMPACTOR

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and commissioning of the screenings washer-compactor complete and all associated ancillary components.

.2 The screening compactor is to work in conjunction with the screens, accepting the raw screening, compacting them to remove water and then conveying them to a disposal bin.

1.2 Standards

.1 ASTM:

.1 A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated and Welded and Seamless.

.2 CSA.

1.3 Submittals

.1 Provide submittals in accordance with Section 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Washer compactor Manufacturer to be the same as the perforated plate screen Manufacturer.

.3 Acceptable Manufacturers:

.1 FSM.

.2 Huber Technology.

.3 JWC Environmental.

.4 Veolia Water Technologies.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Provide the washing and compacting equipment to meet the capacities and operating data are set out in the Technical Requirements.

.2 Operation and normal cleaning of washer-compactor shall not be negatively impacted by the presence of fats, oil, grease or debris.

.3 Washer-compactor shall be capable of processing normal amounts of grit, small rocks and storm related discharge from screens without adverse impact on operation or equipment life.

.4 Washer-compactor shall be automatically self-cleaning and shall not require cleaning by plant staff under normal operating conditions.

.5 Provide screens hopper overflow system to provide discharge of screenings in the event of a failure of the washer-compactor.

.6 System for discharging screenings shall be configured to prevent and break up any plugging or bridging of materials.

.7 Provide high level sensors in the inlet hoppers of each washer-compactor and in any conveyance device on inlet side.

.8 Design all components including mechanical, electrical and instrumentation according to Section 01450 and area classifications for the system.

.9 The design criteria for the following parameters shall conform to the Final Design:

.1 Number of duty and standby washer-compactors.

.2 Washing capacity.

.3 Maximum capacity.

.4 Screw speed.

.5 Inlet hopper dimensions.

.6 Conveyor outlet diameter.

.7 Screen discharge height (above floor).

.8 Washwater flow rate.

.9 Washwater pressure.

.10 Motor power.

.11 Maximum motor speed.

2.3 Materials

.1 Provide all parts of the mechanisms proportioned for all stresses which may occur during testing and operation and for any additional stresses which may occur during the fabrication, shipping and erection.

.2 Base unit: Type 316L stainless steel.

.3 Hopper: Type 316L stainless steel.

.4 Rear and front legs: Type 316L stainless steel.

.5 Spiral and shaft: Hardened Steel.

.6 Hardware: Type 316 stainless steel.

.7 Washwater spray system: Type 316 stainless steel.

.8 Spray nozzles: Type 316L stainless steel.

.9 Discharge piping: Type 316L stainless steel.

2.4 Configuration, Components and Features

.1 Inlet Hopper:

.1 The hopper transports screenings from the mechanically cleaned screen discharge to the washer-compactor.

.2 Fabricate inlet hopper of minimum 3 mm thick Type 316L stainless steel plate.

.3 Minimum angle of the side slopes shall be 60 degrees to the horizontal to prevent screenings accumulation within the hopper.

.4 Hopper shall have a spray water manifold for applying water to the sides of the hopper.

.5 The hopper shall have a removable inspection cover with a safety contact to monitor that the cover is open.

.6 Hopper shall have neoprene sealing strips on its inlet flange for mating with outlet of screenings device.

.2 Washer Tank:

.1 Screenings are washed, separated, dewatered and conveyed to the compaction zone.

.2 Provide perforated screen section with 6 mm openings.

.3 Provide two (2) integral spray manifolds to apply unobstructed wash water onto the section of the auger located above the wash tank's perforated screen.

.4 Provide two (2) drainage piping connections with grooved-end coupling for drainage of the discharged liquid.

.5 Provide inspection ports and removable sections to allow full access to the compacting screw for cleaning and maintenance.

.3 Auger:

.1 Design auger to withstand a maximum operating torque of at least three (3) times the motor overload torque.

.2 Compaction end of auger shall have a dual helix for one full pitch with hardened weld applied to end face of auger.

.3 Brush shall seat into groove and be secured in place with mechanical fastener or set screws.

.4 Brush shall be with stainless steel backing and nylon bristles.

.4 Discharge Chute:

.1 Screenings shall be compacted and conveyed to the discharge point.

.2 Pipe shall be tapered.

.3 Provide flanged pipe connections.

.4 All bend fittings shall be long radius design.

.5 Base Unit:

.1 Provide rear and front legs.

.6 Drive system:

.1 Motor and gear reducer shall comply with the requirements of Section 16223.

.2 Power rating of the motor shall not to be less than the maximum shaft power requirement of the equipment under any condition of operation specified.

.3 Motor capacity shall be sufficient to start and operate the washer-compacter with the screens 100 percent blinded without exceeding nameplate ratings for current and power and without operating in the service factor.

.7 Safety Devices:

.1 Provide emergency stop pushbutton, mounted near the screenings washer/compactor, to enable immediate emergency shutdown of the unit. The PCS alarm signal to be sent to a common alarm light and automation system when pushbutton has been activated.

.2 Provide overtorque protection to detect when the drive is in an overtorque condition. Provide a reverse jog to alleviate overtorque. Provide programming for this function. If overtorque condition is not resolved with process within a reasonable period, proceed to disable unit. If system cannot be cleared, send overtorque alarm to the PCS and disable unit. Interlock the overtorque alarm with the starter software.

2.5 Equipment and System Controls

.1 Provide a HAND-OFF-REMOTE switch and an emergency stop to the equipment.

.2 All devices are to local, including switches, control switch and buttons, motors and sensors to be factory wired to meet the electrical classification of the installation.

.3 Provide programming to incorporate screen operation, monitoring and control into the plant PLC.

.4 All settings to be operator adjustable.

.5 In the OFF position, the screen to be inoperative.

.6 In the REMOTE position, the washer compactor is to start when the screen cleaning system is initiated and to continue to operate for an operator selectable duration after the screen cleaning system stops.

.7 Provide the following signals for remote monitoring of the washer-compactor:

.1 Washer compactor on-off status.

.2 Washer compactor failure (overload).

.3 Washer compactor failure (over torque).

.4 Loss of signal.

.5 Running time.

.6 Remote monitoring is to be by the PCS.

.7 Provide additional signals to the PCS for complete monitoring of the washer-compactor units and adjustment of all key parameters.

.8 Provide local controls to allow for effective performance of all required operational

.8 Provide NO unpowered auxiliary contacts.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 One (1) set of bearings.

.2 Two (2) augers with bearings.

.3 Two (2) complete sets of spray nozzles for inlet hopper.

.4 One (1) replacement removable inspection cover for the hopper.

.5 One (1) perforated screen section for washer tank.

.6 Two (2) complete sets of brushers for the auger replacement.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 During Systems Operational Testing, observe and record screen runtime, screenings washer-compactor runtime, wastewater flow through screenings process, volume of screenings, solids concentration of screenings, power consumption in comparison to Manufacturer's submittals, noise and vibration.

.4 Auger Bearing Temperature Testing:

.1 The test forms part of Functional Testing.

.2 Run each auger for minimum 30 minutes prior to taking temperature readings of the gears and motors.

.3 Bearing temperature shall not exceed 82°C at building design temperatures.

END OF SECTION

INLINE GRINDERS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply installation, testing and commissioning of inline grinders, complete with electric motors and all specified appurtenances.

1.2 Standards

.1 ASTM:

.1 ASTM A395 Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

.2 ASTM A536 Specification for Ductile Iron Castings.

.2 ANSI S1.1 Specification for Octave, Half-Octave and Third-Octave Band Filter Sets.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Details of the grinder mounting and support requirements including specification of the anchor bolts (size, number, type, pattern).

.1 Motor data, including construction, connection boxes, frame size and dimensions, motor and insulation ratings, start-up and operating currents, and operating voltage and amperage tolerances.

.2 Construction and material specifications of all rotating and stationary assemblies for the grinder, grinder pedestal, and motor.

.3 Calculations for shaft design and selection.

.4 Calculations of shaft deflections.

.5 Bearing life calculations.

.6 Balancing reports.

.7 Factory hydraulic test reports and manufacturer’s certification of guarantee of performance in accordance with the Hydraulic Institute Standards.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Vogelsang.

.2 Netzsch.

.3 Boerger.

.4 JWC.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Inline grinder capable of conditioning solids suspended in liquid through the use of a minimum of three (3) hardened blades, mounted in a solid cast headstock, rotating on a reversible abrasion-resistant metal wearplate.

.2 The design criteria for the following parameters shall conform to the Final Design:

.1 Fluid Type/Commodity.

.2 Flowrate.

.3 Solids Content.

2.3 Vibration

.1 The grinder shall operate at any point in its operating range without undue noise and vibration.

.2 Vibration at any point in the operating range shall not exceed limits allowed by the Hydraulic Institute.

2.4 Materials

.1 The in-line pot of the unit shall be constructed of mild steel, chemically treated for abrasion- and corrosion-resistance through a hot dip galvanization process.

.2 The rotary cutter head stock shall be constructed of mild steel.

.3 The cutter blades shall be hardened with a minimum Rockwell hardness of 60.

.4 The shafts of the grinder shall be constructed from alloy steel with a tensile strength of 1,000,000 kPa (150,000 psi).

2.5 Configuration, Components and Features

.1 Wear plate:

.1 The construction of the wearplate shall allow for constant blade support through the entire range of motion.

.2 The standard wearplate openings shall allow for the reduction of solids to equal to or less than 19 mm.

.2 In-line pot:

.1 The internal design of the in-line pot shall be such that it uses a cyclone effect to remove metal and other heavy solids that could damage to the cutting blades.

.2 The pot shall be equipped with two (2) 150 mm ANSI class 150 flanges, and with one (1) 150 mm ANSI clean-out flange.

.3 Cutter blades:

.1 The rotary cutter headstock shall allow for the mounting of three (3) independent cutter blades.

.2 The cutter blades shall be connected to the headstock through a simple, re-usable system of knock-out pins.

.3 Screw or bolt connections shall hold the blades to the cutter head is not permitted.

.4 Serviceability:

.1 The cutter section of the unit shall have the ability to open, and swing out of the way to allow for inspection and replacement of all wear items while not disturbing the pipe work in any way.

.2 Equip unit with a hydraulically-assisted hinge to provide one-handed opening operation.

.3 Provide a safety switch installed on the unit to automatically lock out the electrical current when the unit is opened.

.5 Seals:

.1 The unit shall be equipped with a mechanical seals.

.2 The mechanical seal shall not be equipped with any springs.

.6 Drive:

.1 Drive and motor shall be driven by a planetary or helical speed reducer with a minimum 2.2 kW motor.

.2 The unit shall to exceed 320 RPM.

.3 The unit shall be capable of running in forward and reverse.

2.6 Equipment and System Controls

.1 The control panel shall be front door mounted: Forward-Reverse-Off-Remote switch, run and fault indication lights, fault reset button, main disconnect switch lockable in the Off position.

.2 The grinder control panel shall have: run, fault, switch in Remote position with dry contacts. It must allow for the remote start-stop signal coming from the local control panel.

.3 The panel shall allow for start and stop, manual and automatic auto-reverse, and a method for reversing the direction of rotation every time that the unit is started to maintain sharp cutting blades at all times.

2.7 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Three (3) replacement cutter blades.

.2 Three (3) knock-out pins for mounting replacement blades.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Bearing and Motor Temperature Testing:

.1 The test forms part of Functional Testing.

.2 Run each grinder for minimum 30 minutes prior to taking temperature readings of the gears and motors.

.3 Bearing temperature shall not exceed 82°C.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and equipment specific installation, testing and commissioning requirements for the shaftless screw conveyors, gear reducers, motors, controls and appurtenances.

1.2 Standards

.1 ASTM:

.1 A36/A36M: Standard Specification for Carbon Structural Steel.

.2 A48: Specification for Gray Iron Castings.

.2 ANSI:

.1 B20.1: Safety Standards for Conveyors and Related Equipment.

.2 S1.11: Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and provide the following:

.1 Manufacturer's descriptive literature for materials.

.2 Spiral strength calculations for spring (spiral) compression and elongation showing the supplied spiral meets or exceeds spring effect intent specified herein for conveyors 12 m or longer.

.3 Vibration and critical speed analysis in accordance with 11020.

1.4 Quality Assurance

.1 Manufacturer of specified equipment shall have a minimum of five (5) operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

1.5 Warranty

.1 During the warranties period, if excessive wear occurs replace the conveyor components, as specified below.

.1 Liner: For a wear indicator (two-colour) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second colour) along more than 30 percent of the conveyor length during the first three years of service. If these wear indications occur provide new formed and banded liner to replace all the liner in the conveyor(s) that has excessive wear.

.2 Screw: Excessive wear on the screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found provide new screw to replace the screw in the conveyor that has excessive wear.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 JDV Equipment Corporation.

.2 Parkson Corporation.

.3 Jim Myers & Sons, Inc.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Provide a conveyor that meets the Technical Requirements.

.2 Provide a device that conveys high solids wastewater materials that cannot easily be pumped.

.3 Conveyor to be non-clogging and shall be equipped with components for safe operation.

.4 Vibration at any point in the operating range shall not exceed limits allowed by the Hydraulic Institute and as specified in Section 11020.

.5 The conveyor shall not operate at any point in its operating range with undue noise.

.6 The design criteria for the following parameters shall conform to the Final Design:

.1 Configuration.

.2 Process commodity.

.3 Solids content.

.4 Bulk density.

.5 Capacity.

.6 Screw diameter.

.7 Maximum conveyor fill.

.8 Maximum conveyor rotational speed.

.9 Length.

2.3 Materials

.1 Screw flights: stainless steel, ASTM A167/A240, Type 316.

.2 Trough: stainless steel, ASTM A167/A240, Type 316.

.3 End plates and section flanges: stainless steel, ASTM A167/A240, Type 316.

.4 Inlet and outlet chutes: stainless steel, ASTM A167/A240, Type 316.

.5 Covers: stainless steel, ASTM A167/A240, Type 316.

.6 Trough stiffeners: stainless steel, ASTM A276, Type 316.

.7 Saddle supports: stainless steel, ASTM A167/A240, Type 316.

.8 Guards: carbon steel, ASTM A36.

.9 Wear liner: UHMWPE, ASTM D4020.

.10 Flange gaskets; NEOPRENE, 50 DUROMETER.

.11 Cover gaskets: Neoprene, 50 durometer.

.12 Auxiliary supports: carbon steel, ASTM A36.

.13 Nuts, bolts and washers: stainless steel, ASTM F593/F594, Type 316.

2.4 Configuration, Components, and Features

.1 General:

.1 Conveyor system shall include motor, drive, u-trough, shaftless screw, covers, chutes, gates, drain, controls, control panel, structural steel supports, and appurtenances, as specified, to provide a complete and ready to operate system.

.2 Provide conveyors designed specifically for transport of screenings and grit. Conveyor designs developed for free-flowing bulk material are not permitted.

.3 Provide screw conveyors able to operate continuously at the specified operating conditions and also able to start and operate with a full trough.

.4 Provide each screw conveyor with:

.1 A minimum of 38 mm freeboard between the top of the screw flight and the underside of the trough cover.

.2 Stub shafts flanged and bolted to mating flanges of the conveyors spiral rotor or coupling disc and to incorporate register fits.

.3 Rotating speed of the screw selected to match the pitch, diameter, trough fill, and screenings transport characteristics.

.4 Torque overload and motor overload protection.

.2 Troughs and Casings:

.1 U-shaped in accordance with the dimensional standards of Conveyor Equipment Manufacturers Association (CEMA) 350 and enclosure classification IIE.

.2 Provide a flanged drain outlet with each conveyor to facilitate cleaning.

.1 Provide the drains piped as specified and as required.

.2 Provide drain flushing connections as specified and as required.

.3 Provide each trough equipped with inlets and discharge openings as specified and as required.

.1 Where the inlet and discharge openings connect to another device provide flanged connections.

.2 Provide all interconnecting devices such as chutes and hoppers fabricated from the same grade of material as the troughs.

.3 Provide lockable inspection hatches over drop chutes with Type 316 stainless steel safety mesh.

.4 Sample ports: provide as specified and as required.

.5 Hold-Down Provisions.

.1 In order to avoid excessive wear and increased maintenance provide the conveyors designed without the use of steel hold down bars. Proprietary hold-down guide liners mounted under the lids are acceptable if they do not interfere with the flow of conveyed product.

.6 Provide shaftless spiral screw conveyor trough fabricated of minimum 4.76 mm thick Type 316 stainless steel. Provide troughs with an integral (welded or bolted connection), minimum 12.7 mm thick Type 316 stainless steel end plate and drive support base of all-welded construction onto which the conveyor drive assembly is mounted. The end plate of the last segment of each screw conveyor trough shall consist of a welded minimum 12.7 mm thick Type 316 stainless steel plate of the full cross-section of the trough, and its segment mating flanges.

.7 Provide each conveyor trough with two (2) 38.1 mm wash water connections at the centreline of each conveyor discharge chute, centred, on the spiral's axis. Provide each connection with an isolation ball valve and manifold to a single 38.1 mm connection. Provide ball valves in accordance with Section 15100. Provide connections that allow for manually washing down the screw and trough. Provide a 100 mm flanged drain connection on conveyor troughs as required.

.8 Provide trough segments consisting of rolled sections butt welded together to give a maximum single segment of not more than 6 m in length. Provide trough end flanges roll-formed Type 316 stainless steel bar welded to the ends of the trough segments. Locate bolt holes for connecting trough sections together on the centreline of the roll-formed flanged within a tolerance of plus or minus 0.5 mm of the theoretical radius centreline and at a distance of not greater than 0.5 mm. Provide bolt holes uniformly located on either side of the trough's vertical section centreline. Apply compressible "flow type string" gasket material to flanged faces to give a sealed joint when trough segments are bolted together.

.9 Provide the trough body roll-formed to a uniform radius within a tolerance of plus or minus 3 mm. Provide the trough with double U-shape or L-shape flanges formed by a break press as an integral part of the rolled-trough body. Separate welded flanges are not permitted.

.10 Provide troughs with discharge chutes and automated slide gates for conveyance as required. Provide chutes with flanged ends. Provide transition with a rubber expansion joint.

.11 The maximum length of any preassembled section of trough: 6100 mm. Site welding is not permitted.

.12 Provide separate support extending to a distance of approximately 100 mm below the bottom of the trough at a quantity of not less than one for every 2000 mm of length of trough segment plus one additional support. Provide supports of Type 316 stainless steel with its flat face rolled to match the trough shape and extending around the entire trough circumference up to within 50 mm of the top face of the trough u-flange.

.13 Provide a separate support foot welded to the trough at the drive end of the trough to support the screw conveyor drive and provide a separate support foot welded to the end face of the last segment of trough of each screw conveyor.

.14 Coordinate conveyor support with adjacent equipment and grating to avoid interferences with installation or maintenance of other equipment.

.15 Support leg spacing across the trough shall not exceed 760 mm from centre of support leg to centre of support leg.

.16 Provide a Type 316 stainless steel trough stiffener channel bolted across the width of the trough. Set stiffener channel spacing to match cover edges to give a sealed face upon which the covers are bolted.

.3 Trough Liner:

.1 Provide troughs fitted with a liner manufactured from UHMW, not less than 12 mm thick formed and bonded with two layers each a different color.

.1 The liner to meet the following requirements:

.1 Density: 980 kg/m^3.

.2 Shore hardness, D: 64.

.3 Ball indent hardness: 41 MPa.

.4 Crystalline melting range: 137°C.

.5 Dynamic coefficient of friction: 0.10 to 0.12 ratio of tension/load.

.6 Molecular weight: 9.2 plus 10a g/mol.

.2 Liner length:

.1 1000 mm maximum sections.

.3 Liner shall be held in place with Type 316 stainless steel clips.

.4 Trough Covers:

.1 Covers: Provide bolted covers for any portion of each trough that is not covered by the filling chute.

.1 Individual cover panel length shall not exceed 1200 mm.

.2 Covers shall have a 25 mm turned-down edge on all four sides of the cover. Where covers butt up against chutes or wall penetrations, provide turned-down edges on only two sides.

.3 Provide each cover with a handle. Handle rod shall be fully welded to the cover.

.4 Bolted covers shall be bolted to the trough flange with a minimum of six bolts, three on each side.

.5 Clamped covers shall be clamped to the trough flange with four (4) quick-release clamps, two on each side.

.6 Hinged and clamped covers shall be hinged and clamped to the trough flanges with two (2) quick-release hinges for easy cover removal on one side and two (2) quick-release clamps on the opening side. The hinge supports shall have integral back supports to prevent the cover from opening more than 120 degrees. Cover clamps shall have a single-piece body and over-centre locking clamp. Clamp with adjustable spindles to permit the clamps to be tightened in order to compensate for gasket compression.

.7 Covers shall have handles and gasket seals. Provide each conveyor with the appropriate warning labels to call for lock-out and tag-out of the electrical system before the covers are removed. If inspection of the system during operation is required, provide an inspection hatch with finger guards as required.

.5 Screw Conveyor Flights:

.1 Provide spiral flighting for the shaftless screw conveyors designed to convey material without a centre shaft or hanger bearings.

.2 Spiral flights:

.1 High strength carbon steel with a minimum hardness of 225 Brinnell.

.2 Design the spiral flights to prevent distortion and jumping in the trough.

.3 Design the flights so that the torsional rating of the auger flighting exceeds the torque rating of the drive motor at 150 percent of its nameplate power.

.4 Spring effect of the spiral shall not exceed 10 mm/m of length at maximum load conditions.

.5 Maximum outer spiral thickness shall be 19 mm for spiral up to 228.6 mm diameter and 25.4 mm for spiral greater 228.6 mm diameter.

.6 Provide the spiral flighting formed from one continuous flat bar and concentric to within plus or minus 2 mm.

.7 Sectional flighting formed from plate is not permitted.

.8 Provide spiral flighting with full penetration welds at all splice connections.

.9 Align the flights for true alignment when assembled in the field.

.10 Couple the spiral flights to the end shaft by a flanged, bolted connection.

.11 Provide a gland packing ring consisting of two aramid fiber packing rings to seal the drive shaft where its penetrations through the end plate, along with a greased labyrinth sealing system.

.12 Provide the connection of the spiral to the drive system through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral.

.13 Provide the drive shaft with a mating flange bolted to the spiral connection plate. Provide a grease lubricated labyrinth seal shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

.6 Hoppers and Discharge Boots:

.1 Provide inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs.

.1 Flanges: Minimum 4.76 mm thick.

.2 Provide single-ply flanged discharge boots at locations as required.

.1 Flexible boots: EPDM rubber hose, neoprene,

.2 Acceptable Products:

.1 Linatrile by Linatex Corporation.

.2 Or approved equivalent.

.7 Outlet Slide Gates:

.1 All flat and contour slide gates shall be pneumatically or electrically operated. The requirements of each slide gate shall include:

.1 Construction shall be Type 316 stainless steel. All welding in accordance with AWS standards. The slide gates shall be 50 mm wider and longer than the outside diameter of the screw conveyor.

.2 Gate blade shall be constructed of Type 316 stainless steel.

.3 Gate blade shall be supported on 31.8 mm stainless steel rollers, which are located out of the material flow. Rollers shall include bronze bushings that require no lubrication.

.4 Gate blade leading edge shall be beveled to facilitate its travel through material being handled.

.5 Gate wiping seals shall be made of UHMW. Seals contact the top of the gate blade along the perimeter of the throat opening. Seals are retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

.6 Each frame shall be designed for a gasketed, bolted connection to each screw conveyor trough or chute or flexible connection as applicable.

.2 Provide the pneumatic or electric actuators designed to provide full opening of the gate.

.1 Comply with the requirements of Section 17913.

.2 Actuator rating to suit the classification of the area where it is installed.

.8 Motor:

.1 The conveyor drive assembly to consist of a close-coupled, constant-speed electric motor. The electric motor shall be mounted on the speed reducer.

.2 Size based on the requirements of the driven loads with consideration given to all drive train component efficiencies and system overload requirements.

.3 Provide sufficient power to start under full design load of sludge in the conveyor trough.

.4 Motor rating to suit the classification of the area where it is installed.

.9 Stuffing Box:

.1 Provide a stuffing box on the drive end shaft.

.2 Fabricate the stuffing box from the same material as the conveyor and bolt it to the trough end plate.

.3 Provide three (3) rings per packing.

.4 Packing rings shall be 12 mm x 12 mm impregnated polytetrafluoroethylene (PTFE).

.5 Packing shall be tightened by means of an adjustable packing ring.

.10 Gear Reducer:

.1 Provide parallel shaft arrangement classified for continuous, AGMA Class II, 24 hour duty.

.2 Provide ASTM A48 Class 30 cast iron housing.

.3 Gears: Case hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.

.4 Design reducer to match output speed requirements of the conveyor.

.5 Match torque-rating of driven equipment.

.11 Safety Devices:

.1 Provide guards for all exposed rotating components as required by ANSI B20.1.

.2 Guards shall be welded and bolted construction as required.

.3 Install on each conveyor a safety pull cord and emergency stop switch complete with mounting brackets, eye bolts and pull cord extending along the full length of the conveyor. Install dual systems for conveyors readily accessible from both sides. Allow 25 m maximum between switches. Mount cord supported by brackets at 1200 mm centres.

.4 Emergency stop switch shall be provided in an enclosure to suit the area where it is installed.

.5 Provide a non-contact speed sensor for each conveyor. For shaftless conveyors, install the speed sensor to check the rotation of conveyor opposite the drive shaft.

.6 Provide a speed target ring consisting of a metal protrusion mounted to the shaft to provide sufficient impulse for a proximity-type sensor.

.7 The speed sensor shall be mounted so that any service work on the conveyor not to require removal of the speed sensor.

.8 The speed sensor alarm contact shall open on a loss of motion while the motor is energized. A user-adjustable time delay shall be set to prevent nuisance alarms during normal starting and stopping.

2.5 Equipment and System Controls

.1 Provide programming to incorporate conveyor and outlet gate operation into the plant automation system.

.2 Conveyor to operate based on operation of the equipment feeding the conveyor.

.3 Outlet gates to operate based on the level in the bin that the conveyor is discharging to so that the bin is evenly filled.

.4 Provide shutdown of conveyors on actuation of any conveying system safety device, sound alarm horn and light the safety stop alarm light. System shall be resettable only after the safety devices are restored to the normal condition.

.5 Provide the safety shutdown to interlock with the conveyor motor starter, energize the alarm light and sound alarm horn.

.6 Provide interlock with the respective motor starter, energize the alarm light, and sound the alarm horn.

.7 Provide the following for each conveyor:

.1 HAND-OFF-REMOTE selector switch.

.2 Emergency stop pushbutton.

.3 FORWARD-OFF-REVERSE selector switch (spring to OFF from REVERSE).

.4 Provide an over torque alarm for the conveyor.

.5 Indicating lights:

.1 RUN.

.2 OFF.

.3 General alarm (zero speed or over torque).

.6 Provide an audible alarm to sound as follows:

.1 Emergency stop.

.7 Provide dry contacts for the following:

.1 Equipment run status.

.2 Each alarm condition as specified.

.3 Shutdown feed equipment to the conveyors on conveyor stop.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Two (2) gaskets of each size.

.2 Shaft seal packing materials for re-packing stuffing boxes of each size.

.3 One (1) grease lubricator.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Observe solids conveyance in trough and identify bridging or buildup of solids in the conveyor. If buildup of solids occurs, modify bridging or conveyor or operations to correct the deficiency and re-test the system.

.4 Bearing and Motor Temperature Testing:

.1 The test forms part of Functional Testing.

.2 Run each conveyor for minimum 30 minutes before taking temperature readings of the bearing and motors.

.3 Bearing temperatures shall not exceed 82°C.

END OF SECTION

SHAFTED SCREW CONVEYORS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and equipment specific installation, testing and commissioning requirements of the shafted screw conveyors, gear reducers, motors, controls and appurtenance.

1.2 Standards

.1 ASTM:

.1 A36/A36M: Standard Specification for Carbon Structural Steel.

.2 A48: Specification for Gray Iron Castings.

.2 ANSI:

.1 B20.1: Safety Standards for Conveyors and Related Equipment.

.2 S1.11: Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and the following:

.1 Manufacturer's descriptive literature for materials.

1.4 Quality Assurance

.1 Manufacturer of specified equipment shall have a minimum of five (5) operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

1.5 Warranty

.1 During the warranties period, if excessive wear occurs replace the conveyor components, as specified below.

.1 Liner: For a wear indicator (two-colour) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second colour) along more than 30 percent of the conveyor length during the first three years of service. If these wear indications occur provide new formed and banded liner to replace all the liner in the conveyor(s) that has excessive wear.

.2 Screw: Excessive wear on the screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found provide new screw to replace the screw in the conveyor that has excessive wear.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 JDV Equipment Corporation.

.2 Parkson Corporation.

.3 Jim Myers & Sons, Inc.

.4 Or approved equivalent

2.2 Performance Criteria

.1 Provide a conveyor that meets the Technical Requirements.

.2 Provide a device that conveys high solids wastewater materials that cannot easily be pumped.

.3 Conveyor to be non-clogging and shall be equipped with components for safe operation.

.4 Vibration at any point in the operating range shall not exceed limits allowed by the Hydraulic Institute and as specified in Section 11020.

.5 The conveyor shall not operate at any point in its operating range with undue noise.

.6 The design criteria for the following parameters shall conform to the Final Design:

.1 Configuration.

.2 Process commodity.

.3 Solids content.

.4 Bulk density.

.5 Capacity.

.6 Screw diameter.

.7 Screw shaft diameter.

.8 Maximum conveyor fill.

.9 Maximum conveyor rotational speed.

.10 Length.

2.3 Materials

.1 Screw flights: stainless steel, ASTM A167/A240, Type 316.

.2 Trough: stainless steel, ASTM A167/A240, Type 316.

.3 End plates and section flanges: stainless Steel, ASTM A167/A240, Type 316.

.4 Inlet and outlet chutes: stainless steel, ASTM A167/A240, Type 316.

.5 Covers: stainless Steel, ASTM A167/A240, Type 316.

.6 Trough stiffeners: stainless Steel, ASTM A276, Type 316.

.7 Saddle supports: stainless Steel, ASTM A167/A240, Type 316.

.8 Guards: carbon steel, ASTM A36.

.9 Wear liner: UHMWPE, ASTM D4020.

.10 Flange gaskets; Neoprene, 50 durometer.

.11 Cover gaskets: Neoprene, 50 durometer.

.12 Auxiliary supports: carbon steel, ASTM A36.

.13 Nuts, bolts and washers: stainless steel, ASTM F593/F594, Type 316.

2.4 Configuration, Components and Features

.1 General:

.1 Conveyor system to include motor, drive, u-trough, shafted screw, covers, chutes, gates, drain, controls, control panel, structural steel supports, and appurtenances, as specified and as required for the Final Design, to provide a complete and ready to operate system.

.2 Provide conveyors designed specifically for transport of screenings and grit. Conveyor designs developed for free flowing bulk material are not permitted.

.3 Provide screw conveyors able to operate continuously at the specified operating conditions and also able to start and operate with a full trough.

.4 Provide the rotating speed of the screw selected to match the pitch, diameter, trough fill, and screenings transport characteristics.

.5 Provide each conveyor equipped with torque overload and motor overload protection.

.2 Troughs and Casings:

.1 U-shaped in accordance with the dimensional standards of CEMA 350 and enclosure classification IIE.

.2 Provide a flanged drain outlet with each conveyor to facilitate cleaning.

.1 Provide the drains piped as specified and as required.

.2 Provide drain flushing connections as specified and as required.

.3 Provide each trough equipped with inlets and discharges openings as specified and as required.

.1 Where the inlet and discharge openings connect to another device provide flanged connections.

.2 Provide all interconnecting devices such as chutes and hoppers fabricated from the same grade of material as the troughs.

.3 Provide lockable inspection hatches over drop chutes with Type 316 stainless steel safety mesh.

.4 Sample ports: provide as specified and as required.

.5 Hold-Down Provisions:

.1 In order to avoid excessive wear and increased maintenance provide the conveyors designed without the use of steel hold down bars. Proprietary hold-down guide liners mounted under the lids are acceptable if they do not interfere with the flow of conveyed product.

.6 Provide shafted spiral screw conveyor trough fabricated of minimum 4.76 mm thick Type 316 stainless steel. Provide troughs with an integral (welded or bolted connection), minimum 12.7 mm thick Type 316 stainless steel end plate and drive support base of all-welded construction onto which the conveyor drive assembly is mounted. The end plate of the last segment of each screw conveyor trough shall consist of a welded minimum 12.7 mm thick Type 316 stainless steel plate of the full cross-section of the trough, and its segment mating flanges.

.7 Provide each conveyor trough with two (2) 38.1 mm wash water connections at the centerline of each conveyor discharge chute, centered, on the spiral's axis. Provide each connection with an isolation ball valve and manifolded to a single 38.1 mm connection. Provide ball valves in accordance with Section 15100. Provide connections that allow for manually washing down the screw and trough. Provide a 100 mm flanged drain connection on conveyor troughs as required.

.8 Provide trough segments consisting of rolled sections butt welded together to give a maximum single segment of not more than 6 m in length. Provide trough end flanges roll-formed Type 316 stainless steel bar welded to the ends of the trough segments. Locate bolt holes for connecting trough sections together on the centerline of the roll-formed flanged within a tolerance of plus or minus 0.5 mm of the theoretical radius centerline and at a distance of not greater than 0.5 mm. Provide bolt holes uniformly located on either side of the trough’s vertical section centerline. Apply compressible “flow type string” gasket material to flanged faces to give a sealed joint when trough segments are bolted together.

.9 Provide the trough body roll-formed to a uniform radius within a tolerance of plus or minus 3 mm. Provide the trough with double U-shape or L-shape flanges formed by a break press as an integral part of the rolled-trough body. Separate welded flanges are not permitted.

.10 Provide troughs with discharge chutes and automated slide gates for conveyance as required. Provide chutes with flanged ends. Provide transition with a rubber expansion joint.

.11 The maximum length of any preassembled section of trough: 6100 mm. Site welding is not permitted.

.12 Provide separate support extending to a distance of approximately 100 mm below the bottom of the trough at a quantity of not less than one for every 2000 mm of length of trough segment plus one additional support. Provide supports of Type 316 stainless steel with its flat face rolled to match the trough shape and extending around the entire trough circumference up to within 50 mm of the top face of the trough u-flange.

.13 Provide a separate support foot welded to the trough at the drive end of the trough to support the screw conveyor drive and provide a separate support foot welded to the end face of the last segment of trough of each screw conveyor.

.14 Coordinate conveyor support with adjacent equipment and grating to avoid interferences with installation or maintenance of other equipment.

.15 Support leg spacing across the trough shall not exceed 760 mm from centre of support leg to center of support leg.

.16 Provide a Type 316 stainless steel trough stiffener channel bolted across the width of the trough. Set stiffener channel spacing to match cover edges to give a sealed face upon which the covers are bolted.

.3 Trough Liner:

.1 Provide troughs fitted with a liner manufactured from UHMW, not less than 12 mm thick formed and bonded with two (2) layers each a different color.

.1 The liner to meet the following requirements:

.1 Density: 980 kg/m^3.

.2 Shore hardness, D: 64.

.3 Ball indent hardness: 41 MPa.

.4 Crystalline melting range: 137°C.

.5 Dynamic coefficient of friction: 0.10 to 0.12 ratio of tension/load.

.6 Molecular weight: 9.2 + 10a g/mol.

.2 Liner length:

.1 1000 mm maximum sections.

.3 Liner shall be held in place with Type 316 stainless steel clips.

.4 Trough Covers:

.1 Covers: Provide bolted covers for any portion of each trough that is not covered by the filling chute.

.1 Individual cover panel length shall not exceed 1200 mm.

.2 Covers shall have a 25 mm turned-down edge on all four sides of the cover. Where covers butt up against chutes or wall penetrations, provide turned-down edges on only two sides.

.3 Provide each cover with a handle. Handle rod shall be fully welded to the cover.

.4 Bolted covers shall be bolted to the trough flange with a minimum of six (6) bolts, three (3) on each side.

.5 Clamped covers shall be clamped to the trough flange with four (4) quick-release clamps, two on each side.

.6 Hinged and clamped covers shall be hinged and clamped to the trough flanges with two (2) quick-release hinges for easy cover removal on one side and two (2) quick-release clamps on the opening side. The hinge supports shall have integral back supports to prevent the cover from opening more than 120 degrees. Cover clamps shall have a single-piece body and over-centre locking clamp. Clamp with adjustable spindles to permit the clamps to be tightened in order to compensate for gasket compression.

.7 Covers shall have handles and gasket seals. Provide each conveyor with the appropriate warning labels to call for lock-out and tag-out of the electrical system before the covers are removed. If inspection of the system during operation is required, provide an inspection hatch with finger guards as required.

.5 Screw conveyor:

.1 Provide the spiral with a centre shaft and no intermediate bearings.

.2 Minimum flight thickness: 6 mm.

.3 Spiral flights:

.1 Cold-formed high strength chrome alloy steel with a minimum hardness of 225 Brinnell.

.2 Design the spiral flights to prevent distortion and jumping in the trough.

.3 Shafted screw flight shall be either full face, ribbon face or paddle flight, unless specified otherwise.

.4 Flight shall be installed so that rotor forms a true circular diameter about the centreline of the rotor centre tube within plus or minus 1.6 mm.

.5 Rotors shall be finished so that the variance of the outside diameter of the flights over the entire length of the conveyor is less than plus or minus 1.6 mm.

.6 The pitch measured between flights, measured at the outside diameter of the screw flights, along four straight lines parallel to the axial centreline through the bearings at 0º, 90º, 180º and 270º, must not vary more than plus or minus 1/50 times the outside diameter of the screw flights from the design pitch.

.7 Flights shall be sectional construction made from pre-cut plate, of uniform thickness, formed with an average deviation of the pitch not exceeding plus or minus 1.60 mm over the length of the screw rotor.

.8 Radial welds of the sectional flight segments shall be bevel-welded, both sides.

.9 Flights shall be continuous welded, both sides, to the rotor centre tube.

.10 Flights shall be extended beyond the end of the rotor centre tube to within 4.0 mm of the trough end plates or intermediate bearing supports.

.11 Provide the extended flights section with a support bracket to the centre tube.

.12 Flights to extend to no more than the midpoint of the farthest outlet. Screw to incorporate half-pitch return flight section past farthest outlet to direct material away from the stuffing box.

.13 The flight pitch shall be constant over the entire length of the conveyor (but not less than 0.5 or more than 0.75 times the outside diameter of the screw).

.4 Screw rotor:

.1 Rotor is comprised of the centre tube, flight and end plates.

.2 Design the rotor centre tube with the necessary thickness to give a maximum deflection of 4.0 mm between any two (2) bearing support points, based upon formulas for a simple supported tube and flight.

.3 Rotor centre tube shall be fabricated from a single piece of tubing (not fabricated with butt-welding of multiple tube sections).

.4 Ends of the rotor centre tube shall be fitted with a 25 mm thick recess face plate welded to the centre tube, drilled and tapped for bolted flanged connections, with bolt holes parallel to the centre axis of the rotor.

.5 Rotor centre tube face plate shall have a 3.0 mm or greater register relief matching the adjoining flange face.

.6 Adjoining shaft flanges shall have a 2.0 mm or greater matching relief.

.7 Machine rotor flange faces to true parallel faces perpendicular to centreline axis within plus or minus 0.025 mm.

.8 The rotor face plate and flange bolt holes shall be arranged to permit the removal of bolts in the “as installed” position of the rotor without moving adjoining parts (i.e. bolts can be completely removed without disturbing other conveyor components).

.9 Provide at intermediate bearings a stub flange at the end of the rotor end plate. Stub flange shall be welded to the rotor end flange to permit bolting of the flexible coupling.

.6 Hoppers and Discharge Boots:

.1 Provide inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs.

.1 Flanges: Minimum 4.76 mm thick.

.2 Provide single-ply flanged discharge boots at locations as required.

.1 Flexible boots: EPDM rubber hose, neoprene.

.2 Acceptable Products:

.1 Linatrile by Linatex Corporation.

.2 Or approved equivalent.

.7 Outlet Slide Gates:

.1 All flat and contour slide gates shall be pneumatically or electrically operated. The requirements of each slide gate shall include:

.1 Construction shall be Type 316 stainless steel. All welding in accordance with AWS standards. The slide gates shall be 50 mm wider and longer than the outside diameter of the screw conveyor.

.2 Gate blade shall be constructed of Type 316 stainless steel.

.3 Gate blade shall be supported on 31.8 mm stainless steel rollers, which are located out of the material flow. Rollers shall include bronze bushings that require no lubrication.

.4 Gate blade leading edge shall be beveled to facilitate its travel through material being handled.

.5 Gate wiping seals shall be made of UHMW. Seals contact the top of the gate blade along the perimeter of the throat opening. Seals are retained by a bolted steel bar which forms the inlet throat lining of the slide gate.

.6 Each frame shall be designed for a gasketed, bolted connection to each screw conveyor trough or chute or flexible connection as applicable.

.2 Provide the pneumatic or electric actuators designed to provide full opening of the gate.

.1 Comply with the requirements of Section 17913

.2 Actuator rating to suit the classification of the area where it is installed.

.8 Motor:

.1 The conveyor drive assembly to consist of a close-coupled, constant-speed electric motor. The electric motor shall be mounted on the speed reducer.

.2 Size based on the requirements of the driven loads with consideration given to all drive train component efficiencies and system overload requirements.

.3 Provide sufficient power to start under full design load of sludge in the conveyor trough.

.4 Motor rating to suit the classification of the area where it is installed.

.9 Stuffing Box:

.1 Provide a stuffing box on the drive end shaft.

.2 Fabricate the stuffing box from the same material as the conveyor and bolt it to the trough end plate.

.3 Provide three rings per packing.

.4 Packing rings shall be 12 mm x 12 mm impregnated PTFE.

.5 Packing shall be tightened by means of an adjustable packing ring.

.10 Main Bearings:

.1 Provide outside support bearings. Outside support bearings spherical roller bearings mounted.

.1 Acceptable Manufacturers:

.1 SKF, Type SDN, SNI or SNH.

.2 Or approved equivalent.

.2 Cast iron pillow block bearing housings (Type SSNAD modular iron castings when supporting shaft-mounted gear reducers or return gear assemblies).

.3 Mount bearings outboard of the stuffing box assembly, with sufficient clearance to permit replacement of the packing without having to remove the bearing housing or the bearing from the housing.

.4 Bearing shall be fitted with a grease nipple.

.5 Thrust-carrying bearings shall have a fixed location, with spherical roller bearing mounted on the drive shaft, complete with a bearing recess shoulder.

.6 Non-thrust bearings shall be a non-locating, free-floating assembly and mounted with a tapered bore, plus adapter ring, on a plain diameter shaft, where no power is transmitted from the shaft to another shaft.

.7 Mounting of the pillow block bearing to the drive-end or non-drive-end shaft assembly to conform to the requirements of the bearing Manufacturer for the loading and design conditions of the service. Each bearing shall have a minimum ABMA L-10 life of 50,000 hours.

.11 Gear Reducer:

.1 Provide parallel shaft arrangement classified for continuous, AGMA Class II, 24 hour duty.

.2 Provide ASTM A48 Class 30 cast iron housing.

.3 Gears: Case hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.

.4 Provide horizontal parallel or bevel right angle shafting.

.5 Design reducer to match output speed requirements of the conveyor.

.6 Match torque-rating of driven equipment.

.7 Minimum gear reducer service factor 1.50 minimum, based on motor horse power rating.

.12 Safety Devices:

.1 Provide guards for all exposed rotating components as required by ANSI B20.1.

.2 Guards shall be welded and bolted construction as required.

.3 Install on each conveyor a safety pull cord and emergency stop switch complete with mounting brackets, eye bolts and pull cord extending along the full length of the conveyor. Install dual systems for conveyors readily accessible from both sides. Allow 25 m maximum between switches. Mount cord supported by brackets at 1200 mm centres.

.4 Emergency stop switch shall be provided in an enclosure to suit the area where it is installed.

.5 Provide a non-contact speed sensor for each conveyor. For shaftless conveyors, install the speed sensor to check the rotation of the spiral drive shaft.

.6 Provide a speed target ring consisting of a metal protrusion mounted to the shaft to provide sufficient impulse for a proximity-type sensor.

.7 The speed sensor shall be mounted so that any service work on the conveyor not to require removal of the speed sensor.

.8 The speed sensor alarm contact shall open on a loss of motion while the motor is energized. A user-adjustable time delay shall be set to prevent nuisance alarms during normal starting and stopping.

2.5 Equipment and System Controls

.1 Provide programming to incorporate conveyor and outlet gate operation into the plant automation system.

.2 Conveyor to operate based on operation of the equipment feeding the conveyor.

.3 Outlet gates to operate based on the level in the bin that the conveyor is discharging to so that the bin is evenly filled.

.4 Provide shutdown of conveyors on actuation of any conveying system safety device, sound alarm horn and light the safety stop alarm light. system shall be resettable only after the safety devices are restored to the normal condition.

.5 Provide the safety shutdown to interlock with the conveyor motor starter, energize the alarm light and sound alarm horn.

.6 Provide interlock with the respective motor starter, energize the alarm light, and sound the alarm horn.

.7 Provide the following for each conveyor:

.1 HAND-OFF-REMOTE selector switch.

.2 Emergency stop pushbutton.

.3 FORWARD-OFF-REVERSE selector switch (spring to OFF from REVERSE).

.4 Provide over torque alarm.

.5 Indicating lights:

.1 RUN.

.2 OFF.

.3 General Failure (zero speed or over torque).

.6 Provide an audible alarm to sound as follows:

.1 Emergency stop.

.7 Provide dry contacts for the following:

.1 Equipment run status.

.2 Each alarm condition as specified.

.3 Shutdown feed equipment to the conveyors on conveyor stop.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Two (2) gaskets of each size.

.2 Shaft seal packing materials for re-packing stuffing boxes of each size.

.3 One (1) grease lubricator.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Observe solids conveyance in trough and identify bridging or buildup of solids in the conveyor. If buildup of solids occurs, modify bridging or conveyor or operations to correct the deficiency and re-test the system.

.4 Bearing and Motor Temperature Testing:

.1 The test forms part of Functional Testing.

.2 Run each conveyor for minimum 30 minutes before taking temperature readings of the bearing and motors.

.3 Bearing temperatures shall not exceed 82°C.

END OF SECTION

SUBMERSIBLE MIXERS: PROPELLER TYPE

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and supervision of the installation testing and commissioning of horizontally mounted, submerged, medium speed, medium diameter propeller mixers.

1.2 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Performance evaluation for the mixing units. Include characteristics of induced flow, calculations of energy gradient through the tank, and other pertinent details which illustrate the ability of the mixing system to maintain homogeneity or the desired level of turbulence within the process system.

.3 Motor operating data, including motor and insulation ratings, operating voltage and amperage tolerances, description of construction complete with illustrative drawings, and any other pertinent information.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 ABS/Sulzer.

.2 Flygt/Xylem.

.3 Amamix/KSB.

.4 Landia.

.5 Uniprop/Wilo.

.6 Or approved equivalent.

2.2 Performance Criteria

.1 Medium speed, medium diameter propeller mixers rotate at 200 RPM to 1200 RPM.

.2 Submersible, horizontally-mounted, and include a motor and propeller in a close-coupled configuration.

.3 Provide mixers shall be able to be raised and lowered and easily removable for inspection without the need for personnel to enter mixing tank.

.4 The mixer, with its appurtenances and cable, shall be capable of continuous submerged operation.

2.3 Materials

.1 Provide material types and strengths suitable for service in activated sludge.

.2 Fabricate propeller of Type 316 stainless steel or closed cell polyurethane.

.3 Fabricate shafts of Type 329 or Type 420 stainless steel conforming to ASTM A276.

2.4 Configuration, Components and Features

.1 Propeller:

.1 Provide non-clogging three (3) or four (4) blade propellers, with back-curved leading edges that shed stringy material.

.2 Secure propeller to the propeller shaft by polygon friction fitting and nut.

.3 Dynamically balance propeller.

.2 Propeller Shaft:

.1 Provide shafts of sufficient size to limit whip or deflection.

.2 Shafts shall operate at less than 80 percent of their critical speed.

.3 Bearings:

.1 Support propeller shafts by two permanently lubricated bearings. The outer bearing a double row angular contact ball bearing and the inner bearing a single row, cylindrical roller bearing or ball bearing.

.2 L10 bearing life: 100,000 hours.

.4 Motor:

.1 Provide submersible motors in compliance with Division 11 and Division 16.

.5 Gear drives:

.1 For designs that employ gear drives to achieve the appropriate propeller speed, design to AGMA standards for continuous heavy-duty service.

.2 Seal gear drives in watertight enclosures and provide permanent oil lubrication.

.3 Use bearings with ABMA L10 bearing life of 100,000 hours.

.6 Seals:

.1 Fit the propeller shaft with a mechanical seal and two (2) lip seals where it exits the moisture protection oil reservoir.

.2 Provide single mechanical seals with Type 316 stainless steel metal parts, Viton O-rings, and tungsten carbide faces.

.3 Provide lip seals made of FKM (inner) and nitrile rubber (outer).

.7 Accessories:

.1 Guide Bar:

.1 Type 316 stainless steel.

.2 Provide mounting brackets and mast mounted socket.

.3 Configure single mast guide bar arrangements as hollow square sections; 100 mm x 100 mm 4.0 mm thick material, or

.4 Configure double mast guide bar arrangement of two (2) cylindrical sections; 114.3 mm diameter, 6.0 mm thick.

.2 Power cable.

.3 Stainless steel lifting chain, shackle and hook.

.4 Portable equipment lifting davit.

.5 Power lifting device:

.1 Provide a powered lifting device. Mixers shall be retrievable within five minutes. The removal system shall be designed to withstand 1.5 times the maximum torque of the retrieval motor and shall be designed not to overload the retrieval motor at any point.

.6 Pedestal:

.1 Type 316 stainless steel matched to the crane and complete with mounting hardware for anchoring to concrete platforms.

2.5 Spare Parts

.1 Provide spare parts in accordance with the Technical Requirements and the following:

.1 Mechanical seal, one (1) spare lip seal of each type, and one (1) set of bearings.

.2 Propeller and one (1) propeller shaft and end fitting.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Test to confirm satisfactory mixing using the service commodity.

.1 The test forms part of Functional Testing.

.2 Fill the tank with water with the solids as close to the maximum concentration specified. Start and continue mixing for 30 minutes. At that time, withdraw samples from at least three (3) points in the tank, at various depths, one (1) per 200 m^3. Analyze each sample to determine the suspended solids content. The test to be deemed successful if all suspended solids concentrations are within 10 percent of the average. Repeat the test at a concentration at 50 percent of the initial test. The same test conditions apply.

.4 Complete vibration and critical speed analysis in accordance with Section 11020.

END OF SECTION

VERTICAL SHAFT HYPERBOLOID IMPELLER MIXERS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of hyperbolic vertical shaft mixers complete with all accessories and appurtenances.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 INVENT Environmental Technologies Inc.

.2 Or approved equivalent.

2.2 Performance Criteria

.1 Design each mixer to mix mixed liquor in the swing zone of the aeration tank.

.2 Mixers shall be of the non-clogging, vertical shaft, hyperboloid-body type.

.3 The mixer and its appurtenances shall be specifically designed for continuous duty operation in a submerged application. The mixers shall not overload the motors at any point within the operating limits recommended by the mixer Manufacturer.

.4 The mixer shall be mounted on an equipment pad.

.5 The mixer shall be designed with no submerged bearings and with a dry installed motor. The mixers shall to produce a steady stationary flow pointed downward parallel to the mixer shaft. During operation the mixer shall not to exert any upward forces on the equipment pad.

.6 All submerged components shall be stainless steel or fibreglass.

.7 Operating conditions: Provide mixing units to operate over the range of operating conditions specified without overloading, jamming and excessive vibration. The operating conditions for the following parameters shall conform to the Final Design:

.1 Suspended solids concentration.

.2 Maximum liquid flow rate.

.3 Liquid temperature.

.4 Liquid pH range.

.5 No. of tanks.

.6 No. of mixers per tank.

.7 Total number of mixers.

.8 Tank dimensions.

.9 Tank side water depth.

.10 Mixer motor rated power.

.11 Impeller diameter.

.12 Impeller speed.

.13 Shaft Length.

.14 Mixing intensity.

2.3 Configuration, Components and Features

.1 Provide stainless steel fasteners, bolts, nuts and washer exposed to the wastewater.

.2 Mixing equipment shall consist of speed reducer and electric motor as an assembly, base plate, mixer shaft, and mixing impeller.

.3 Impellers:

.1 Provide removable FRP impellers, with streamlined stress-free bodies without any mounted or fitted parts. Provide impellers with laminated stainless steel insert nuts for attachment to the mixer shaft.

.2 Transport ribs which accelerate the flow shall be integrated in the mixer body. Mixer body shall have a durable polished surface.

.3 Operating speed of shaft impeller system shall not to exceed 70 percent of first lateral critical speed.

.4 Minimum impeller size: 2500 mm with flat surface underneath.

.4 Mixer shafts:

.1 Provide rigid coupling between impeller shaft and speed reducer drive shaft.

.2 Provide hollow Type 316 stainless steel impeller shaft. Shaft diameter shall be determined by the Manufacturer to provide sufficient static and dynamic load resistances, such as sufficient torsional stiffness, shear, bending moments, and buckling. Shaft length shall be determined by the Manufacturer for best mixing efficiency.

.3 Agitator shaft shall be overhung design; submerged steady bearings shall not be permitted.

.4 Maximum total indicated runout at lower end of shaft shall not to exceed 3.2 mm for every 3.05 m of overhang, as measured when turning over by hand.

.5 Coordinate shaft length with height of concrete support pad for mixer assembly.

.5 Motors:

.1 The mixer motor shall be integral with the gear box and to be supplied as one (1) assembly.

.2 Enclosure: TEFC.

.3 Maximum motor (nominal) speed: 1800 RPM.

.4 Provide inverter rated variable frequency drive (VFD) duty motor suitable for operation with VFD. The motors shall be suitable for continuous operation at low speed and have a turn down ratio of 10 (180 RPM) without overheating.

.6 Speed reducers:

.1 Provide heavy-duty gear reduction system, with the housing made of cast iron or fabricated steel with lifting lugs or holes. The gears shall be (helical, or combination helical and spiral bevel, or spur gear) with two (2) or three (3) stages for highest efficiency. The assembly shall be designed for easy mounting, installation, and maintenance. Worm gears shall not be permitted.

.2 Basic rating shall adhere to AGMA 420.04 or AGMA 6010-F97 and bear AGMA nameplate or manufacturer to certify, in writing, speed reducer designed to AGMA 420.04 or 6010-F97. All gears shall be manufactured according to AGMA quality No. 10 or better, in accordance with AGMA 390.03.

.3 Provide base plate suitable for mounting on concrete or fabricated metal access platform.

.4 Mixer gear drive shall be designed with hollow shaft system suitable for loadings imposed by specified duty.

.5 Provide anti-friction type ball or roller drive bearings and output shaft bearings with minimum L10 life of 100,000 hrs.

.6 Provide dipstick or sight glass to observe oil level. Configure to prevent oil leakage for all the gear shafts and down output shaft.

.7 Provide high-quality lip seal to retain grease if output shaft bearings are grease lubricated. Oil fill and drain lines and grease fittings shall be easily accessible.

.8 Provide necessary mounting accessories including, but not limited to, mixer mounting plate.

.9 Provide rubber vibration dampeners.

.7 Protective coatings:

.1 Coating:

.1 Manufacturer shall be responsible for surface preparation, priming and finish coating of motor and gear reducer prior to shipment. System to comply with Section 09900.

.2 Protection:

.1 Surfaces normally left uncoated, such as couplings, do not require special coating. However, protect these surfaces prior to shipment by covering with rust-preventative compound sprayed or hand applied. Coating shall be easily removable with solvent.

.2 Run drive unit with polarizing rust-inhibiting oil before shipment. Spray unit with vapor phase inhibitor sprayed into reducer housing interior at factory to further guard against internal corrosion during shipping and storage of equipment.

.3 Apply specifically prepared paper treated with vapor phase inhibitor and covered with water repellent tape over external couplings and bearings that could be exposed to corrosion.

.4 Cover openings in equipment with vapour-phase inhibitor impregnated paper and water-repellent tape.

.5 Apply water-repellent tape and vapour-phase inhibitor treated paper over any adapter sleeves, lock nuts, reducer dipsticks, breather assemblies, and other areas or openings requiring protection.

.8 Mounting accessories:

.1 General: Provide anchor bolts, nuts washers, accessories and other adapter equipment necessary for mounting the mixers. Construct anchor bolts, nuts, washers, accessories and adapter equipment of stainless steel.

.9 VFDs:

.1 Provide a VFD for each mixer in accordance with Section 16229.

.2 Provide all cabling between VFD and motor. Provide power cable (minimum one (1) conductor per phase) between the motor and the VFD in accordance with Division 16.

2.4 Equipment and System Controls

.1 Provide mixers suitable for continuous or intermittent operation.

.2 Each mixer shall be equipped with a VFD.

.3 Each mixer shall be equipped with motor winding thermistors which stop the motor when high temperature is detected.

.4 On start-up of the mixer, mixer shall run at full speed to re-suspend the tank contents. Once the contents have been mixed, the speed of the mixer shall decrease to minimize electrical power costs while maintaining adequate mixing.

.5 Provide a Hand-Off-Auto (HOA) selector switch local to each mixer.

2.5 Spare Parts

.1 Provide spare parts in accordance with the Technical Requirements and the following:

.1 Set of rubber buffers per installed mixer.

.2 Shaft holder for each shaft diameter supplied.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Test to confirm satisfactory mixing using the service commodity.

.1 The test forms part of Functional Testing.

.2 Fill the tank with water with the solids as close to the maximum concentration specified. Start and continue mixing for 30 minutes. At that time, withdraw samples from at least three (3) points in the tank, at various depths, one (1) per 200 m^3. Analyze each sample to determine the suspended solids content. To be deemed successful if all suspended solids concentrations are within 10 percent of the average. Repeat the test at a concentration at 50 percent of the initial test. The same test conditions apply.

.4 Complete vibration and critical speed analysis in accordance with Section 11020.

END OF SECTION

COARSE BUBBLE DIFFUSER EQUIPMENT

1. GENERAL

1.1 Summary

.1 This Section specifies air distribution assemblies, coarse bubble diffusers, and appurtenances for use in mixing applications.

1.2 Standards

.1 ASTM A240 – Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

.2 ASTM A276 – Stainless and Heat-Resisting Steel Bars and Shapes.

.3 ASTM A380 – Standard Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and systems.

.4 ASTM A743 – Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

.5 ASTM A774 – AS-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

.6 ASTM A778 – Welded, Unannealed Austenitic Stainless Steel Tubular Products.

1.3 Definitions

.1 Standard cubic metre per minute: the volumetric flow rate in cubic meters per minute at standard conditions. Standard conditions defined as 20°C, one atmosphere (101.325 kPa), and 36 percent relative humidity.

.2 Diffuser Headloss: The total pressure loss from the connection point of the diffuser connector to the header through the entire diffuser to the point of air exit to the aerated liquid, measured in kPa.

1.4 Submittals

.1 Provide submittals in accordance with Section 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Manufacturer's literature indicating diffuser head loss versus airflow through the diffusers.

.3 Product samples.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Xylem.

.2 Evoqua.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Performance requirements:

.1 Provide coarse bubble diffuser equipment that meets the performance requirements set out in the Technical Requirements.

.2 Provide adequate mixing air to maintain solids in suspension as required by the design.

.3 Provide a proven diffuser design that does not allow for the buildup of sludge within piping and diffuser heads.

.4 Design for use in wastewater without corrosion or clogging from debris, grit or suspended solids.

.5 Area Exposure: per Section 01450

.2 The design criteria and operating conditions for the following parameters shall conform to the Final Design:

.1 Fluid Type/Commodity.

.2 Fluid Temperature.

.3 Minimum number of diffusers.

.4 Maximum airflow per diffuser.

.5 Maximum diffuser submergence, water surface to top of diffuser.

.6 Nominal air pressure to diffuser dropleg at maximum airflow.

.7 Nominal temperature of air supply to diffuser dropleg.

.8 Minimum air flow rate per length of channel.

2.3 Materials

.1 Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. Alternative materials for the purpose of providing greater strength may be proposed provided the alternative materials must have at least the same qualities as those specified for the purpose.

.2 Wide band diffusers: stainless steel, ASTM A240, Type 316L; 20 gauge minimum.

.3 Cast components: stainless steel, ASTM A743, Grade CF-3.

.4 Piping and fittings: stainless steel, ASTM A774 and ASTM A778, Type 316L; Schedule 10.

.5 Piping supports, guides, and anchors: Stainless steel, ASTM A240 and ASTM A276, Type 316; Type 304L for welded components.

.6 Fasteners: stainless steel, Type 404.

.7 Gaskets: Neoprene, 40 to 50 durometer.

2.4 Configuration, Components and Features

.1 General: Air diffuser assemblies consist of air distribution piping, supports, diffuser connectors, diffusers and appurtenances. Construct diffuser assemblies in accordance with the requirements for each location. Design assemblies for not more than the maximum pressure loss listed in this Section between the air main and the exit of the last air diffuser when operating at the maximum airflow rate per diffuser. Restrain diffuser assemblies above the water line to prevent uplift. Reinforce all pipe connections with welded saddles for stress distribution.

.2 Provide piping as specified in this Section and in accordance with the requirements of Section 15050, 15055 and 15067.

.3 Air distribution piping: Air distribution piping consists of the dropleg from the main air connection and the air diffuser header.

.1 Provide a loose follower flange for the connection of the dropleg to the main air distribution header.

.2 Provide lifting lugs on the top and at the middle of the dropleg of the air diffuser assemblies. Provide each dropleg with a stainless steel chain attached to the top lifting lug and a wall-mounted J-hook to prevent a disconnected air diffuser assembly from falling into a channel.

.3 Provide air diffuser headers with removable end caps.

.4 Provide a pressure gauge on each dropleg.

.4 Piping supports and anchors:

.1 Supply air diffuser header supports include cradles, stands, and base plates that conform, at a minimum, with the requirements of Sections 15096, 15097, and 15098.

.2 Mount header supports in the channels using anchor bolts conforming to the requirements of Section 05501.

.3 Provide a cradle on each support with a bearing surface contoured to fit a minimum of 90 degrees of the bottom of the air diffuser header. The cradle to be a minimum of 50 mm wide. Include a mechanism to provide for a minimum of 50 mm vertical and 13 mm lateral adjustment for alignment of the air diffuser header with all header supports.

.4 Provide guides for directional control and self-alignment of the air diffuser assemblies when lowered into the support cradles.

.5 Diffuser connectors:

.1 Factory weld diffuser connectors to the bottom centerline of the air diffuser header. Weld the connector to the header using a full penetration butt weld. Use of fillet welds at the connection between the diffuser connector and diffuser header are not permitted. The diffuser connectors to be on a common horizontal plane. Air release from the diffuser into the wastewater to be at or below this common horizontal plane. The connectors to be of such length and so positioned that the air exiting the diffuser clears the air diffuser header.

.2 Design the headers and connectors to resist a vertical load applied to the threaded end of the connector that results in a bending moment of 113 N-m without exceeding 165,475 kPa design stress in any part of the header wall or connector. Reinforce the header and both sides of the connector using a continuously welded gusset. Provide a minimum cross sectional area of 0.81 cm^2 for the gussets.

.6 Diffusers: Diffusers to be wide band diffusers with a design that prevents clogging with rags or other debris.

2.5 Fabrication

.1 Welding and finishing:

.1 All welding in the factory shall use MIG, TIG, or plasma-arc welding inert gas processes. Add filler wire to all welds to provide for a cross section equal to or greater than the parent metal. Use full penetration gas shielded butt welds for fabrication or air diffuser assemblies. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1.5 mm beyond the inner surface of the air header or fittings. Continuously weld face rings and flanges, both sides. Field welding shall not be allowed.

.2 Wire brush all outside weld areas to remove weld splatter. Brushes shall be stainless steel and used only on stainless steel. After welding and brushing, clean and descale all stainless steel assemblies and parts in accordance with the recommendations of ASTM A380.

2.6 Spare Parts

.1 Provide spare parts in accordance with the Technical Requirements and the following:

.1 10 percent complete spare air diffuser assemblies.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Equipment mounting:

.1 Tolerances: All diffusers on a single air header shall be aligned in a single horizontal plane within a tolerance of 12 mm.

.4 After the piping, headers, and air diffuser assemblies for each channel have been installed, introduce clean water into the channels until the air diffuser assemblies are submerged 50 to 100 mm. Release compressed air through the air diffuser assemblies and repair any leaks and improperly aligned diffusers. Repeat this test until the entire system is airtight and properly aligned.

.5 Systems Operational Testing to include operation of the assemblies with the channels filled with clear water to the design operating depth. Test pressure at maximum air flow and diffuser submergence.

.6 Mixing test:

.1 The test forms part of Functional Testing.

.2 Test each channel after filling to normal operating depth with service commodity.

.3 Measure air flow to each air header with air flow meters.

.4 Measure and record air flow and pressure measurements at 20 minute intervals during three (3) hours of continuous operation in two (2) channel locations.

.5 Test total suspended solids (TSS) at minimum air flow rates as required by the Final Design.

.6 Test at two (2) depths at each of three (3) channel locations selected by the Professional of Record.

.7 Collect samples at each depth and location using Van Dorn sampler.

.8 Comply with Standard Methods for Examination of Water and Wastewater to determine the TSS in each sample.

.9 Solids samples collected during mixing test should be within 10 percent of each measured sample to be considered in compliance with a completely mixed channel. If samples are outside of this range, repeat test one (1) time. If samples during second test do not meet these criteria, modify the diffuser system to improve mixing until samples collected fall within this range.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the requirements for the supply, installation, and commissioning of all process pumps.

1.2 Definitions

.1 Efficiency: pump efficiency shall be calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. Efficiency calculations to take full account of mechanical and electrical losses.

.2 Performance Curve: the performance curve is a graph of the flow delivered (L/s, x-axis) in relation to the discharge head (m, y-axis). It generally denotes efficiencies as isopleths and may include Net Positive Suction Head (NPSH) requirements as a function of the flow.

.3 Best Efficiency Point: the best efficiency point is the point in the pump performance curve where the pump operates at its highest efficiency.

.4 Rating Point: the pump rating point is the combination of discharge head and flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one (1) or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, and maximum discharge head). This condition is listed in the detailed pump specification and must be satisfied by the pump supplied.

.5 Low Head Point: the low head point is the combination of head and flow which corresponds to the least head the pump might operate against. It is determined on the basis of only one (1) duty pump operating against the system conditions which would produce the least discharge pressure (typically minimum headloss, maximum suction head, and minimum discharge head). The minimum system head is shown or described for each pump. The Manufacturer must demonstrate that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.

.6 Low Speed Point: the minimum flow and head conditions against which a variable speed pump is expected to operate.

.7 NPSH: The available NPSH is the pressure available at the pump suction and is a function of site atmospheric pressure and suction piping losses.

.8 NPSH3: is the pressure required at the pump suction to prevent cavitation due to water column separation. Required NPSH3 shall be defined by the pump manufacturer at the pump inlet connection whether that be at the casing or at the face of a suction reducer-elbow supplied as an integral part of the pump plus a minimum margin of 1.5 m.

.9 Minimum Diameter Passing: solids-handling pumps have listed a minimum diameter passing. A sphere of this size must be capable of passing from the pump intake to the discharge.

1.3 Standards

.1 Hydraulic Institute - Standards (Hydraulic Institute Pump Standards, Joint Standards of Hydraulic Institute and ANSI).

1.4 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Provide catalog performance curves at maximum pump speed as specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).

.3 Performance curve for the pumping unit(s) shall be superimposed on the system curve for the particular pumping application. With the performance curve, include efficiency isopleths and NPSH3 variation with flow. Where required in the specific pump sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.

.4 Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and required for the Final Design. Identify curves by speed and provide all curves on one sheet. Provide NPSH3 curve for each speed.

.5 Required ancillary services including, but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.

.2 Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet Final Design and specified requirements for head, capacity, horsepower, efficiency and $NPSH_3$.

.1 For units of same size and type, provide curves for a single unit only.

.2 Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch sheets, one (1) curve per sheet.

.3 Factory hydraulic test reports and Manufacturer’s certification of guarantee of performance in accordance with the Hydraulic Institute Standards.

.4 Results of Factory Acceptance Testing results as required in Section 11330 and the individual sections.

.5 Manufacturer to obtain final conditions of flow and head for trimming the impeller prior to shipment. Manufacture to design casings to the conditions given on the system head curves, but complete final trim of the impellers according to the flow and head supplied for this pump.

2. PRODUCTS

2.1 Pump Performance Requirements

.1 Provide pumps that are designed and fabricated for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency within 5 percent of the efficiency at the best efficiency point.

.3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the rating point to the low speed point at efficiencies with 10 percent of efficiency at the best efficiency point.

.4 Provide pump motors that are sized to not be overloaded under any pump operating condition.

.5 Provide pumps capable of operating at 30 percent of maximum design flow within 85 percent of the rated efficiency without exceeding the motor horsepower, and capable of operating at any point on its characteristic curve, to where that curve intersects the low head point, without exceeding motor power rating.

.6 Provide all pumps of the same type from a single manufacturer.

.7 Provide non-overloading motor at any point on the pump operating curve.

2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump.

.2 For centrifugal pumps provide transmitter with indicator for the inlet and outlet of each pump.

.3 For submersible pumps, provide one (1) transmitter per pump for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wetwell.

.4 For positive displacement pumps provide full pipe diameter annular ring pressure sensor for both the suction and discharge complete with gauges and connections for instrumentation devices.

2.3 Pump Seals

.1 Provide pumps, seals, housing and location of seals design for mechanical seals and the ability to fit with cartridge type seals.

.2 Provide mechanical seals for all direct coupled pumps unless otherwise specified.

.1 Mechanical seal:

.1 Acceptable Manufacturer:

.1 John Crane.

.2 Chesterton.

.3 Or approved equivalent.

.2 Materials:

.1 Potable water:

.1 316 or 317L metal parts.

.2 Hastelloy C or Elgiloy springs.

.3 Buna-N or Viton O-rings.

.4 Silicon-carbide on carbon faces.

.5 Or approved equivalent.

.2 Sewage:

.1 316 or 317L metal parts.

.2 Hastelloy C or Elgiloy springs.

.3 Viton O-rings.

.4 Sintered silicon-carbide on carbide faces.

.5 Or approved equivalent.

.3 Sludge and scum:

.1 316 or 317L metal parts.

.2 Hastelloy C or Elgiloy springs.

.3 Viton O-rings.

.4 Tungsten-carbide on sintered silicon-carbide.

.5 Or approved equivalent.

.4 Elastomers:

.1 Viton.

.2 Or approved equivalent.

.5 Restriction Bushing: Split type, glass filled teflon.

.2 For pumps not requiring seal water provide:

.1 Acceptable Product:

.1 Enviroseal Spiraltrac bushing version D, type A.

.2 Or approved equivalent.

.2 For vertically mounted pumps provide seal vent in accordance with API Plan 13.

.3 Provide non-destructive, self-aligning seals of the stationary design with required no wearing sleeve for the shaft. Provide seals capable of being reconditioned.

2.4 Pump Mounting

.1 Provide ribs or reinforcing required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust and to support the motor.

.2 Provide components with machined registered concentric shoulder fits for precision alignment. Equipment without registered fits is not permitted.

2.5 Seal Water Connection

.1 For each pump handling fluids with abrasive or corrosive constituents, including wastewater flows of any type, provide seal water connections to the pump seals.

.2 Provide seal water in accordance with Section 11399.

2.6 Bearings

.1 For all pumps other than submersible provide a bearing shield, complete with labyrinth seals, to prevent the ingress of water.

2.7 Couplings

.1 Provide non-lubricated, polyurethane flex material type, split design, spacer type couplings.

.2 Design couplings so that the pump unit can be disassembled without disturbing suction and discharge piping.

.3 Spacer coupling shall be large enough for renewal of the pumps rotating assembly without disturbing the motor.

.4 Acceptable Manufacturer:

.1 Rexnord Omega.

.2 Or approved equivalent.

2.8 Shafts

.1 Design shafts to absorb 2.0 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

.2 Use stainless steel shafts, without any allowance for shaft sleeves.

2.9 V-Belt Drives

.1 Do not use V-belt drives unless specified in the Final Design.

2.10 Finishes

.1 Prime Coat: Shop applied, coating material.

.2 Finish Coat: Shop applied, coating material.

.3 Provide at least 1 L of finish coat per pump for field touch-up painting.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Install pumping units on a concrete pad and align in accordance with Section 11002.

.4 Factory Acceptance Test:

.1 Factory tests shall be conducted on equipment and motor assembly in accordance with Section 11330.

3.2 Functional Testing

.1 Field test all pumps greater than or equal to 3.7 kW, and smaller units where specified, to verify performance.

.2 Perform additional field testing requirements for pumps greater than or equal to 30 kW, as specified in Section 11330.

.3 Provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.4 Flow metering:

.1 Where possible, use fill-and-draw techniques to measure the volume pumped during the test. Volumes shall be sufficient for at least five (5) minutes of pump operation at the flows to be tested, other than run-out.

.2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing. Permanent flow meters shall be calibrated to within 1 percent of the rated flow of the pump to be tested prior to testing.

.3 Temporary metering may be used. Temporary meters shall have an accuracy of plus or minus 2 percent, at the rated flow of the pump.

.4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing shall be by a qualified professional. Measured flows during the testing shall be certified to be within 2 percent of the actual flows.

.5 Pressure monitoring:

.1 Do not use permanent gauges for pressure monitoring during tests. Where possible, temporary test gauges can be connected to the permanent gauge taps. In cases where permanent gauge taps cannot be used (e.g. in line-isolated gauges) provide an additional tap for the test gauge.

.2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5 percent. Where pump suction draws from an open tank or wet well, test gauge shall be capable of measuring pressure at pump suction within 1.0 kPa.

.3 Provide evidence of pressure gauge calibration within 12 months of conducting tests.

.6 Test pump at a minimum of three (3) flow conditions, typically corresponding to the rating point flow, 75 percent of that flow, and 120 percent of that flow. At each test point, measure flow, suction pressure, discharge pressure, power and amperage. In addition, verify run-out conditions.

.7 For variable speed pumps, conduct the tests at four speeds, typically 100, 70, 50 and 30 percent of the design speed.

.8 Field test report:

.1 Submit compiled field test results into a report certified by a qualified professional.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submission.

.9 Where field tests do not verify compliance with specified performance requirements, investigate cause for noncompliance, undertake remedial Work as required to bring pump into compliance, or replace the pump and all necessary ancillaries, and re-test to prove compliance. Use clear water for the test. Determine equivalency factors for clear water and wastewater product based on Manufacturer's recommendations.

3.3 System Operational Testing

.1 Repeat Functional Testing for all pumps greater than or equal to 3.7 kW under the Final Design operating conditions to confirm the pump meets the requirements of the Final Design through the complete operating range.

.2 Perform additional field testing requirements for pumps greater than or equal to 30 kW, as specified in Section 11330.

END OF SECTION

MOTORIZED STRAINER

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and testing of motorized strainers.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Fluid Engineering Eliminator Series 723.

.2 Tate Andale Inc.

.3 Sureflow Equipment Inc.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Motorized strainer shall remove solids from a liquid stream of a designated size and periodically discharge waste to drain.

.2 Strainer to be designed for the liquid stream it is used in and shall meet area exposure classification in Section 01450.

.3 Motorized strainer shall be designed such that solids can be removed automatically and that they do not permanently accumulate.

.4 Motorized strainer shall be sized to conform to the Final Design, including the flow and maximum pressure clean drop.

.5 Size the strainer body for the necessary retention time to filter the process stream.

2.3 Materials

.1 Body and cover: carbon steel, designed, manufactured, and tested to ASME Section VIII Standards.

.2 Straining element: Type 316 stainless steel.

.3 Fabricate all other internal parts of Type 316 stainless steel.

2.4 Configuration, Components and Features

.1 Provide a motorized, automatic, self-cleaning strainer for continuous debris removal.

.2 The system provided shall allow for full-time uninterrupted flow.

.3 Housing shall be suitable for a design pressure of 1000 kPag.

.4 Provide flanged inlet and outlet connections conforming to ANSI B16.5.

.5 Provide a single backwash connection on the side and large drain connections on the bottom of the housing.

.6 Provide unit complete with factory-supplied steel support legs for bolting to concrete or steel base.

.7 The design criteria for the flanged connections shall conform to the Final Design.

.8 Manufacture the straining element of wedge-shaped profile wire and rod. Weld each intersection to produce a rugged, one-piece element. Fabricate of Type 316 stainless steel. Provide 0.15 mm (150 micron) openings.

.9 Provide drive shaft and hollow port assembly fitted with all necessary bearings and seals.

.10 Make the drive arm and hollow port assembly free-running, with no direct contact with the screen surface. Make the port assembly factor- and field-adjustable for positive effective cleaning and shear capability.

2.5 Equipment and System Control

.1 Provide a backwash control package for continuous or intermittent operation of the backwash cycle. Provide 120 V, 1 phase, 60 Hz power supply.

.2 Provide a NEMA 4X panel with an adjustable timer, relays, drive motor starter, HOA selector switch, and indicating lights for Power On, Backwash Operating, and High Differential.

.3 Provide an appropriately sized backwash valve with electric actuator.

.4 Provide alarms and monitoring signals as recommended by the Manufacturer in accordance with the Automation Design Guide.

.5 Provide a single element differential pressure transmitter with indicator to override the timed backwash sequence while also providing a 4-20 mA signal to automation system for monitoring and alarm.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

SHAFT DRIVEN SOLIDS HANDLING CENTRIFUGAL PUMP

1. GENERAL

1.1 Summary

.1 This Section specifies supply, installation, testing, and commissioning of custom-engineered, vertical lineshaft coupled, variable speed, solids handling, mixed-flow centrifugal pumps for pumping raw wastewater.

.2 Pumping units shall consist of pump, intermediate shafting, couplings, electric motor, ring base and variable speed drive.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

.2 Predicted variable speed pump performance curves showing total dynamic head, power, efficiency, and NPSH3 required plotted against capacity for the following, at a minimum:

.1 Annual average day flow at max static head.

.2 Annual average day flow at min static head.

.3 Peak wet weather flow at max static head.

.4 Peak wet weather flow at min static head.

.5 Minimum flow at min static head.

.6 Minimum flow at max static head.

.7 All curves shall clearly display the specified operating conditions and the Manufacturer’s limits for the POR and AOR. If the submittal does not include boundaries of the AOR and POR it will be rejected.

.8 Complete description and sketch of proposed test setup for factory test. Provide sample calculations and proposed test log format.

.9 Test report summarizing certified factory test procedures and results, including not less than eight (8) test points documenting peak efficiency at full speed within a tolerance of minus 0 percent.

.10 Vibration and critical speed analysis in accordance with Section 11020.

.11 Documentation providing detailed procedures/sequence of operation for conducting a cleaning cycle of the wet well. The details of this sequence shall be confirmed during commissioning.

1.3 Standards

.1 Products provided under this specification must comply with all regulations and codes in effect in Manitoba.

.2 Electrical work shall be in accordance with the Canadian Electrical Code and with applicable standards of the EEMAC and the CSA.

.3 The pump/motor assembly shall have CSA approval as one unit, per CSA standard C22.2-108. Proof of this approval shall be submitted by the pump manufacturer with the approval drawings. An approval of the motor unit only will not be acceptable.

.4 The pump/motor shall also be approved by CSA for service in Class1, Division I, Groups C or D hazardous locations.

.5 ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

.6 ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

.7 ANSI/HI 9.1-9.5 – Pumps—General Guidelines.

.8 ANSI/HI 9.6.1 – Centrifugal and Vertical Pumps for NPSH Margin.

.9 ANSI/HI 9.6.2 – Centrifugal and Vertical Pumps for Allowable Nozzle Loads.

.10 ANSI/HI 9.6.3 – Centrifugal and Vertical Pumps Allowable Operating Region.

.11 ANSI/HI 9.6.4 – Centrifugal and Vertical Pumps, Vibration Measurements and Allowable Values.

.12 ANSI/HI 9.6.6 - Rotodynamic Pumps for Pump Piping

.13 ANSI/HI 9.8 – Pump Intake Design.

.14 ANSI/HI 14.6 – Hydraulic Performance Acceptance Tests.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The Manufacturers' standard products may not comply.

.1 Cornell.

.2 Fairbanks Nijhuis.

.3 Flowserve.

.4 KSB.

.5 Grundfos Morris.

.6 Xylem/Flygt.

.7 Or approved equivalent.

2.2 Performance Criteria

.1 The pumps have the following operating conditions:

.1 Condition A is the rated, continuous-duty operating condition; guarantee performance at Condition A in accordance with 1U tolerances set forth in the test standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating is cause for rejection.

.2 Condition B indicates operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve.

.3 Condition C indicates operating conditions when the pump is operating against maximum anticipated system head, assuming a hypothetical head-capacity curve.

.4 The operating characteristics for the following parameters shall conform to the Final Design for each operating condition:

.1 Capacity at rated head.

.2 Total head.

.3 Net positive suction head available (NPSHA), NPSH3 and Margin.

.4 Pump speed.

.5 Motor power.

.6 Inlet/outlet size.

.5 Total head in the above list is the algebraic difference between the total discharge head and total suction head as defined in the standards of the Hydraulic Institute; total head includes velocity head, but is exclusive of pump inlet and discharge headlosses.

.6 NPSHA in the above list is referenced to the project elevation and is calculated in accordance with Hydraulic Institute standards for the worst combination of fluid temperature and barometric pressure.

.2 The number of vanes shall conform to the Final Design.

.3 Provide pumps which operate without cavitation; provide motor and pump combination which operates at no more than 50% of the vibration limits specified ANSI/HI 9.6.4 over the specified range of conditions.

.4 Design all pump components to safely withstand forces resulting from flow reversal up to 125 percent of maximum speed within the pump during shutdowns including those caused by power failure.

.5 Provide non-overloading pumps at any point on the pump operating curve.

.6 Pumps shall be designed and tested in accordance with applicable portions of ANSI/HI 14.6 and the requirements of this Section and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

.7 All operating conditions listed in Item 1.3.1.3, above, shall lie within the Manufacturer's AOR, as defined under ANSI/HI 9.6.3.

.8 Guarantee performance at minimum week flow of 154 ML/d and AAF of 236 ML/d in accordance with 1U tolerances set forth in the test standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating is cause for rejection.

.9 Pumphead capacity curves shall have no points of reverse slope inflection within the specified operating range.

.10 NPSH3 at any operating condition within the range specified shall be as per the Design Builder's curves submitted in accordance with clause 1.2.2, with a tolerance of plus 0 percent, minus unlimited.

.11 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.12 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve.

.13 Pump General Performance:

.1 The pumps shall be designed to function over the entire variable speed, operating range, including start-up and shutdown, without cavitation and without vibration more than specified.

.2 The pump runout condition shall be defined as the flow produced at the runout head of the maximum AOR limit. The equipment shall be designed to operate at pump run-out without producing deficient vibrations, stresses, or other undesirable conditions.

.3 Design the pump casing, base supports and all other components to resist all forces on the pump casing and support due to static and dynamic hydraulic forces at both the suction and discharge connections of the pump. These forces include the unbalanced hydraulic force acting on the pump casing.

.4 Certify that recirculation has been considered in the design of the impeller and that the impeller has been designed to current design techniques that recognize and minimize all negative effects of recirculation.

.14 Motor General Performance:

.1 Overall sound-pressure level of each motor shall not exceed 80 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four (4) or more readings at evenly spaced points, 1 m from motor.

.2 Motors furnished with pumps intended for variable speed operation shall be inverter duty type.

.3 No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.15 Service Conditions:

.1 Provide pumps of the solids handling type, suitable for installation in a dry well which could be flooded. Pumping units to continue to operate during and after immersion. Motors shall be installed above the flood level.

.2 Design pumps and motors to operate at variable speed generally in a dry indoor environment with an ambient temperature range of 10 to 25°C. Provide pumping units for continuous or intermittent operation across the full range of speeds.

.3 If testing of fluid to be pumped is deemed to be required by the Manufacturer, samples can be provided upon the Manufacturer's request.

.16 Mass Elastic System and Natural Frequencies:

.1 The pumping unit, consisting of pump, shafting, couplings, motor, and all attached appurtenances shall have no critical or resonant torsional frequencies or multiples of resonant frequencies within 15 percent of the speed range required by the pump to meet the specified operating conditions.

.2 For the purposes of design, a dangerous critical speed shall be defined as one which produces a combined (operating plus normal operational) torsional stress exceeding 24 MPa.

.3 Submit the analysis of critical speeds and the complete mass elastic system. The method used for analysis of the mass elastic system shall be at least equal to the techniques developed by Holzer.

.4 Submit an interference diagram showing the relationship between operating range, natural frequencies and exciting frequencies. The diagram shall include calculated stresses throughout the range of frequencies considered in the analysis.

.5 The lateral natural frequencies (first, second, third and half order) for the pump and motor frames and all appurtenances shall be not less than 20 percent above the frequencies induced by the rotating system operating at any speed required to achieve the specified performance. Demonstrate compliance with this requirement by submitting reed frequency calculations for each frame and rotating element.

.6 The analyses shall be the work of a registered Professional Engineer regularly engaged in this type of work. All calculations, reports and graphic representations produced by the engineer shall bear the engineer's registration seal and signature.

.7 Design the pump casing, base supports and all other components to resist all static and dynamic hydraulic forces on the pump casing and support, including unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed suction valve.

2.3 Materials

.1 Casing, volute, back head, stuffing box cover, bearing frame: cast iron, ASTM A48 class 30B.

.2 Wetted cast iron parts shall have 2 to 3 percent nickel added to the cast iron.

.3 Impeller: cast stainless steel ASTM A743/A743M Grade CA-6NM (13 percent Cr, 4 percent Ni-Mo).

.4 Shaft: ASTM A332 Grade 4140 or equal.

.5 Safety guards: expanded or sheet metal Type 316L stainless steel.

.6 Combined wear ring and grit shield assemblies: 440 C stainless steel.

.7 Fasteners: stainless steel, ASTM A276 Type 316.

.8 Intermediate couplings:

.1 Sleeve: EPDM or TPC-ET.

.2 Disks: stainless steel, ASTM A276 Type 316.

.3 Hubs: steel.

.4 Bolts and nuts: stainless steel, ASTM A276 Type 316.

.9 Mechanical seals:

.1 Metal parts: stainless steel, ASTM A276 Type 316.

.2 Springs: stainless steel, ASTM A276 Type 316.

.3 Rotary faces: silicon carbide.

.4 Stationary faces: silicon carbide.

.10 O-rings, elastomers: FKM.

2.4 Configuration, Components and Features

.1 General:

.1 Provide pumps with solids handling, vertical bottom suction nozzle entry, side discharge for variable speed operation.

.2 Pump rotation shall be clockwise when viewed from the drive end.

.3 Each pump shall be designed so that the impeller, back head, frame and pump shaft can be removed without disturbing the connecting piping or casing.

.4 All components of the equipment system shall be chosen to provide compatibility, ease of construction, and efficient maintenance.

.5 All flanges shall conform in dimension and drilling to ANSI B16.1, Class 125. Flanges shall be oriented with two (2) bolt holes straddling the vertical axis.

.2 Casing:

.1 The casing shall have well-rounded water passages and smooth internal surfaces free of cracks, porosity, projections, or other irregularities.

.2 Minimum 125 mm diameter hand holes shall be provided in the casing at the discharge nozzle. The inner contours of the hand hole cover shall conform to that of the casing in which it fits. Provide pump pedestal with clear access to hand hole cleanouts. Gaskets: Neoprene or Buna-N.

.1 Equip hand holes with covers designed for easy removal.

.2 Hardware: Type 316 stainless steel.

.3 All pressure containing parts and bearing frame shall be made from cast iron, designed to withstand all stresses and strains of service.

.4 All mating surfaces where water-tight sealing is required shall be machined and registered fit with either rubber O-rings or gaskets, depending on which is most appropriate for the size of the mating surface.

.5 Provide two (2) 12.8 mm NPT tapped holes fitted with forged Type 316 stainless steel plugs on top and bottom of the casing adjacent to the discharge flange of the pump.

.6 Provide one (1) 25.4 mm NPT tapped hole fitted with forged Type 316 stainless steel plug on the top of the casing adjacent to the discharge flange of the pump.

.7 Provide the suction and discharge nozzles with 12.8 mm NPT tapped service connections. Service connections shall be fitted with forged Type 316 stainless steel plugs.

.8 Each casing shall be fitted with a minimum of three lugs, adequate for lifting the pump.

.9 The casing interior surfaces shall be grit blasted and designed for durability.

.1 Acceptable Products:

.1 Belzona 1321.

.2 Or approved equivalent.

.10 Pumps with splitter vanes in casing shall not be permitted.

.3 Impeller:

.1 The impeller shall be one-piece, single-stage, single-suction design. The surface finish shall be uniform and smooth without hollows, projections, cracks, pinholes, or other surface irregularities.

.2 The inlet area to the impeller shall be large enough to maintain the inlet velocity below 6 m/s at the rated operating conditions.

.3 Provide vanes having wide suction and waterways that pass solids and stringy material without clogging.

.4 Provide pumps capable of passing a solid sphere size as required in the Technical Requirements.

.1 Pumps capable of only passing a deformable sphere are not acceptable.

.5 Provide impellers not greater than 50 percent of the maximum trim range available for the model of pump and motor.

.6 The impeller shall be keyed to a tapered or concentric shaft and held securely in place by a locking assembly. The key and locking assembly shall be designed such that neither forward nor reverse rotation loosens or unscrews the assembly. Provide features to prevent stringy material from adhering to the locknut.

.7 The impeller shall be fixed in position with no expected or required adjustment.

.8 The finished impeller with its wear ring attached shall be statically and dynamically balanced.

.4 Mechanical Seal:

.1 The pump shall be fitted with a mechanical seal capable of withstanding pressures to 1.5 times higher than the maximum operating pressure.

.2 Use split mechanical seals.

.1 Seals shall use non-potable City utility water rather than plant flushing water.

.2 Install SpiralTrac to allow seal to function when supply of non-potable City utility water fails.

.3 Seal shall be capable of tolerating maximum design misalignment and deflection of the shaft.

.4 Acceptable Manufacturers:

.1 Chesterton Style 442.

.2 John Crane.

.3 Or approved equivalent.

.5 Pump Bearing Frame:

.1 Design the pump bearing frame to carry loads from both radial and thrust bearings. Frame shall be accurately centred, shimmed, and bolted to the back head and pump casing.

.2 Provide pump feet integral to the casing and designed for hydraulic thrust equivalent to two (2) times the shut-off head times the area of the discharge nozzle and acting at centreline of the discharge nozzle.

.3 Design Builder shall cause the pump Manufacturer to be responsible for the design of the pumps' and motors' anchor bolting systems. Anchorage requirements shall conform to the standards of the Hydraulic Institute.

.6 Driver Support:

.1 Driver support shall span an opening in the floor sufficient to allow removal of the complete pump.

.2 Driver support top plate and all portions of the assembly intended to join with surfaces in the installation structure shall be milled flat and parallel to 0.051 mm per 304.8 mm (0.002" per foot).

.3 Provide access provisions allowing adjustment or disassembly of couplings.

.7 Pump Shaft:

.1 Pump shaft shall be engineered for the impeller, heat treated, turned, ground and polished and key seated for mounting the impeller and drive coupling.

.2 The end of the shaft shall be tapered or concentric for mounting the impeller.

.3 Provide shafts with strength and stiffness to operate without distortion or damaging vibration throughout the range of service specified.

.4 Limit deflection of shaft at the stuffing box to not more than 0.15 mm when the pump is operating continuously at any point within the specified range.

.5 The section of the shaft (or impeller hub) which extends through or into the stuffing box shall be fitted with a replaceable stainless steel shaft sleeve. The sleeve shall be held securely to the shaft to prevent slip rotation and sealed to prevent leakage between the shaft and sleeve.

.6 Shaft length shall be arranged to meet HI Standards and the Technical Requirements.

.8 Bearings:

.1 Provide the pump with two (2) sets of anti-friction grease-or oil-lubricated line and thrust bearings of the pump manufacturers design, designed for the bearing life specified

further herein. Provide standard Alemite fittings (or approved equivalent) for greasing. Lubrication fittings shall be accessible at the outside diameter of the bearing frame.

.2 Calculate the radial loads as per the volute design.

.9 Wear Rings:

.1 Provide suction cover fitted with a replaceable wear ring with a Brinnell hardness in the range of 600 BHN.

.2 The hardness of the suction cover wear rings shall exceed that of the impeller wear rings by at least 50 BHN.

.3 Wear ring fasteners shall be stainless steel.

.4 The wear rings shall not require impeller axial adjustment to maintain clearance.

.5 L-form wearing rings are not acceptable.

.10 Intermediate Shafting and Couplings:

.1 Intermediate shafting of the universal joint type shall be furnished including pump and motor couplings and any required steady bearings. Shafting shall be ASTM A332 Grade 4140 or equal. The number of sections shall be as recommended by the shafting Manufacturer on the basis of lateral and torsional analysis.

.2 Shafting shall be selected with an L-10 bearing life of 20,000 hours for the industrial bearings and 100,000 hours for the steady bearings. Shafting to avoid critical speeds and harmonics as recommended by the shafting manufacturer. Shafting Manufacturer to submit all data and calculations substantiating selection and number of sections.

.3 Furnish intermediate bearing supports where multiple shaft sections are required. Intermediate bearing supports design shall be sealed by a Professional Engineer completely independent of equipment manufacturers, experienced in the design of supports for variable speed rotating equipment.

.1 Provide Type 316 stainless steel metal guards around each shaft for protection of personnel.

.2 Steady Bearing Supports:

.1 As required for the Final Design.

.2 Structural steel, ASTM A36.

.3 Spans shall be as short as possible with rigid end connections.

.4 Install supports so that principal section of modulus opposes horizontal forces.

.3 The natural frequency of the bearing support shall be a minimum of four (4) times the running speed forcing frequency. The proposed support and design calculations shall be submitted for approval prior to construction.

.4 Acceptable Manufacturer:

.1 Johnson Power Ltd.

.2 Or approved equivalent.

.11 Flanges and Pipe Threads:

.1 Provide flanges on cast iron equipment and appurtenances that conform in dimension and drilling to ANSI B16.1, Class 125 and flanges on steel equipment and appurtenances that conform in dimension and drilling to ANSI B16.5, Class 150, unless specified otherwise.

.2 Provide pipe threads that conform in dimension and limits to ANSI B1.1, coarse thread series, Class 2 fit.

.3 Provide flange assembly bolts that are heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts, conforming to ANSI B18.2.1 and B18.2.2.

.4 Provide threads that conform Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

.12 Each pump shall have an engraved or stamped ANSI Type 316 stainless steel nameplate showing the following additional information:

.1 Radial bearing designation.

.2 Thrust bearing designation.

2.5 Equipment and System Controls

.1 Provide vibration sensors to protect the pump and motor.

.2 Provide temperature sensors to protect the motor.

2.6 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following:

.1 Intermediate shaft coupling assembly.

.2 Mechanical seal repair kit.

.3 Wear rings (casing and impeller).

.4 Five (5) tubes of bearing grease as per bearing Manufacturer's recommendation.

.5 Five (5) tubes of coupling lubricant as per the coupling Manufacturer's recommendation.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory tests shall be conducted on pump assembly in accordance with Section 11330. Copies of all shop test data and interpreted results.

3.2 Performance Testing

.1 Certified witnessed performance tests shall be conducted in accordance with ANSI/HI 14.6. for all pumps. The test setup shall duplicate as closely as possible the inlet conditions in the Final Design.

.2 A minimum of 8 test points shall be taken, including a minimum of four (4) within plus or minus 8 percent of individual pump flow at annual average day flow, and a minimum of two (2) within plus or minus 4 percent of the pump's best efficiency point at test speed. Head and power requirements at shut off head shall be determined by one (1) test point. All tests shall meet 1U tolerance and -0 for efficiency.

.3 Any pump not included in the certified witnessed factory performance tests shall undergo non-witness factory certified performance tests.

END OF SECTION

GRIT REMOVAL EQUIPMENT

1. GENERAL

1.1 Summary

.1 This Section specifies the supply installation, testing and commissioning for the grit removal equipment.

1.2 Standards

.1 ASTM A36 – Standard Specification for Carbon Structural Steel.

.2 ASTM A48 – Standard Specification for Gray Iron Castings.

.3 ASTM A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.

.4 ASTM A167 – Standard Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip.

.5 ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.

.6 ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

.7 ASTM A312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

.8 ASTM A479 – Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

.9 ASTM A532 – Standard Specification for Abrasion-Resistant Cast Irons.

.10 ASTM A582 – Standard Specification for Free-Machining Stainless Steel Bars.

.11 ASTM A682 – Standard Specification for Steel, Strip, High Carbon, Cold Rolled, General Requirements.

.12 ASTM A743 – Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Provide certification that grit removal unit is designed to withstand dynamic forces from liquid and vortex forces.

.3 Gear reducer data including service factor, efficiency, torque rating and materials.

.4 Motor characteristics and performance information.

.5 Provide electrical characteristics and connection requirements

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers are:

.1 Grit concentrator, grit slurry washing and grit dewatering.

.1 Hydro International.

.2 Or approved equivalent.

.2 Grit Pumps:

.1 As required by Final Design.

2.2 Performance Criteria

.1 General

.1 Provide a complete removal system that will remove grout from wastewater concentrate it and produce a product that can be collected in a bin and disposed of at a solid waste disposal site.

.2 The system shall be designed for operation and peak and low grit loads and shall be designed for self-cleaning and non-plugging operation.

.3 Design to meet Section 01450 for classification and corrosion resistance.

.4 System shall be designed for ease of operation and replacement of warn components.

.2 The grit concentrator unit design criteria for the following parameters shall conform to the Final Design and as noted:

.1 Number of units.

.2 Diameter size.

.3 Number of trays.

.4 Peak and average flow per unit.

.5 Surface area per unit.

.6 Peak loading rate.

.7 Maximum design loading rate.

.8 95 percent removal of all grit ≥ 125 micron (specific gravity of 2.65) at flow of 860 ML/d.

.9 95 percent removal of all grit ≥ 106 micron (specific gravity of 2.65) at flow of 705 ML/d

.10 95 percent removal of all grit ≥ 75 micron (specific gravity of 2.65) at flow of ADWF.

.11 Headloss at average and peak flow.

.12 Inlet duct opening.

.13 Discharge weir.

.14 Underflow connection.

.15 Fluidization water supply.

.3 The grit washing unit design criteria for the following parameters shall conform to the Final Design and as noted:

.1 Number of units.

.2 Diameter size.

.3 Average and peak flow per unit.

.4 95 percent removal of all grit ≥ 75 micron (specific gravity of 2.65).

.5 Influent connection.

.6 Effluent connection.

.7 Underflow connection.

.8 Water supply.

.9 Utility water required.

.4 The dewatering unit design criteria for the following parameters shall conform to the Final Design and as noted:

.1 Number of units.

.2 Operating frequency.

.3 Average and peak flow per unit.

.4 Settling rate.

.5 Clarifier volume.

.6 Overflow connection.

.7 Drain connection.

.8 Washwater connection.

.9 Performance: Dewatered grit: > = 60 percent dry solids.

.10 Performance: Dewatered grit: < = 20 percent volatile solids.

.11 Motor power.

2.3 Materials

.1 Grit Concentrators:

.1 Fabricate all parts and assemblies from Type 304 stainless steel with a 2D finish conforming to the following standards, unless noted otherwise:

.1 Plate and Sheet: ASTM A167, ASTM A240.

.2 Bar: ASTM A276, ASTM A479.

.3 Tube: ASTM A312.

.2 All stainless steel used for the anchor bolts shall be Type 316 stainless steel.

.3 All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.

.4 All stainless steel surfaces shall be acid washed.

.5 All non-submerged exterior surfaces shall be glass-bead blasted to a uniform finish.

.6 Grit removal unit trays shall be constructed with a minimum 19 mm thick LDPE on the pans and sidewalls.

.2 Grit Slurry Washing:

.1 Fabricate all parts and assemblies from Type 304 stainless steel.

.2 Dished and flanged heads, min thickness 6.3 mm.

.3 Vessel walls, minimum thickness 4.8 mm.

.3 Grit Dewatering:

.1 Type 304 stainless steel housing.

.2 Rubber-cleated belt.

.4 Pump:

.1 Comply with the requirements of Final Design.

2.4 Configuration, Components and Features

.1 Grit Concentrator:

.1 Grit concentrator unit trays shall be installed in concrete tanks.

.2 Wearing parts readily accessible for inspection, repairs, and replacement.

.3 Replacement parts easily duplicated and attainable.

.4 No submerged bends or elbows for grit piping.

.5 The grit concentrator unit shall be characterized by a controlled boundary layer flow to enhance settleable solids concentration and removal.

.6 The grit concentrator unit shall be all-hydraulic consisting of self-cleaning corrosion-resistant, non-metallic trays with no moving parts within the unit.

.7 All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.

.8 Flushing water shall be continuously supplied to the base of the grit concentrator.

.9 The stack of trays to securely fit into a stainless steel support frame. Fit and secure the support frame to the bottom of the concrete support structure.

.10 All pipe flanges to conform to ANSI B16.1 bolt patterns.

.2 Grit Slurry Washing:

.1 Provide a minimum 457 mm diameter access at the top of the unit.

.2 All internal elements shall be removable.

.3 Provide clearance between the bottom of the grit underflow pipe and the grit dewatering unit clarifier surface.

.4 The grit underflow from the grit slurry washer shall be conveyed by gravity to the grit dewatering unit.

.5 Provide a flushing water connection.

.6 Provide the following valves, in compliances with Division 15, with the grit slurry separator to regulate the automatic flushing water supply:

.1 Electrically actuated plug valve to isolate underflow.

.2 Ball valve for main water flushing water supply shut off.

.3 Ball valve to regulate fluidizing water flow.

.4 Ball valve to regulate flushing water flow.

.5 Solenoid valve to automate system fluidizing water.

.6 Solenoid valve to automate system flushing water.

.3 Grit Dewatering:

.1 Provide an integral clarifier with walls sloping at least 45 degrees from the horizontal. Provide a minimum of 75 mm of freeboard in the clarifier. Fit the clarifier with an overflow weir and overflow discharge connection.

.2 The housing for the grit classifier escalator belt shall be fitted under the clarifier. The housing for the grit classifier escalator belt shall be fabricated from 3.5 mm thick Type 304 stainless steel, with urethane bonded to the internal surfaces. Incline the belt housing at 30 degrees from horizontal.

.3 Provide the belt housing with clean-out plates and one flanged drain with a 75 mm. A 75 mm plug valve shall be supplied loose for connection directly to the 75 mm drain.

.4 Provide two-ply polyester-reinforced belt. The belt cleats shall be molded 60 Durometer neoprene and aluminum reinforced, and vulcanized on the belt. The cleats shall attach to the belt with minimum 4 mm thick neoprene hinges.

.5 Provide a headroll manufactured from Type 304 stainless steel. The headroll shall be adjustable to allow take-up of slack in the grit dewatering unit belts. Adjustment of the headroll shall not affect the headroll retainer plate, scraper or drive unit.

.6 The grit dewatering units shall be provided with a headroll scraper having 6.35 mm thick HDPE contact surfaces with a 6.35 mm thick HDPE retainer plate. Both retainer plate and scraper shall be loaded to keep belt cleats closed tightly around the headroll during operation.

.7 The grit dewatering units shall be provided with a tailroll manufactured of Type 304 stainless steel. The tailroll shall be designed to mount internal to the unit belt housing with external sealed bearings.

.8 The tailroll mechanism shall be self-cleaning. As the belt rotates with the tailroll at the bottom of the unit the belt cleats lift from the belt to provide a gap of at least 25 mm. The grit dewatering unit belt shall be provided with 50 mm opening to allow transfer of fine solids internal to the belt to the underside of each cleat. The tailroll shall be fitted with a scraper, which also functions as an internal belt scraper.

.9 Provide a rinse bar system, pre-piped and factory installed. The flow to the rinse bars shall be manually adjustable with a flow indicator at the tailroll rinse. The system is to include:

.1 One (1) spray bar above the belt and above the clarifier liquid level for belt rinse.

.2 Two (2) spray bars above the belt and below the clarifier liquid level to enhance grit washing. This section shall be isolated from the belt rinse water piping by a ball valve for maintenance.

.3 One (1) spray bar at the bottom of the clarifier as a tailroll area rinse. The tailroll rinse shall include a globe valve to regulate the flow of rinse water to the tailroll section.

.10 Provide a motion sensor on the side of the grit classifier to monitor movement of the headroll scraper arm. Lack of motion of the headroll scraper arm to indicate lack of belt movement, drive unit failure and/or scraper arm overload. Motion sensor to comply with requirements of Section 17994.

.11 The grit classifier support structure shall be anchored to a stable base.

.12 Provide stainless steel odour control covers.

.4 Motor and Gear Reducers:

.1 The drive unit consisting of the motor and helical gear reducer shall be mounted as a single integrated unit. Heavy-duty bearings are required on the output shaft.

.2 Motors shall comply with requirements of Section 16223.

.5 Flow Meters:

.1 Provide one (1) flow meter upstream of each grit slurry washing unit.

.2 Provide one (1) flow meter for the grit concentrator fluidization water.

.3 Flow meters shall comply with requirements of Section 17920.

2.5 Equipment and System Controls

.1 Integrate all controls with the PCS.

.2 The control panel shall include the following:

.1 System power indicator.

.2 Grit slurry washing unit three-position “hand/off/remote” switch.

.3 Grit slurry washing unit drain valve three-position Open-Close-Remote switch.

.4 Grit slurry washing unit drain valve OPEN indicating light.

.5 Grit slurry washing unit fluidizing water three-position Open-Close-Remote switch.

.6 Grit slurry washing unit fluidizing water valve OPEN indicating light.

.7 Grit slurry washing unit flushing water valve three-position Open-Close-Remote switch.

.8 Grit slurry washing unit flushing water valve OPEN indicating light.

.9 Grit slurry washing unit auto drain three-position “hand/off/remote” switch.

.10 Grit dewatering unit running light.

.11 Grit dewatering unit fail indicating light.

.12 Grit dewatering unit reset push button.

.13 Grit dewatering unit manual STOP push button.

.14 Grit dewatering unit manual START push button.

.15 Grit dewatering unit manual speed potentiometer.

.16 Grit dewatering unit rinse water valve three-position Open-Close-Remote switch.

.17 Grit dewatering unit rinse water valve OPEN indicating light.

.18 Grit washing auto drain off-on.

.19 Grit washing manual initiate auto cycle.

.3 Control panel input from PCS:

.1 System run (enable).

.2 Grit dewatering unit speed call.

.3 PCS to control the grit washing and fluidizing valves.

.4 Control panel output to PCS:

.1 Grit washing in “hand/off/remote”.

.2 Grit dewatering in “hand/off/remote”.

.3 Grit dewatering fail.

.4 Grit slurry washing fluidizing solenoid valve in Remote.

.5 Grit slurry washing fluidizing solenoid valve Open.

.6 Grit slurry washing flushing solenoid valve in Remote.

.7 Grit slurry washing flushing solenoid valve Open.

.8 Grit slurry washing rinse solenoid valve in Remote.

.9 Grit slurry washing rinse solenoid valve Open.

.10 Grit slurry washing drain motor-operated valve in Remote.

.11 Grit slurry washing drain motor-operated valve Open.

.12 Grit slurry washing auto drain switch in Remote.

.13 Grit dewatering motor speed (from VFD interface).

.14 Grit dewatering motor current/instantaneous ampacity (from VFD interface).

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Conveyor belt.

.2 Two (2) retainer plates and scraper for grit dewatering.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Test at least one (1) grit removal train at peak wet weather flows using screened raw sewage subject to the following:

.1 Where necessary, add supplemental grit to the inflow to simulate the peak grit loading during the initial flush of a major storm event.

.2 Measure the amount of grit entering and the amount of grit removed and calculate the actual removal efficiency.

END OF SECTION

FACTORY AND FIELD PERFORMANCE TESTING FOR PROCESS PUMPS

1. GENERAL

1.1 Description

.1 This Section specifies the testing requirements for centrifugal wastewater pumps greater than 30 kW.

1.2 Standards

.1 ANSI/HI 14.6 – American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

.2 I.E.E.E. Standard No. 112.

.3 ISO Standards.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit a factory testing configuration the following procedure.

.1 Qualifications of individuals performing the tests.

.2 Vibration testing report for the pumping system in accordance with Section 11020.

.3 Recommended location of suction and discharge pressure gauges.

.4 Submit with the Shop Drawing a Factory Acceptance Testing plan:

.1 A minimum of 30 Calendar Days' notice prior to the commencement of the Factory Acceptance Testing, submit the following:

.1 Written notice indicating the date and location of the performance tests to be witnessed by Design Builder.

.2 A detailed description of the proposed testing procedure complete with drawings of the test set-up. The drawings to indicate the types, sizes, lengths, and elevations of all pipes and fittings of the test set-up from the suction point to discharge point. Provide a listing of any head loss-discharge relationships for special fittings (e.g. Cv factors for valves).

.3 Certified calibration certificates of the performance test equipment, traceable to a National Standard. All certificates shall be for calibrations performed within the preceding 30 Calendar days.

.5 A minimum of seven (7) Calendar Days prior to the commencement of the Factory Acceptance Testing, submit the following:

.1 Certified hydrostatic test results for each pump.

.2 Certified dynamic balance certificate for each impeller and shaft assembly (including the coupling).

.3 Certified test report for each motor which includes the following:

.1 Locked rotor amps.

.2 Speed, phase currents, input kW and KVA, power factor, efficiency, all at no load, and at 50, 75 and 100 percent rated load.

.3 Starting torque and breakdown torque.

.4 Rated load slip.

.5 Rated temperature rise.

.6 Stator resistance between lines at 20°C.

.7 Dielectric test.

.8 Dynamic test and balance logs.

.9 Torque and current versus speed curves.

.10 Efficiency as determined by the dynamometer test method I.E.E.E. Standard No. 112, Method B.

.6 Resonant frequency modelling on pump and drive assembly through the complete range of Final Design operating conditions. Resonant frequency analysis to confirm the ability of the pump to operate within the vibration tolerances through the complete range of operating speeds. Programming out high resonant frequencies on variable speed drives within the Final Design operating range is not permitted.

.3 Factory Test results: A maximum of seven (7) Calendar Days after the completion of the shop performance tests, submit the following:

.1 Pump performance curves derived from tests showing the pumphead-discharge characteristics, NPSH required, efficiency and brake horsepower over the full operating range of the pump. Include all data sheets and calculations to convert data to rated speed.

.2 Displacement graphs showing x, y, and z displacement (unfiltered peak to peak) for a minimum of the following three (3) test conditions:

.1 At all duty points.

.2 At the run-out condition.

.3 At shut-off.

.3 Provide vibration signature for each pump and drive assembly using the results of the vibration test data.

.4 Factory test results shall be certified by a qualified professional.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Hydrostatic testing:

.1 Each pump shall be hydrostatically tested in accordance with ANSI/HI 14.6. The test pressure shall not be less than 125 percent of the shut-off head at the rated speed as shown on the Manufacturer's pump performance curve, or 150 percent of the pressure that is to occur in the pump when operated at rated conditions. At no time during this test is the casing to show undue deflection or signs of weakness at any point, nor are the external surfaces of the casing to show sweating through porous metal or leaking through gaskets or cracks or other defects.

.4 Factory Acceptance Tests:

.1 Supply motor starter or VFDs, matching installed arrangement, to power the pumps and run them over their complete operating range. Supply a power analyzer to measure output power from the starter or VFDs during the tests.

.2 The pump shall be subject to witnessed Factory Acceptance Testing to determine the head, capacity, NPSH3 required, efficiency, and brake horsepower at minimum and maximum rated speeds over the full range of operation.

.3 Tests shall be conducted in accordance with the ANSI/HI 14.6 – American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests, except that predicted performance from model tests or from the performance at a single test speed is not permitted.

.4 Conduct full speed pump testing as follows:

.1 Sufficient test data shall be collected to produce certified performance and the Shop Drawing performance curves showing head versus capacity, efficiency, net positive suction head required, and brake horsepower for the rated speeds.

.2 Correct test data to the rated speed by the methods outlined in ANSI/HI 14.6.6.

.3 Each performance curve shall be determined with a minimum of five (5) test points over the operating range plus one (1) point at shutoff condition and one (1) point at the run-out condition. Each of the five (5) test points shall be determined from the

statistical average of the measured data at each point. The number of data readings taken shall be sufficient to obtain a 95 percent confidence level. Test points shall be at the conditions specified.

.1 Operate each pump for not less than one (1) hour and take readings to determine that the pump operates as specified and as required for the Final Design without cavitation at the specified minimum head condition with not more than the specified NPSH available. Test at the Final Design submergence.

.4 For pumps operating on VFDs collect variable speed test data as follows:

.1 Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.

.2 Run one (1) speed test at speed required to discharge the minimum Final Design rating point specified with one point of test at the minimum rating point.

.3 Run a second test at a speed approximately midway between full and minimum speed.

.4 Run additional tests for each reduced speed operating condition specified.

.5 The design operating points specified in the pump specification shall be considered “guarantee points” from the perspective of ANSI/HI 14.6. These points shall meet level “1U” tolerance as defined in ANSI/HI 14.6.3.

.6 Five (5) certified copies of all original test data, calculations, and final performance curves shall be furnished before shipment of the equipment. Compute an average weighted efficiency based on the contractually specified design points in each Section to determine acceptance of the pump.

.7 The average weighted efficiency shall be calculated as follows:

average weighted efficiency = $1/n\ \Sigma(a_i E_i)$

where, n = number of contractually specified design points

a = weighting factor based on portion of time the pump is expected to operate at the point. For the purpose of this specification, "a" shall be assumed to be equal for all design points.

E = measured efficiency at the design point

.8 Pumps may be rejected if the average weighted efficiency does not equal or exceed the efficiency computed from the performance curves submitted with the Manufacturer’s Shop Drawings.

.9 Pumps may be rejected if the deviation of the NPSHR (as measured during the Factory Acceptance Testing) at the minimum and maximum flows exceeds the standard deviation of NPSH3 at the rated flow (the best efficiency point) by a mutually agreed factor, (but not less than 1.5 m).

.10 If initial testing fails to meet performance requirements, perform the necessary whatever corrective work to meet the specified performance requirements.

.11 The results of the factory tests coupled with the analysis of those results shall be considered official and conclusive for determining compliance with the performance requirements prior to shipping. Final acceptance of the equipment shall depend on field acceptance tests completed after installation under the supervision and direction of the Manufacturer.

.12 All equipment used in the tests shall have been calibrated a maximum of 90 Calendar Days prior to the Factory Acceptance Testing and Functional Acceptance Testing. Provide certified test equipment calibration documents for all pieces of equipment and instrumentation.

.13 Dynamically balance the couplings, pump shaft with the impeller and wear ring mounted as an assembly according to ISO 1940. The maximum balance grade for these components shall be G6.3 at the maximum rated speed. The pump shaft, impeller and couplings shall have matching marks to indicate the alignment when balanced.

.14 Dynamically balance the rotating assembly in the motor according to ISO 1940. The maximum balance grade for the motor shall be G2.5 at the maximum rated speed. The electric motors shall be test run under rated voltage. During the test run, vibration reading including overall vibration level in velocity (mm/sec) and vibration spectra with bandwidth of minimum 25 times rotation speed and spectrum resolution of 0.1 times rotation speed shall be taken. Measurements shall be taken in three (3) directions on each end of the motor, and at suitable locations on the pump frame near each bearing. Test bed mounting conditions and measurement locations shall be recorded on the test results.

.15 In all applicable key ways where the components are not assembled for balancing, balancing shall be done using a standard one-half key in the key seat in accordance with ISO 8821. If a "full key", corresponding to the half key used for balancing, is not provided with the rotating machine, a tag shall be attached to the machine indicating the dimension of the key used to perform the balance test.

.5 Factory Vibration Tests:

.1 Acceptance shall be given if the levels measured are within the limitations as per Section 11020. Measurements shall be taken at two locations (perpendicular and parallel to the discharge piping) at each bearing on the pump and motor. Additional measurements shall be taken in the axial direction on top of the motor and pump. Exceedance of the spectrum band levels is to initiate further analysis to determine the cause of the fault for further corrective action.

.5 Testing:

.1 Test piping connections to prove the pump nozzle shall be installed with the pipe in a free-supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. Connections shall be complete and the piping acceptable prior to field performance testing.

3.2 Functional Testing

.1 Perform the Functional Testing specified in Related Sections listed in Part 1 of this Section and the following additional testing:

.1 After installation, the pumping unit shall be commissioned and tested in the field under the supervision and direction of the Manufacturer to verify its ability to operate within the vibration and temperature limits specified and to deliver its rated capacity under the Final Design operating conditions and efficiencies. The equipment shall be accepted when these field tests are complete and results analyzed and all defects and deficiencies have been corrected.

.2 Perform field testing under the supervision and direction of the Manufacturer.

.3 If field testing fails to meet performance requirements, perform the necessary whatever corrective work to meet the specified performance requirements.

.2 Pump Performance Tests:

.1 The pump shall be subject to field performance tests to determine the head, capacity, efficiency, NPSH3 required and brake horsepower. Capacity shall be determined volumetrically using the wet well or a calibrated non-intrusive meter. Pressure shall be measured with pressure transducers. Speed shall be measured with an optical tachometer. Motor input power shall be calculated from voltage, current, and power factor measurements from a digital multimeter.

.2 Record pump bearing housing and motor bearing temperatures. Bearing temperatures shall not exceed 82°C.

.3 At shut-off head, measure and record:

.1 Head.

.2 Motor input power.

.4 At each duty point, measure and record:

.1 Head.

.2 Capacity.

.3 Motor input power.

.4 Sound level.

.5 At all other points required to determine average weighted efficiency, measure and record:

.1 Head.

.2 Capacity.

.3 Motor input power.

.4 Sound level.

.6 Field acceptance test tolerances shall be as per ANSI/HI 14.6.3 Level “2U” for all operating points defined in pump specification.

.7 Pump performance test results shall be certified by a qualified professional.

.3 Field Vibration Tests:

.1 Acceptance to be given if the levels measured are within the limitations as per Section 11020. Measurements shall be taken at two (2) locations (perpendicular and parallel to the discharge piping) at each bearing on the pump and motor. Additional measurements shall be taken in the axial direction on top of the motor and pump. Exceedance of the spectral band levels is to initiate further analysis to determine the cause of the fault for further corrective action.

3.3 System Operational Testing

.1 Perform the System Operational Testing activities specified in the Technical Requirements and the following additional testing activities:

.1 Run pump through full range of operating conditions under Final Design process organic and inorganic solids loading conditions.

.2 Collect test data at a minimum of five (5) test points within the Final Design operating range.

.3 During operational tests, measure and record flow, organic and inorganic solids content, head, motor inputs, noise, vibration, overheating and motor overload.

END OF SECTION

HORIZONTAL, SCREW IMPELLER PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of horizontally mounted, screw impeller, centrifugal pumps.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

1.3 Quality Assurance

.1 Provide materials and equipment that are new and of a quality equal to that specified. Mechanical and electrical equipment shall be the products of manufacturers of established good reputations regularly engaged in the fabrication of such equipment. Any equipment offered to have current modifications which have been in successful regular operation under comparable conditions for a period of at least three (3) years.

.2 The pump manufacturer to have at least 10 years' experience in designing and manufacturing horizontal screw impeller pumps of similar size for this project.

.3 Demonstrate that Manufacturer has at least two (2) proven installations with pumps of the same size. North American installations are preferred.

.4 Provide workmanship, materials and methods of construction that conform to the best practice and highest standard of the industry.

.5 Design and proportion all parts to have robust strength, stability, stiffness and specially adapted to the conditions of service.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Wemco (Hidrostal).

.2 Hayward Gordon (XCS).

.3 Vaughan.

.4 Fairbanks Morse.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Use these pumps for sludge that has total suspended solids concentrations less than 25,000 mg/L, with minimal abrasive material.

.2 Provide solids handling pumps designed for non-clogging operation with automatic cleaning procedures.

.3 Design equipment to meet requirement of Section 01450.

.4 Pumps shall be designed for ease of operation and replacement of wear parts.

2.3 Materials

.1 Fabricate impeller of hardened high-chrome iron, ASTM A532, with minimum Brinnell hardness of 550.

.2 Fabricate casing of cast iron, ASTM A48, with no less than 3 percent nickel.

.3 Fabricate suction liner of Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinnell hardness of 550.

.4 Fabricate shaft of steel, ASTM A322, Grade 140 or ASTM A276 Type 420 stainless steel.

.5 Fabricate shaft sleeve of stainless steel, ASTM A276, Type 416 or 420, Brinnell hardness of 450, minimum.

.6 Manufacture pump bases of fabricated steel.

.1 Mount each pump and drive on a common base.

.1 Material: ASTM A36 fabricated structural steel.

.2 Provide structural steel shape bases, bent form bases are not permitted.

.3 Provide bases with provisions for grouting and for anchor bolts.

.4 Design baseplates to support pump and driver.

.5 Provide planed surfaces of bearing pads for pumps and drives.

2.4 Configuration, Components and Features

.1 Impellers:

.1 Provide spiral screw type impeller combining the action of positive displacement screw and a single-vane centrifugal impeller.

.2 Provide conical geometry of the impeller and suction pieces to maintain optimum running clearances along the entire length of the impeller.

.3 Statically and dynamically balance impellers.

.4 Secure impeller to shaft with an impeller bolt, formed to shed stringy material.

.2 Casings:

.1 Provide casings of two-piece construction consisting of volute and suction cone, with an end suction and that discharge vertically upwards.

.2 Provide suction cone internal profile with a straight-sided cone to allow axial adjustment to maintain running clearances between the impeller and suction cones.

.3 Provide back pull-out design to permit withdrawal of the impeller without disturbing the discharge or suction piping.

.4 Provide self-centring back head with back pull-out.

.5 Provide casing with a tapped and plugged connection at the discharge nozzle for a pressure gauge, a vent on top of the case, and a drain on the bottom of the case.

.6 Design the casing so that it is capable of passing solid spheres of the following sizes:

.1 100 mm or smaller casing connections: 50 mm sphere.

.2 150 mm casing connections: 75 mm sphere.

.3 Larger than 150 mm casing connections: 100 mm sphere.

.7 Foot-mount casings to allow easy access to pump interior.

.8 Provide suction and discharge connections that are flanged, faced, and drilled to conform to ASTM B16.5, Class 125.

.3 Inlet Nozzle:

.1 Provide inlet nozzle with an eccentric reduction to the connection at the casing.

.2 The top of the nozzle shall be horizontal and parallel to the pump shaft with no pockets or discontinuities which might trap air.

.4 Suction Liner:

.1 To allow adjustment of clearances between the suction cone and impeller, provide replaceable and externally adjustable suction liner.

.2 Provide adjustment for the suction liner by means of not more than three (3) external screws, placed equidistant around the circumference of the suction cone.

.3 Provide adjusting screws capable of advancing or retracting the suction liner and of locking the position of the suction liner.

.5 Cleanouts:

.1 Supply each pump with a hand-sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

.6 Shafts:

.1 Fit to impeller with impeller key.

.2 Make the shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration or undue deflection at operating loads. Where L = impeller overhang and D = shaft diameter, maintain $L^3/D^4 < 80$.

.3 Provide shaft manufactured of heat-treated high-strength steel, turned, ground and polished of proportions suitable for use in fixed speed or variable speed pumping applications.

.4 Provide reduced diameter section for sleeves.

.5 Each shaft shall be of sufficient section to limit deflection at the outer seal face to not more than 0.10 mm when pump is operating at continuous duty point defined by the operating conditions.

.7 Bearings:

.1 Oil- or grease-lubricated duplex thrust angular contact and roller bearings.

.2 Design radial and thrust bearings for the worst combination of loading developed at all operating conditions.

.8 Motors:

.1 Motor types, voltages, service conditions and power ratings are indicated in the detailed pump specification sheets.

.2 Certify compatibility between pump motor and drive.

.9 Mechanical Seal:

.1 Provide flushless mechanical seals in accordance with the following requirements:

.1 Split mechanical seal.

.2 Designed for abrasive slurry service.

.3 Flushless seal capable of operating at conditions specified in this Section, without an external flushing, quench, or coolant supply.

.4 Self-aligning, self-centring, non-fretting.

.5 Springs isolated from the process fluid.

.6 Pressure rating: minus 100 to 2000 kPag.

.7 Stationary face: tungsten carbide or silicon carbide.

.8 Rotary face: tungsten carbide or silicon carbide.

.9 Metal parts: Type 316 stainless steel.

.10 Springs: Type 316 stainless steel or Elgiloy.

.11 O-rings: fluorocarbon or ethylene propylene.

.12 Acceptable product:

.1 Chesterton 442C fitted with vented solids removal restriction bushings,

.2 EnviroSeal SpiralTrac Version N or D.

.3 Or approved equivalent.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each pump size:

.1 One (1) bearing set.

.2 One (1) suction cone.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory Acceptance Testing:

.1 Factory testing shall comply with requirements of Section 11330.

.2 Pressure test casings at 1.5 times the pressure developed by the pump at shut-off head.

END OF SECTION

HORIZONTAL, SOLIDS-HANDLING CENTRIFUGAL PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of solids handling horizontal centrifugal pumps.

1.2 Quality Assurance

.1 Manufacturer of specified equipment to have a minimum of 10 operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Flowserve.

.2 Ebara.

.3 Fairbanks.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Pumps shall be designed for wastewater sludge that is high in solids.

.2 Provide solids handling pumps designed for non-clogging operation with automatic cleaning procedures.

.3 Design pumps to meet requirements of Section 01450.

.4 Pumps shall be designed for ease of operation and replacement of wear parts.

.5 The design criteria for the following parameters shall conform to the Final Design:

.1 Area exposure.

.2 Area classification.

.3 Fluid type.

.4 Fluid temperature.

.6 The pumps have the following operating conditions:

.1 Condition A is the rated operating condition. Guarantee performance at the rated condition. Provide pumps capable of continuous operation at Condition A and also operate continuously at the head specified under Condition B without exceeding vibration limits specified in Section 11020. Condition A must be within the pump manufacturer's published allowable operating range (AOR) for the pump.

.2 Condition B represents operation at maximum speed and minimum system head conditions. Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed to be rejected. Net positive suction head available (NPSHA), as listed for Condition B, is calculated based on an estimated flow rate at Condition B. The flow rate at Condition B, expressed as a percentage of best efficiency point flow (BEPQ) for the Condition B operating speed, to be within the operating limits specified for Condition B.

.3 Condition C is the anticipated continuous duty minimum speed condition. Provide pumps capable of sustained (24 hours per day) operation at this condition without exceeding vibration limits specified in Section 11020. The flow rate at Condition C, expressed as a percentage of BEPQ for the Condition C operating speed, to be within the operating limits specified for Condition C.

.4 Condition D represents the expected minimum flow condition with maximum estimated TDH at minimum flow. Provide pumps capable of sustained (24 hours per day) operation at this condition without exceeding vibration limits specified in Section 11020. Condition D must be within the pump manufacturer's published allowable operating range (AOR) for the pump.

.5 The operating characteristics for the following parameters shall conform to the Final Design for each operating condition:

.1 Capacity.

.2 Total head.

.3 NPSHA.

.4 NPSH margin ratio, minimum.

.5 Operating limits, percent of BEPQ.

.6 BEPQ is the flow rate at the peak pump efficiency point on the pump curve, for the operating speed required to achieve operation at Condition A.

.7 Total head in the above list is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 through 1.6.

.8 NPSHA in the above list is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA to be calculated for the configuration required for the Final Design. NPSHA may change from the indicated value based on the actual pump configuration. Provide calculations justifying the actual configuration meet the NPSHA conditions.

.9 NPSH margin ratio in the above list is NPSHA/$NPSH_3$, as defined in ANSI/HI 9.6.1.

2.3 Materials

.1 Casing: ASTM A48, closed grained cast iron with no less than 3 percent nickel.

.2 Inlet nozzle: ASTM A48, closed grained cast iron with no less than 3 percent nickel.

.3 Frame: ASTM A48, Class 30, cast iron.

.4 Impeller: ASTM 743, CA6MN stainless steel.

.5 Shaft: ASTM A108, Grade 4140, steel.

.6 Shaft sleeve: ASTM 276, Type 416, stainless steel, Brinnell hardness of 450 minimum.

.7 Seal: Mechanical split type seal.

2.4 Configuration, Components and Features

.1 General:

.1 Horizontal, heavy-duty, solids-handling pumps.

.2 Provide pumps complete with motor, VFD, mounting plate and all specified appurtenances.

.3 Provide pumps, electric motors, and VFD, designed for variable speed operation.

.4 Select and design pumps specifically for continuous or intermittent pumping of specified commodity without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

.5 Pumphead capacity curve shall slope in one continuous curve with no point of reverse slope inflection.

.6 Design and select pumps specifically for high efficiency, continuous duty pumping of commodity specified derived from the treatment of municipal wastewater. The design criteria for the solids concentrations shall conform to the Final Design.

.7 Pumps shall be capable of handling liquids containing soft solids, stringy material, rags, fibrous solids, and solids up to 100 mm diameter without clogging or fouling at any operating condition within the range of service specified.

.8 Design pump and drive trains including the pumps designed for variable speed operation and those with V-belt drives, to transmit 150 percent of the maximum torque under the full range of operating conditions.

.2 Casing:

.1 Design mounting arrangement shall permit rotation of the discharge nozzle in 45-degree increments.

.2 Provide casing with a tapped and plugged connection at the discharge nozzle for a pressure gauge, a vent on top of the case, and a drain on the bottom of the case.

.3 Provide discharge nozzle with hand hole and cover matching the contours of the discharge nozzle.

.4 Back pull-out design shall permit withdrawal of the impeller without disturbing the discharge or suction piping.

.5 Flanged suction and discharge nozzles conforming to ANSI B16.1.

.6 Provide casing capable of withstanding 1.5 times the pressure developed by the pump at shut-off head.

.3 Inlet Nozzle:

.1 The top of the nozzle shall be horizontal and parallel to the pump shaft with no pockets or discontinuities which might trap air.

.2 On top of inlet nozzle, provide a hand hole and cover matching the contour of the water way.

.3 Hand hole shall be of large enough to permit access to the impeller for de-ragging and inspection.

.4 Wearing Rings:

.1 Provide wearing rings for the impeller and the casing, attached by screwed fasteners.

.2 Casing ring hardness shall exceed the impeller ring hardness of 350 Brinnell by not less than 100.

.5 Back head:

.1 Self-centring and with back pull-out.

.2 Slope all horizontal surfaces in the back head to the specified drain in the mounting plate.

.6 Frame:

.1 Provide openings in the frame to permit adjustment of mechanical seal.

.2 Provide connection between the back head and frame with self-registering and centring fits.

.7 Equipment Mounts:

.1 Group B Equipment Mounting system shall be in accordance with the equipment mounting schedule in Section 11002.

.2 Provide motor mounting blocks such that one (1) size greater motor frame may be accommodated by replacing the mounting blocks.

.3 Mount pump and motor on a common fabricated steel baseplate per Section 11002.

.4 Provide jacking screws at the motor end to facilitate alignment.

.8 Impeller:

.1 Balance impeller both statically and dynamically as specified in Section 11020.

.2 Provide enclosed, single suction, three-vane impeller.

.3 Secure impeller to shaft with a cap screw and lock washer.

.9 Shaft:

.1 Fit with impeller key.

.2 Maintain the ratio of L^3/d^4 less than 80 where "L" is the impeller overhang and "d" is the shaft diameter.

.3 Provide shaft manufactured of heat-treated high-strength steel, turned, ground and polished. Shaft proportions shall be suitable for use in variable speed pumping applications.

.4 The section of the shaft fitting between radial and thrust bearings shall be suitable thickened to withstand bending loads at all speeds of operation and at all conditions of flow and head.

.5 Each shaft shall be of sufficient section to limit deflection at the outer seal face to not more than 0.10 mm when pump is operating at any continuous duty point defined by the operating conditions specified above.

.6 Calculate shaft deflection using the following relationship:

$$Y_{max}=\frac{W_r}{3E}\left(\frac{b^3}{I_b}+\frac{a^3-b^3}{I_a}+\frac{a^2c}{I_c}\right)1$$

where:

Y_{max}	=	deflection, mm
E	=	modulus of elasticity, MPa 207 x 109 for carbon steel 193 x 109 for Type 316 stainless steel
a	=	shaft length, mm, from impeller centreline to the centreline of the radial bearing
b	=	shaft length, mm, impeller centreline to shaft sleeve (should be at radial bearing)
c	=	shaft length between bearings, mm

Ia	=	area moment of inertia of the shaft just outboard of the radial bearing, mm4
Ib	=	area moment of inertia of the shaft under the shaft sleeve, mm4
Ic	=	area moment of inertia of the shaft between the radial and thrust bearings, mm4
Wr	=	radial force, N
Wr	=	KHD2B2

where:

H	=	total head, Pa at any specified continuous-duty point
D2	=	impeller diameter, mm
B2	=	impeller width, including shrouds, mm
K	=	impeller constant:

$$K = 0.36\ (1-\frac{Q}{Q_n})^2$$

where:

Q	=	pumped flow at any specified continuous operating condition (see performance requirements in this Section)
Qn	=	capacity at the pump's best efficiency point

.10 Bearings:

.1 Oil-or grease-lubricated duplex-thrust angular contact and roller bearings.

.2 Design radial and thrust bearings for the worst combination of loading developed at operating conditions A, B, C, or D.

.3 Minimum L-10 life of 50,000 hours at specified operating conditions. Minimum L-10 bearing life determined in accordance with ABMA Standards.

.4 Fit grease-lubricated bearings with easily accessible grease supply, flush, drain and relief fittings. Provide extension tubes when necessary. Provide standard hydraulic alemite type grease supply fittings.

.11 Bearing Isolators:

.1 Provide bearing isolators on pump and motor bearings.

.2 Bearing isolators fitted for the specific size and type of bearing.

.3 Labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent escape of lubricants. Provide vapor block capability.

.4 Inpro/Seal.

.12 Seal:

.1 Provide mechanical seals in accordance with Section 11300.

.13 Spacer coupling:

.1 Provide coupling with sufficient gap between the horizontal solids-handling pump and motor shafts to allow complete withdrawal and removal of the pump back head, frame and impeller without disturbing the motor when the coupling is removed.

.14 Motor and drive unit:

.1 Direct-coupled to pump.

.2 Provide VFDs and controllers for each of the horizontal solids-handling pumps in accordance of requirements in Section 16228.

.3 Standard VFD output frequency shall be adjustable from 0 to 70 Hz.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each pump size:

.1 Two (2) bearings and bearing isolaters.

.2 Two (2) complete seals.

.3 Two (2) repair kits for seals.

.4 Two (2) complete wear rings for the impeller.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory tests on pump and motor assembly shall be in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

.2 Pressure test casings at 1.5 times the pressure developed by the pump at shut-off head.

END OF SECTION

SUBMERSIBLE SUMP PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of submersible pumps for process waste drainage and floor drainage systems.

.2 Provide submersible pumps complete with electric motor, guide brackets, lifting chain, access cover and all specified appurtenances.

.3 Provide submersible pumps and electric motors for fixed-speed operation.

.4 Submersible pumps are submersible centrifugal solids-handling type.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Details of coating systems to be applied.

.3 Vibration and critical speed analysis in accordance with Section 11020.

.4 Test Reports: submit all test reports and inspection reports of the equipment.

1.3 Service Conditions

.1 Fluid passing through submersible pumps may contain concentrations of dissolved hydrogen sulfide (H_2S) gas, and grease.

.2 The allowable suspended solids concentration in the fluid passing through the submersible pumps shall conform to the Final Design.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Flygt Xylem.

.2 ABS Sulzer.

.3 KSB.

.4 Myers.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Sump pumps shall be designed for wastewater or solids handling to suit the application.

.2 Design to meet area classification in Section 01450.

.3 Identify pumps by their equipment number.

.4 The submersible pumps have the following operating conditions:

.1 Condition A is the rated, continuous-duty operating condition; guarantee performance at Condition A in accordance with tolerances set forth in the Test Standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor nameplate rating is cause for rejection.

.2 Condition B indicates operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve.

.3 Condition C indicates operating conditions when the pump is operating against maximum anticipated system head, assuming a hypothetical head-capacity curve.

.4 The operating characteristics for the following parameters shall conform to the Final Design for each operating condition:

.1 Rated head.

.2 Capacity at rated head.

.3 NPSHA.

.4 Pump speed.

.5 Maximum motor power.

.6 Inlet/outlet size.

.5 Total head in the above list is the algebraic difference between the total discharge head and total suction head as defined in the standards of the Hydraulic Institute; total head above includes velocity head but is exclusive of pump inlet and discharge column headlosses.

.6 NPSHA in the above list is referenced to project elevation and is calculated in accordance with Hydraulic Institute standards for the worst combination of fluid temperature and barometric pressure.

.5 Supply submersible pumps under this specification suitable for continuous operation.

.6 Submersible pumps to be capable of operating continuously under full load with the motor dry, without damage, for 24 hours.

2.3 Materials

.1 Material selection to be confirmed for designated service.

.2 Provide pump that is chemically compatible with all expected commodities that may come into contact with the pump.

.1 Casing, discharge: cast iron, Class 30, to ASTM A48.

.2 Elbow: cast iron, Class 30, to ASTM A48.

.3 Bracket: cast iron, Class 30, to ASTM A48.

.4 O-rings: nitrile rubber.

.5 Access cover and frame: stainless steel, Type 316, ASTM A276.

.6 Impeller: cast iron, Class 30, to ASTM A48.

2.4 Configuration, Components and Features

.1 Pump volute and motor casing:

.1 Construct pump volute and motor casing of cast iron.

.2 All mating surfaces where water-tight sealing is required shall be machined and fit with nitrile rubber O-rings.

.2 Wear ring:

.1 Provide a wear ring designed for abrasion resistance at the inlet of each submersible pump to provide protection against impeller wear.

.3 Guide bracket and discharge connection:

.1 Provide each pump casing with an integral sliding bracket, guide bars or cables and discharge pipe extending outside the sump.

.2 Bolt the discharge connections to the floor to serve as a lower bracket for the guide bars or cables.

.3 Provide upper, lower and intermediate guide rail supports.

.4 Provide submersible pump that automatically connects to the discharge elbow when lowered into place on the discharge connections.

.5 Submersible pump shall be easily removable for inspection or service, requiring no bolt, nuts or other fastenings to be removed, and no need to enter the pump well or sump.

.6 The pumping unit shall seal to the discharge connection by a simple linear downward motion of the submersible pump with the entire weight of the pumping unit guided to and pressing tightly against the discharge connection. No portion of the submersible

pump shall bear directly on the floor of the sump, and rotary motion of the submersible pump shall not be required for sealing.

.7 Sealing at the discharge connection by means of a diaphragm or similar method of sealing shall not be permitted.

.4 Lifting chain:

.1 Provide a Type 316 stainless steel lifting chain of adequate strength and length to permit raising for inspection and removal for each pump.

.5 Access covers for process sumps:

.1 Provide each sump with unsealed covers and frames of Type 316 stainless steel.

.2 Include with each frame an upper attachment for guide rails, lifting chain, and power cable.

.3 Design covers for a 1.5 T fork lift truck wheel load.

.4 Provide covers with the required number and size of compression spring operators to facilitate opening and, and to dampen the closing speed.

.5 Provide a hold-open arm that automatically locks the cover in the fully open position.

.6 Provide Type 316 stainless steel spring tubes, springs, lifting mechanism supports, tube caps, support shoes, hold-open arms, hinges, hinge pins, snaplock, lock strike, and all fasteners.

.7 Provide a removable latch handle key with each cover.

.8 Provide access covers and frames Bilco Type J, modified to provide the specified features.

.6 Impeller:

.1 Solids handling single- or dual-Vane.

.2 Minimum solids passing shall conform to the Final Design.

.7 Bearings:

.1 Provide heavy-duty grease lubricated bearings, ball type, double shielded and factory sealed and designed for at least five (5) years of heavy-duty service without requiring additional lubrication.

.8 Mechanical Seal:

.1 Provide each submersible pump with a tandem double mechanical seal running in an oil reservoir, composed of two separate lapped face seals.

.2 Each seal consists of one (1) stationary and one (1) rotating tungsten-carbide ring, with each pair of rings held in contact by a separate spring.

.3 Conventional double mechanical seals with a single or a double spring between the rotating faces or requiring constant differential pressure to effect sealing and are subject to opening and penetration by pumping force shall not be permitted.

.4 Provide submersible pumps capable of continuous submergence to a depth of 20 m without loss of water-tight integrity.

.9 Motor and Cable:

.1 For process and drainage sumps, submersible motors shall be supplied with motor and cable.

.2 Provide a heavy-duty flexible, water-resistant, continuous non-wicking submersible power cable, sealed at the motor bell and of sufficient length to connect to a junction box.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each pump size:

.1 Two (2) sets of bearings.

.2 Two (2) complete sets of o-rings.

.3 Two (2) wear rings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory testing in compliance with requirements of Section 11300.

.2 Pressure test casings at 1.5 times the pressure developed by the pump at shut-off head.

END OF SECTION

CENTRIFUGAL CHOPPER PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of horizontal, solids handling, end suction centrifugal chopper pumping units.

.2 Each pumping unit shall be complete with pump, an electric motor, flexible coupling or belt drive, and baseplate. Each pump and drive unit shall be mounted on a common baseplate and shall be provided with anchor bolts and all other appurtenances specified or otherwise required for proper operation.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The manufacturers' standard products may not comply:

.1 Vaughan.

.2 Hayward Gordon.

.3 Wemco.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Heavy duty centrifugal chopper pump designed to condition and macerate solids as part of the pumping action.

.2 Materials shall be macerated and conditioned by the pumps as an integral part of the pumping action. The pump must demonstrate the ability to grind through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.

.3 Pump head capacity curves shall have no points of reverse slope inflection within the specified operating range.

.4 Supply pumps suitable for continuous operation at full rated power.

.5 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.6 Provide pumps which operate without cavitation; provide motor and pump combination which operates without excess vibration over the specified range of conditions in accordance with ANSI/HI 9.6.4.

.7 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve. No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.8 The pump runout condition shall be defined as the flow produced at the runout head of the maximum AOR limit. The equipment shall be designed to operate at pump run-out without producing deficient vibrations, stresses, or other undesirable conditions.

.9 Design the pump casing, base supports and all other components to resist all forces on the pump casing and support due to static and dynamic hydraulic forces at both the suction and discharge connections of the pump. These forces include the unbalanced hydraulic force acting on the pump casing.

.10 Certify that recirculation has been considered in the design of the impeller and that the impeller has been designed to current design techniques that recognize and minimize all negative effects of recirculation.

.11 Provide impellers not greater than 90 percent of the maximum diameter impeller available for the model of pump and motor supplied.

.12 The fluid temperature is expected to range from 10 to 25°C.

2.3 Configuration, Components and Features

.1 Casing:

.1 The pump casing shall be of semi-concentric design, with flanged connections. The suction nozzle shall have a flanged cleanout hand hole with interior surfaces flush with casing water passage. Casing parts shall have registered fits to maintain alignment. The nozzle flanges shall be flat-face with ANSI/ASME B16.1, Class 125 diameter and drilling. Pipe tapped openings shall be provided for draining, priming, and venting the casing. The pump discharge and suction flanges shall be tapped and plugged for a 6.35 mm pressure gauge connection.

.2 Casing: Ductile cast iron, ASTM A536. All water passages shall be smooth, and free from imperfections that inhibit good flow characteristics.

.2 Impeller:

.1 The impeller shall be semi-open chopper style with pump out vanes or partial back shroud to reduce seal area pressure, and to draw lubricant down from the reservoir should leakage occur. Grinding and maceration of materials shall be by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter

bar at the intake openings, with a set clearance between the impeller and cutter bar of between 0.254 mm and 0.381 mm. The impeller shall be rigidly held in place with an impeller bolt and have no axial adjustments and no set screws.

.2 Impeller: Cast Steel, ASTM A532, heat treated to minimum Brinell hardness of 650.

.3 Cutter Bar:

.1 The cutter bar shall be recessed into the pump bowl, with a funnel shaped inlet opening, and to extend diametrically across entire pump suction opening.

.2 Cutter Bar: T1 plate steel ASTM A276, heat treated to minimum Brinell hardness of 650.

.4 Cutter Nut:

.1 The impeller shall be secured to the shaft using a special cutter or deflector nut designed to cut stringy material and prevent binding without exception. Impeller mounting nuts or other devices that do not include a cutting mechanism are not acceptable.

.2 Cutter nut: AISI 8620 alloy steel case hardened to minimum Rockwell C60.

.5 Pump Shaft Ball Bearings:

.1 The bearings shall have a minimum L-10 life rated 100,000 hours. Shaft thrust shall be taken up by either a double-row angular contact ball bearing or two back-to-back mounted single-row contact ball bearings, which bear against a machined shoulder on one side and the seal sleeve on the other side. Overhang from the centreline of the lower thrust bearing to the seal faces shall be a maximum of 30.5 mm, with a mechanical seal to isolate the bearings from the pumped media at up to 121°C.

.2 Pump shaft: stainless steel, Type 316 to ASTM A276.

.3 Pump shaft ball bearing: oil-bath lubricated by ISO Grade 46 or 48 turbine oil.

.6 Mechanical Seal:

.1 Flushless mechanical seal system shall be specifically designed to require no seal flush through the elimination of the stuffing box. The seal shall be made of AISI Type 316 stainless steel and shall be cartridge-type with FKM O-rings and tungsten or silicon carbide faces.

.2 The mechanical seal cartridge shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the seal faces together shall be shielded from the pumped fluid. The cartridge shall include a 17-4PH, heat-treated seal sleeve and an ASTM A536 ductile iron seal gland.

.3 The mechanical seal faces shall be lubricated and cooled by a separate oil chamber. The area between the seal oil chamber and bearing oil chamber shall be vented and drained to prevent contamination of the bearings.

.7 Shaft Coupling:

.1 T.B. Woods Sureflex (or approved equivalent) elastomeric type, with a minimum 1.5 service factor based on the drive rated power, protected with Type 316 stainless steel guards.

.8 Pump Base Plate:

.1 The pump base plate shall be fabricated carbon steel, 17.6 mm minimum thickness, and to include lifting lugs.

.2 Base plate: fabricated steel.

2.4 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 One (1) impeller.

.2 One (1) cutter bar and nut for every two (2) pumping units of similar size.

.3 One (1) impeller sleeve for every two (2) pumping units of similar size.

.4 One (1) impeller bolt and washer for every (2) two pumping units of similar size.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Provide copies of all shop test data and interpreted results.

END OF SECTION

SELF-PRIMING SOLIDS HANDLING CENTRIFUGAL PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of self-priming solids-handling centrifugal pumps.

1.2 Standards

.1 ASTM A532/A532M - Abrasion-Resistant Cast Irons.

.2 ASTM A536 - Specification for Ductile Iron Castings.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The manufacturers' standard products may not comply:

.1 Gorman-Rupp Company.

.2 Hayward Gordon.

.3 Wemco.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Horizontal, self-priming centrifugal pumping units for raw, unscreened wastewater containing solids and/or fibrous materials, complete with motors as required and as show on the Drawings.

.2 Pumphead capacity curves shall have no points of reverse slope inflection within the specified operating range.

.3 Supply pumps suitable for continuous operation at full rated power.

.4 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.5 Provide pumps which operate without cavitation; provide motor and pump combination which operates without excess vibration over the specified range of conditions in accordance with ANSI/HI 9.6.4.

.6 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve. No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.7 The pump runout condition shall be defined as the flow produced at the runout head of the maximum AOR limit. The equipment shall be designed to operate at pump run-out without producing deficient vibrations, stresses, or other undesirable conditions.

.8 Design the pump casing, base supports and all other components to resist all forces on the pump casing and support due to static and dynamic hydraulic forces at both the suction and discharge connections of the pump. These forces include the unbalanced hydraulic force acting on the pump casing.

.9 Certify that recirculation has been considered in the design of the impeller and that the impeller has been designed to current design techniques that recognize and minimize all negative effects of recirculation.

.10 Provide impellers not greater than 90 percent of the maximum diameter impeller available for the model of pump and motor supplied.

.11 The fluid temperature is expected to range from 10 to 25°C.

.12 Reprime Performance:

.1 The loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate centreline of the impeller shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

.2 During unattended operation, the pump shall return adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

.3 Pump must reprime 6.1 vertical meters at the specified speed and impeller diameter. The pump must reprime and deliver full capacity within five (5) minutes after the pump is energized in the reprime condition.

.4 Certified reprimed performance test results, prepared by the Manufacturer, and certified by a registered Professional Engineer, shall be submitted for approval prior to shipment.

2.3 Configuration, Components and Features

.1 General:

.1 Self-priming, single-stage, centrifugal pumps. Driven by VFD as required for the Final Design.

.2 Design and proportion all parts of pump specially adapted for the service specified and capable of pumping unscreened raw wastewater, grit, plastics, grease and hair balls, without plugging.

.2 Casing:

.1 Ductile Iron Grade 80-55-06, resistant to abrasive action of solids or foreign matter contained in liquid.

.2 Provide ceramic lining of all wetted surfaces except impeller and wear plate.

.1 Cured Properties.

.2 Hardness:

.1 Hardners (Shore D): 85.

.2 Tensile Strength: 45 MPa.

.3 Centreline discharge.

.4 Back pull-out design.

.5 Suction and Discharge Connections:

.1 Flanges faced and drilled in accordance with 125 lb ANSI B16.1 (PN10).

.6 Provide casings for removal of rotating parts without disconnecting suction or discharge piping.

.7 Provide lifting devices on casings as required for ease of handling.

.8 Provide ribs or reinforcing if required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust, and to support the motor.

.9 Provide components with machined-registered concentric shoulder fits to ensure precision alignment.

.10 Fit high point of casing with an air vent and low point with a drain.

.11 Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 32 mm (1-1/4 inch) NPT and one (1) 6 mm (1/4 inch) NPT tapped hole with pipe plugs for mounting gauges or other equipment.

.3 Main Frame:

.1 ASTM A48 Class 30 Cast iron.

.2 Fit to casing with machine-faced joints.

.3 Main frame shall resist all stresses due to impeller thrust and bearing loads safely and without distortion.

.4 Pump main frame shall support shaft and impeller and contain stuffing box and bearings.

.4 Hand hole cleanout access cover:

.1 Provide a removable casing front cover for access to the impeller and mechanical seal.

.2 Provide a hand hole cover for access to the internal check valve.

.3 Covers shall be removable without and without disturbing the suction and discharge piping.

.4 Shape interior surface of covers to maintain contour of interior of casing so as to maintain efficiency and to prevent lodging of solids.

.1 Gaskets: Neoprene or Buna-N.

.2 Equip hand holes with covers designed for easy removal.

.3 Hardware: Type 316 stainless steel.

.5 Impeller:

.1 Type: semi-open solids handling.

.2 Material:

.1 Raw wastewater: ASTM A536 ductile Iron Impeller and AISI 1015 HRS wear plate.

.2 Grit slurry: Impeller and wear plate: ASTM A897 Grade 4 Austempered ductile iron with minimum 400 BHN.

.3 Statically and dynamically balance each impeller.

.4 Provide external adjustment of impeller face clearance.

.6 Shaft:

.1 ASTM A322-C4140 heat treated steel, accurately machined.

.2 Protect shaft from wear at stuffing box and from contact with pumped liquid by removable and replaceable sleeve.

.7 Sleeves:

.1 Extend sleeves through stuffing box.

.2 ASTM A743/A743M Grade CA-15 stainless steel 300 to 350 BHN.

.8 Bearings:

.1 Outboard bearing shall be combination thrust and radial type; inboard bearing radial type.

.2 Provide bearings in dust and moisture proof enclosures.

.3 Provide bearings with minimum L-10 life rating of 100,000 hours at specified operating conditions and 40,000 hours minimum at 25 percent of the BEP at highest speed, based on latest ABMA and ANSI Standards.

.4 Oil-lubricated with dedicated reservoir.

.5 Provide the bearing cavity with an oil-level sight gauge and fill-plug check valve.

.6 Provide a clear sight gauge for monitoring the bearing cavity oil level and condition of oil without removal of the fill plug check valve.

.7 Provide the check valve to vent the cavity but prevent introduction of moist air into the bearings.

.9 Mechanical seal:

.1 Cartridge oil-lubricated mechanical type.

.2 Stationary and rotating seal faces: Tungsten titanium carbide alloy.

.3 Provide each mating surface lapped to within three light bands flatness (889 Nm), as measured by an optical flat under monochromatic light.

.4 Stationary seal seat shall be double floating dual O-ring design. An external O-ring shall secure the stationary seat to the sealplate, and an internal O-ring shall hold the faces in alignment during periods of mechanical or hydraulic shock.

.5 Elastomers: FKM.

.6 Cage and spring: Type 316 stainless steel.

.7 Lubrication: Oil-lubricated from a dedicated reservoir:

.1 Provide the seal cavity with an oil level sight gauge, fill plug and vent plug.

.2 Provide a clear sight gauge to permit monitoring of the seal cavity oil level and condition of oil without removal of the fill or vent plug.

.10 Motor and drive unit:

.1 In addition to the requirements for bearings specified under Electric Motors in Section 16223, provide pump motors with ball or roller bearings. Provide vertical motors with at least one (1) bearing designed for thrust with bearings. Provide bearing with a minimum L-10 life of 100,000 hours.

2.4 Spare Parts

.1 Provide spare parts in accordance with Schedule 18.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory test: Factory tests to be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

.2 Balance the pump rotor to Balance Quality Grade G2.5 per Section 11020.

.3 Factory test the performance of each pump specified in this Section. Demonstrate performance throughout the specified range of operating conditions on each pump.

.4 Measure vibration at each test point during Factory Acceptance Test. Factory test pump for vibration as specified in Section 11020.

.5 Pressure test the pump casing to 150 percent of the pump shut off head at maximum speed.

END OF SECTION

LINE SHAFT CORROSIVE SERVICE CENTRIFUGAL PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of vertically-mounted, corrosive-media service pumps complete with motors, bearings, and discharge piping.

1.2 Standards

.1 ASTM:

.1 ASTM A276 – Specification for Stainless Steel Bars and Shapes.

.2 ASTM A48 – Gray Iron Castings.

.2 ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings.

1.3 Definitions

.1 BPO-DMA: benzoyl peroxide-dimethylaniline.

.2 FRP: fibreglass reinforced plastic, vinyl ester resin with BPO – DMA cure system.

.3 PPS: polyphenylene sulphide.

1.4 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Fybroc.

.2 Goulds.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Pumps shall be designed for wastewater.

.2 Design pumps to meet area classification in Section 01450.

.3 Design pumps for corrosion resistance for the product being pumped.

.4 Area exposure per Section 01450.

.5 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Fluid temperature.

.6 The pump design requirements for the following parameters shall conform to the Final Design:

.1 Capacity.

.2 Total differential pressure.

.3 NPSHA.

.4 Full speed efficiency.

.5 Inlet and discharge piping connection size.

.6 Speed.

.7 Maximum operating speed.

.7 The motor design requirements for the following parameters shall conform to the Final Design (see Section 16223):

.1 Horsepower.

.2 Speed.

.3 Motor enclosure.

.4 Space heater.

2.3 Materials

.1 Mounting plate casing, impeller, and inlet strainer: FRP.

.2 Column pipe assembly and discharge piping: FRP.

.3 Baseplate: FRP.

.4 Shaft: titanium.

.5 O-rings: FKM.

.6 Vapor seal: PTFE.

.7 Guide bearings: PTFE and carbon-filled PPS.

.8 Fasteners and anchor bolts: Hastelloy C or titanium.

2.4 Configuration, Components and Features

.1 Suitable for installation with the pump suspended from a baseplate, a tube that encloses the drive shaft and guide bearings, and discharge piping terminating above baseplate.

.2 Baseplate:

.1 Design each baseplate to span one-half of sump opening; one pair of baseplates shall cover the sump opening.

.3 Impeller:

.1 Balance impeller statically and dynamically to ensure accurate and permanent alignment.

.2 Fit impeller with an external adjusting device located above the baseplate.

.3 Provide inlet strainer.

.4 Place impeller to provide 300 mm minimum submergence (referenced to pump inlet) when strainer bottom is 150 mm above sump invert.

.4 Shaft: heavy duty, one-piece.

.5 Thrust Bearing:

.1 Provide heavy-duty, double-row, grease-lubricated, ball-thrust type bearing. Design to carry impeller thrust load throughout entire pump operating range.

.2 Place above baseplate and provide vapor seal.

.6 Guide Bearing:

.1 Suitable for flushing by an external water source; place below baseplate and discharge directly to drain.

.2 Shafts shall be properly aligned; 0.5 m maximum spacing.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each size of pumps:

.1 Two (2) complete thrust bearings.

.2 Two (2) guide bearings.

.3 One (1) complete set of o-rings

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory test: Factory tests to be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

CHEMICAL TRANSFER PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies supply and installation of chemical transfer pumps.

1.2 Standards

.1 ASTM A48 – Specification for Gray Iron Castings.

.2 ASTM A216 – Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

.3 ASTM A276 – Specification for Stainless Steel Bars and Shapes.

.4 ASTM A278 – Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Finish Thompson.

.2 Goulds.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Pump and motor rated for continuous duty.

.2 Design pumps to meet area classification in Section 01450.

.3 Design pumps for corrosion resistance to the fluid being conveyed.

.4 Design pumps for ease of maintenance and repair.

.5 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Fluid specific gravity.

.3 Fluid temperature.

.6 Operating Conditions:

.1 The pump operating conditions for the following parameters shall conform to the Final Design:

.1 Capacity.

.2 Total dynamic head.

.3 Operating speed.

.4 Maximum operating speed.

.2 The motor operating conditions for the following parameters shall conform to the Final Design (see Section 16223):

.1 Type.

.2 Enclosure.

.3 Horsepower.

.4 Space heater.

.3 General:

.1 Operating conditions as specified describe the range of operating requirements for each pumping system.

.2 Pump curves shall continuously rise towards the shut-off head.

.4 Rated Operating Capacity and Head:

.1 The condition upon which the pumping system has been designed.

.2 The pump to be selected such that the rated condition is to the right of the best efficiency point on the head capacity curve.

.3 Other specified operating points are estimates defined by the expected operating characteristics of the pumping system.

.4 These estimates describe conditions at which the pumping system may operate, such as maximum capacity, maximum head and minimum capacity.

.5 Total Dynamic Head:

.1 The sum of static head, friction losses, dynamic losses, and turbulence losses.

.2 Does not include inlet, discharge elbow, or internal losses.

.3 Maximum nameplate motor power applies to the entire range of specified pump operating conditions.

2.3 Materials

.1 Select materials most suitable for exposure to design operating conditions and process fluid characteristics.

.1 Casing: stainless steel, PVDF, or polypropylene.

.2 Impeller: stainless steel, PVDF, polypropylene Shaft: sintered silicon carbide.

.3 Bearings: silicon carbide.

.4 O-rings: FKM, EPDM, PTFE.

.5 Wear-ring: silicon carbide.

.6 Magnet assembly: neodymium iron boron.

2.4 Configuration, Components and Features

.1 Casing:

.1 One-piece construction with integral flat face flanges dimensioned according to ASME B16.5, Class 150.

.2 Provide double nuts for casing thru-bolts to allow for back pull-out without breaking fluid containment.

.3 Provide with plugged casing drain.

.2 Impeller:

.1 Statically balanced, enclosed type, with balance hubs and holes.

.2 Provide impeller with a replaceable inner magnet assembly.

.3 Provide with high-strength magnet of neodymium iron boron construction, completely encapsulated in a corrosion-resistant, non-metallic material.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each size of pumps:

.1 Two (2) complete sets of bearings.

.2 One (1) complete set of o-rings.

.3 Two (2) wear-rings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory test: Factory tests to be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

PROGRESSING CAVITY PUMP SEVERE DUTY

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of positive displacement progressing cavity (PC) pumps, complete with electric motors and all specified appurtenances, mounted on a common base plate.

.2 Pumps shall be self-priming, positive displacement, progressing cavity type specifically designed for pumping stabilized or unstabilized sludges generated from municipal wastewater where abrasive material may be present.

1.2 Standards

.1 ASTM A532, Abrasion Resistant Cast Iron.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified.

1.4 Service Conditions

.1 Fluid passing through the progressing cavity pump is expected to contain concentrations of dissolved H_2S gas, grease, scum, and grit.

.2 The allowable suspended solids concentration shall conform to the Final Design.

.3 The expected fluid temperature range shall conform to the Final Design.

2. PRODUCTS

2.1 Function

.1 Select and install pumps specifically for continuous or intermittent duty pumping of, and suitable for exposure to, concentrated solids derived from the treatment of municipal wastewater including primary, secondary and thickened primary, digester sludge or secondary sludge.

2.2 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Moyno.

.2 Seepex.

.3 Netzsch.

.4 Or approved equaivalent.

2.3 Performance Criteria

.1 Design pumps to meet area classification Section 01450.

.2 Design pumps for corrosion resistance to the fluid being conveyed.

.3 Design pumps for ease of maintenance and repair.

.4 The pumps have the following operating conditions:

.5 Condition A is the rated, continuous-duty operating condition.

.6 Condition B indicates operating conditions when the pump is operating against minimum anticipated pressure.

.7 Condition C indicates operating conditions when the pump is operating against maximum anticipated pressure.

.8 Condition D indicates operating conditions when the pump is operating at the maximum anticipated discharge flow rate.

.9 The operating characteristics for the following parameters shall conform to the Final Design for each operating condition:

.1 Rated pressure.

.2 Capacity at rated head.

.3 Maximum motor power.

.4 Inlet/outlet size.

.10 Maximum pump speed for all operating points shall be 120 RPM.

.11 Rated pressure in the above list is the algebraic difference between the total discharge pressure and total suction pressure.

.12 Supply PC pumps under this specification suitable for continuous operation.

.13 Provide all PC pumps from a single manufacturer.

2.4 Materials

.1 Casing: cast iron.

.2 Rotor: high-carbon, high-chrome tool steel, plated with minimum Brinnell hardness of 1250 or 1 percent aluminum nitriding steel, hardened in excess of Rockwell 70 C.

.3 Stator: Buna-N synthetic rubber with a Shore durometer hardness of 76, bonded to a steel tube.

.4 Pump body: cast iron.

.5 Shaft sleeve: stainless steel, type 420, Brinnell hardness of 450 minimum.

2.5 Equipment Components

.1 Rotor and stator:

.1 Minimum single-stage design employing a convoluted rotor operating in a similarly convoluted stator.

.2 Configure convolutions to form a cavity between the rotor and stator progressing from the pumps inlet to discharge port with the operation of the rotor.

.3 Fit the rotor and stator so that at the point of contact the stator material is sufficiently compressed to form a good seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

.2 Gear joint rotor drive train (Type 1):

.1 Drive the pump rotor through a connecting rod coupled to an input shaft.

.2 Joint shall be designed to transmit the maximum expected torque at the maximum speed at the maximum pressure rating of the pump.

.3 Couple the connecting rod to the rotor and input shaft through machined crowned gear type joints.

.4 Machine balls and sockets from chrome alloy tool steel, designed to withstand shock and thrust reversal.

.5 Protect each gear joint against the entrance of dirt, sludge, and other foreign objects by a sealed steel shell.

.6 Positively secure the gear joint to the connecting rod to prevent failure when the pump is in operation.

.7 Provide input shaft with bearings and housing.

.3 Casing:

.1 Provide pump casing of two-piece construction to allow vertical pull out of rotor. Provide with a cleanout opening on each side of the inlet fitting.

.2 Provide cleanout opening located immediately opposite the rotor-connecting rod joint to allow access for maintenance.

.3 Provide suction with a 12 mm tap to permit installation of a water lubrication system.

.4 Bearings:

.1 Provide grease-lubricated thrust and radial bearings designed for all loads imposed by the service.

.5 Motor and drive unit:

.1 Provide gear motors or gear reducers designed in accordance with AGMA 6019-E (Class II) or AGMA 6010-E (Service Factor 1.25).

.2 Provide the required reduction ratio to operate the pump at the maximum specified operating conditions at 100 percent motor speed.

.6 Mounting:

.1 Mount pump and motor along with associated drive appurtenances on a one-piece, fabricated steel base plate with full drip lip, grouting holes, drains, and other components as required for the Final Design.

.2 Grouting holes: a minimum of one (1) at the centre and one (1) at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.3 Bases shall have square corners in all three directions, with parallel surfaces.

.4 Provide motor mounting blocks so that one size greater motor frame may be accommodated by replacing the mounting blocks.

.7 Over-pressure protection:

.1 Provide each pump with a pressure sensor ring with a dual mounted gauge and single point pressure switch.

.2 Provide the pressure ranges for the switch and gauge.

.8 Run-dry protection:

.1 Provide the stator fitted with a sensor sleeve and thermistor sensor.

.2 Provide a controller to monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller.

.1 Manufacturer to provide temperature settings.

.3 Provide the controller with a manual local and remote reset function.

.9 Mechanical seal:

.1 Flushless mechanical seal system specifically designed to require no seal flush through the elimination of the stuffing box. The seal shall be made of AISI Type 316 stainless steel and shall be cartridge-type with FKM O-rings and tungsten or silicon carbide faces.

.2 The mechanical seal cartridge shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the seal faces together

shall be shielded from the fluid to be pumped. The cartridge shall include a 17-4PH, heat-treated seal sleeve and an ASTM A536 ductile iron seal gland.

.3 The mechanical seal faces shall be lubricated and cooled by a separate oil chamber. The area between the seal oil chamber and bearing oil chamber shall be vented and drained to prevent contamination of the bearings.

2.6 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 One (1) stator assembly.

.2 One (1) rotor.

.3 One (1) connecting rod.

.4 One (1) set connecting rod joint assemblies.

.5 Two (2) sets of mechanical seals.

.6 Two (2) sets of drive pins, washers, and retention screws.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

ANSI HORIZONTAL CORROSIVE SERVICE CENTRIFUGAL PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of ANSI horizontal end-suction frame-mounted centrifugal pumps for pumping aqueous corrosive solutions.

1.2 Standards

.1 ANSI/ASME B73.1 - Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

1.4 Definitions

.1 FRP: Fibreglass reinforced plastic.

.2 BPO-DMA: Benzoyl peroxide-dimethylaniline.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Fybroc.

.2 Goulds.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Design pumps to meet area classification Section 01450.

.2 Design pumps for ease of maintenance and repair.

.3 Design pumps for corrosion resistance to the fluid being conveyed.

.4 Area exposure per Section 01450.

.5 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Fluid temperature.

.6 Operating Conditions:

.1 The pump operating conditions for the following parameters shall conform to the Final Design:

.1 Capacity.

.2 Total dynamic head.

.3 NPSHA.

.4 Minimum operating speed efficiency.

.5 Minimum inlet and discharge piping connection size.

.6 Maximum operating speed.

.2 The electric motor operating conditions for the following parameters shall conform to the Final Design (see Section 16223):

.1 Horsepower.

.2 Operating duty.

.3 Motor enclosure.

.4 Space heater.

.3 General:

.1 Specified operating conditions describe the range of operating requirements for each pumping system.

.2 Pump curves continuously rise towards the shut-off head.

.4 Rated Operating Capacity and Head:

.1 The condition upon which the pumping system has been designed.

.2 Select pump such that the rated condition is to the right of the maximum efficiency point on the head capacity curve.

.3 Other specified operating points are estimates defined by the expected operating characteristics of the pumping system.

.4 These estimates describe conditions at which the pumping system may operate, such as maximum capacity, maximum head and minimum capacity.

.5 Total Dynamic Head:

.1 The summation of static head, friction losses, dynamic losses, and turbulence losses.

.2 Does not include pump inlet, discharge elbow, or internal losses.

.6 Maximum nameplate motor horsepower applies to the entire range of specified pump operating conditions.

2.3 Materials

.1 Casing: continuous-strand vinyl ester FRP with BPO-DMA cure.

.2 Back head: continuous-strand vinyl ester FRP with BPO-DMA cure.

.3 Shaft: stainless steel, ASTM A276, Type 303.

.4 Shaft sleeve: continuous-strand vinyl ester FRP with BPO-DMA cure.

.5 Baseplate: FRP or solid polymer concrete.

.6 Bearing frame: ductile iron, ASTM A395, or cast iron ASTM A48, Class 40.

.7 Impeller: continuous-strand vinyl ester FRP with BPO-DMA cure.

.8 Pump hardware: stainless steel, ASTM A276, Type 316.

2.4 Configuration, Components, and Features

.1 General:

.1 Horizontal end-suction, self-venting, top centreline discharge casing, designed in accordance with ANSI/ASME B73.1 Standards for chemical process pumps.

.2 Back pullout design.

.3 Conform to ANSI B73.1M standards for complete interchangeability.

.2 Casing and back head:

.1 Double-volute type casing with one-piece construction.

.2 Back head shall permit removal of the impeller, shaft, and bearings without disturbing piping connections.

.3 Integral flat-face flanges shall be dimensioned in accordance with ANSI/ASME B16.5, Class 150.

.4 Hold casing and back head together utilizing stainless steel through-bolts and sealed FKM O-rings.

.3 Impeller: integrally molded with shaft sleeve, semi-open, single-suction type, with pump-out vanes, statically and dynamically balanced.

.4 Shaft and Shaft Sleeve:

.1 High-strength Type 303 stainless steel sized to limit shaft deflection to 0.05 mm maximum at the seal faces.

.2 Sleeve shall be integral to pump impeller or replaceable with O-ring seals.

.5 Bearings:

.1 Provide grease-lubricated anti-friction bearings with sight glass.

.2 Bearing frame hardware shall Type 303 stainless steel.

.3 Cast-iron bearing frame epoxy-coated for corrosion protection.

.4 Include oil-fill port and sight glass.

.6 Baseplate: provide pump and motor mounted on a common base with a drain connection; provide drilled and tapped holes with stainless steel inserts.

.7 Flexible couplings: non-lubricated resilient material, heavy-duty type, sized for continuous operation at full load at maximum rotational speed when misalignment is within Manufacturer's tolerance limit.

.8 Mechanical seals. provide double mechanical seals in accordance with the following requirements:

.1 Dual cartridge.

.2 High-capacity barrier fluid ports.

.3 Self-centring, non-fretting.

.4 Springs isolated from the both process and barrier fluids.

.5 Pressure rating: 1724 kPa.

.6 Stationary face: silicon carbide.

.7 Metal parts: Type 316 stainless steel.

.8 Springs: Hastelloy C, or approved equivalent.

.9 O-rings: fluorocarbon.

.10 Acceptable product:

.1 Chesterton 255.

.2 Or approved equivalent.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of submersible axial flow pumps, motors, variable frequency motor controllers and appurtenances for pumping primary effluent.

.2 Pumping units shall consist of pump, electric motor, discharge tube, and variable speed drive.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Predicted variable speed pump performance curves showing total dynamic head, power, efficiency, and NPSH required plotted against capacity for the following, at a minimum:

.1 Average dry weather flow at max static head.

.2 Average dry weather flow at min static head.

.3 Maximum capacity of the secondary process at max static head.

.4 Maximum capacity of the secondary process at min static head.

.5 Minimum capacity of the secondary process at max static head.

.6 Minimum capacity of the secondary process at min static head.

.7 Minimum flow at min static head.

.8 Minimum flow at max static head.

All curves shall clearly display the specified operating conditions and the Manufacturer’s limits for the POR and AOR If the submittal does not include boundaries of the AOR and POR it will be rejected.

.3 Complete description and sketch of proposed test setup for factory test. Provide sample calculations and proposed test log format.

.4 Vibration and critical speed analysis in accordance with Section 11020.

.5 Test report summarizing certified factory test procedures and results, including not less than eight (8) test points documenting peak efficiency at full speed within a tolerance of minus 0 percent. Documentation providing detailed procedures/sequence of operation for conducting a cleaning cycle of the wet well. The details of this sequence shall be confirmed during commissioning.

1.3 Standards and References

.1 Products provided under this specification must comply with all regulations and codes in effect in Manitoba.

.2 Electrical work shall be in accordance with the Canadian Electrical Code and with applicable standards of the Electrical and EEMAC and the CSA.

.3 The pump/motor assembly shall have CSA approval as one unit, per CSA standard C22.2-108. Proof of this approval shall be submitted by the pump Manufacturer with the approval drawings. An approval of the motor unit only will not be acceptable.

.4 The pump/motor shall also be approved by CSA for service in Class1, Division II, Groups A, B, C, or D hazardous locations.

.5 ABMA:

.1 ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

.2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.6 ANSI/HI:

.1 ANSI/HI 1.1-1.5 – Centrifugal Pumps.

.2 ANSI/HI 9.1-9.5 – Pumps - General Guidelines.

.3 ANSI/HI 9.6.1 – Centrifugal and Vertical Pumps for NPSH Margin.

.4 ANSI/HI 9.6.3 - Centrifugal and Vertical Pumps Allowable Operating Region.

.5 ANSI/HI 9.6.4 - Centrifugal and Vertical Pumps, Vibration Measurements and Allowable Values.

.6 ANSI/HI 9.8 – Pump Intake Design.

.7 ANSI/HI 14.6 – Hydraulic Performance Acceptance Tests.

1.4 Performance Testing

.1 Certified witnessed performance tests shall be conducted in accordance with ANSI/HI 14.6. The test setup shall duplicate as closely as possible the inlet conditions in Design Builder's Design.

.2 A minimum of 10 test points shall be taken, including a minimum of four (4) within plus or minus 8 percent of individual pump flow at average dry weather flow, and a minimum of two (2) within plus or minus 4 percent of the pump's best efficiency point at test speed. Head and power requirements at shut off head shall be determined by one (1) test point.

.3 NPSH3 tests shall be performed using the method described in ANSI/HI 14.6. All NPSH3 tests shall extend from 30 to 140 percent of best efficiency flow at full speed, or to not less

than 10 percent in excess of the maximum capacity of the secondary process, whichever is greater.

.4 Any pump not included in the certified witnessed factory performance tests shall undergo non-witness factory certified performance tests.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The manufacturers' standard products may not comply.

.1 ABS/Sulzer.

.2 KSB.

.3 Xylem/Flygt.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Pumps shall be designed and tested in accordance with applicable portions of ANSI/HI 1.1-1.5, 9.1-9.6, and 14.6 and the requirements of this section and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

.2 All operating conditions listed in clause 1.3.1.3, above, shall lie within the Manufacturer's AOR, as defined under ANSI/HI 9.6.3.

.3 Guarantee performance at average dry weather flow and average annual flow in accordance with tolerances set forth in the test standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating is cause for rejection.

.4 Pumphead capacity curves shall have no points of reverse slope inflection within the specified operating range.

.5 NPSH required at any operating condition within the range specified shall be as per Design Builder's curves submitted in accordance with Item 1.3, with a tolerance of plus 0 percent, minus unlimited.

.6 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.7 Provide pumps which operate without cavitation; provide motor and pump combination which operates without excess vibration over the specified range of conditions in accordance with ANSI/HI 9.6.4.

.8 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve.

2.3 Components, Configuration and Features

.1 Pumps: Submersible axial flow pumps. Driven as required for the Final Design.

.2 Pump configuration: As required for the Final Design.

.3 Design and proportion all parts of pump specially adapted for the service specified in this Agreement.

.4 Each pump and discharge tube shall be designed and installed so that the pump and motor can be removed without disturbing the discharge tube or other equipment.

.5 Pumps shall be self-centreing in the discharge tube and self-sealing due to the pump and motor's own weight, allowing for leakage free operation.

.6 Install pump and discharge tube in strict accordance with the pump manufacturer's recommendations.

.7 Pump Casing:

.1 Pump diffuser casing and inlet nozzle of cast iron ASTM A48 Class 30 B.

.2 Motor casing, bearing housing, and bearing cover of cast iron ASTM A48 Class 40.

.3 Casing wear ring of stainless steel ASTM A276 Type 316 Ti.

.4 Provide lifting devices on pumps for handling.

.8 Lining:

.1 Acceptable Products:

.1 Belzona Supermetalglide.

.2 Devcon Brushable Ceramic Blue.

.3 Or approved equivalent.

.2 Type: Ceramic filled epoxy.

.3 Percent Solids by Volume: 100 percent.

.4 Provide two (2) coats 8 to 15 mils (200 to 380 microns) thick with total minimum DFT of 20 mils (500 microns).

.5 Cured Hardness: 90D in accordance with ASTM D2240.

.6 Surface preparation, mixing and application and safety requirements shall be in accordance with the lining Manufacturer's printed instructions and as specified.

.9 Impeller:

.1 Type: Axial propeller, open multi-vane.

.2 Provide pumps capable of passing a solid sphere size.

.1 Pumps capable of only passing a deformable sphere shall not be permitted.

.3 Key-seat and hold impeller to shaft by a streamlined bolt or locknut capable of holding in event of motor reversal under full torque.

.1 Impeller Fasteners: Type 416 stainless steel or Type 316Ti stainless steel.

.4 Statically and dynamically balance each impeller.

.5 Provide cast duplex stainless steel ASTM A890 Grade 1A, Type 25Cr-5Ni-Mo-Cu CD 4 MCu impellers for all pump services except as specified herein.

.10 Shafts and Shaft Seals:

.1 Provide shaft of ASTM A276 Type 420 stainless steel.

.2 Tandem double mechanical seal consisting of the following materials:

.1 Pump-side: Silicon carbide/Silicon carbide.

.2 Bearing-side: Carbon/Silicon Carbide.

.11 Motors:

.1 Max 900 RPM.

.2 Motors shall be IP68 rated, having insulation class H.

.3 Motors furnished with pumps intended for variable speed operation shall be inverter duty type.

.4 No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.5 The motor shall be capable of withstanding at least 10 evenly spaced starts per hour.

.12 Moisture and Temperature Probes:

.1 Provide two (2) moisture detection probes to detect moisture in the seal and stator cavity.

.2 Provide moisture detection panel and one piece cable from pump to panel.

.3 Provide PTC thermistors in winding to provide over temperature protection.

.4 Moisture detection to alarm, over-temperature to shut down pumps, indicate condition and alarm.

.5 Provide NEMA 4X Type 316L stainless steel panel with moisture detection system.

.13 Bearings:

.1 Provide a minimum of two (2) bearings permanently lubricated but capable of being re-greased.

.2 Provide a 100,000 hour L-10 life for pump bearings including for motors and shafts in accordance with ABMA 9 or 11.

.3 Provide RTD for thrust bearing.

.14 Provide a Type 316 lifting attachment capable of lifting the entire pump and motor assembly.

.15 Provide a motor resistance monitor.

2.4 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 For each pump size:

.1 Complete set of gaskets and O-rings.

.2 One (1) set of wearing rings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory Acceptance Testing

.1 Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

RECESSED IMPELLER PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of horizontally mounted, recessed impeller end suction centrifugal pumps.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

1.3 Standards and References

.1 Products provided under this specification must comply with all regulations and codes in effect in Manitoba.

.2 Electrical work shall be in accordance with the Canadian Electrical Code and with applicable standards of the Electrical and EEMAC and the CSA.

.3 The pump motor assembly shall have CSA approval as one (1) unit, per CSA standard C22.2-108. Proof of this approval shall be submitted by the pump Manufacturer with the approval drawings. An approval of the motor unit only will not be acceptable.

.4 The pump/motor shall also be approved by CSA for service in Class1, Division I, Groups C or D hazardous locations.

.5 ASTM A532, Abrasion Resistant Cast Iron.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The manufacturers' standard products may not comply:

.1 Wemco.

.2 Egger.

.3 Hayward Gordon.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Horizontal centrifugal recessed impeller pump designed to pass grit slurry, wastewater or wastewater sludge with solids content up to 80,000 mg/L and/or with a high fraction of debris.

.2 Pump head capacity curves shall have no points of reverse slope inflection within the specified operating range.

.3 Supply recessed impeller pumps suitable for continuous operation at full rated power.

.4 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.5 Provide pumps which operate without cavitation; provide motor and pump combination which operates without excess vibration over the specified range of conditions in accordance with ANSI/HI 9.6.4.

.6 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve. No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.7 The pump runout condition shall be defined as the flow produced at the runout head of the maximum AOR limit. The equipment shall be designed to operate at pump run-out without producing deficient vibrations, stresses, or other undesirable conditions.

.8 Design the pump casing, base supports and all other components to resist all forces on the pump casing and support due to static and dynamic hydraulic forces at both the suction and discharge connections of the pump. These forces include the unbalanced hydraulic force acting on the pump casing.

.9 Certify that recirculation has been considered in the design of the impeller and that the impeller has been designed to current design techniques that recognize and minimize all negative effects of recirculation.

.10 Provide impellers not greater than 90 percent of the maximum diameter impeller available for the model of pump and motor supplied.

.11 The fluid temperature is expected to range from 10 to 25°C.

2.3 Materials

.1 Casing: Ni-hard or hardened high-chrome iron, ASTM A532, with minimum Brinnell hardness of 600.

.2 Impeller: Ni-hard or hardened high-chrome iron, ASTM A352, with minimum Brinnell hardness of 600.

.3 Suction cover and wear plate: Ni-hard or hardened-high chrome iron, ASTM A532, with minimum Brinnell hardness of 600.

.4 Pump shaft: steel, ASTM A322 C4140.

.5 Pump shaft sleeves: stainless steel, ASTM A276, Type 416 or 420, Brinnell hardness of 450, minimum.

.6 Base plate: fabricated steel.

2.4 Configuration, Components and Features

.1 Impellers:

.1 Use heavy-duty recessed impellers of either the radial or cup-type design, mounted completely out of the flow path so that solids pumped shall not be required to pass through the impeller while traversing from the inlet to the outlet.

.2 Key the impeller to shaft and secure by a shrouded bolt and lockwasher or connect by babbiting to a tapered shaft and secure by an impeller bolt.

.3 Statically and dynamically balance impellers.

.2 Wear Elements:

.1 For pumps with radial vane impeller, provide a rear casing wear plate and integral tapered radial wear element. Minimum thickness of the radial wear element at the base shall be 30 mm.

.2 For pumps with cupped impeller, the suction cover is the primary wear element. Minimum thickness of the suction cover shall be 19 mm, thickened to at least 30 mm at critical wear areas.

.3 Casing:

.1 Provide casings with an end suction and that discharge vertically upwards.

.2 Use either three-piece construction with separate rear liner and suction pipe to allow front or back pull-out, or one-piece casing with integral suction and discharge nozzles plus a back plate with integral wear element.

.3 Make all internal clearances equal to or greater than the discharge diameter so that all material that can pass through the discharge can pass through the pump.

.4 Design the casing to be capable of passing a solid sphere as large as the discharge diameter.

.5 Minimum casing thickness shall be 19 mm. Pressure test casings at 1.5 times the pressure developed by the pump at shut-off head.

.6 Solidly foot-mount casings to allow each access to pump interior.

.7 Suction and discharge connections shall be flanged, faced, and drilled to conform to ASTM B16.5, Class 125.

.8 Provide the suction and discharge nozzles with 12.8 mm NPT tapped service connections. Service connections shall be fitted with forged Type 316 stainless steel plugs.

.4 Shafts:

.1 The shaft shall be of sufficient stiffness and diameter to rigidly support the impeller and to transmit loads without slip, damaging vibration, or deflection at operating loads. Where L = impeller overhang and D = shaft diameter, maintain $L^3/D^4<80$.

.5 Shaft Sealing:

.1 Provide split mechanical seals, and provide for seal or flush water connection from an external source. Refer to Section 11399.

.6 Mount each pump and drive on a common base.

.1 Provide planed surfaces of bearing pads for pumps and drives. Bases are to have square corners in three perpendicular directions, with parallel surfaces.

.2 Provide motor mounting blocks so that one size greater motor frame may be accommodated by replacing the mounting blocks.

2.5 Fabrications

.1 Cleanouts:

.1 Supply each pump with a hand-sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

2.6 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 One (1) split mechanical seal.

.2 One (1) set of wearing elements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests to be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

.2 Pressure test the pump casing to 150 percent of the pump shut-off head at maximum speed.

END OF SECTION

HORIZONTAL CENTRIFUGAL PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of horizontal constant-speed solids-handling end-suction frame-mounted, centrifugal pumps and motors.

.2 Provide pumps complete with electric motors, baseplate and all specified appurtenances.

.3 Provide pumps and electric motors designed for fixed-speed operation.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

1.3 Quality Assurance

.1 Provide materials and equipment that are new and of a quality equal or better to that specified. Mechanical and electrical equipment shall be the products of manufacturers of established good reputations regularly engaged in the fabrication of such equipment. Any equipment offered to have current modifications which have been in successful regular operation under comparable conditions for a period of at least three (3) years.

.2 The pump Manufacturer shall have at least 10 years of experience in designing and manufacturing shaft driven non-clog centrifugal pumps of similar size for this project.

.3 Demonstrate that Manufacturer has at least five (5) proven installations with pump of the similar size in North American installations.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers are:

.1 Flowserve.

.2 Ebara.

.3 Fairbanks.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Horizontal centrifugal pumps shall be designed for wastewater and solids conveyance.

.2 Design to meet area classification in Section 04150.

.3 The horizontal centrifugal pumps have the following operating conditions:

.1 Condition A is the rated, continuous-duty operating condition; guarantee performance at Condition A in accordance with tolerances set forth in the Test Standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating shall be cause for rejection.

.2 Condition B indicates operating conditions when the pump is operating against minimum anticipated system head, assuming a hypothetical head-capacity curve.

.3 Condition C indicates operating conditions when the pump is operating against maximum anticipated system head, assuming a hypothetical head-capacity curve.

.4 The operating characteristics of each operating condition for the following parameters shall conform to the Final Design:

.1 Rated head.

.2 Capacity at rated head.

.3 NPSHA.

.4 Pump speed.

.5 Minimum efficiency.

.6 Motor power.

.7 Inlet/outlet size.

.5 Total head in the above list is the algebraic difference between the total discharge head and total suction head as defined in the standards of the Hydraulic Institute; total head includes velocity head, but is exclusive of pump inlet and discharge headlosses.

.6 NPSHA in the above list is referenced to the project elevation and is calculated in accordance with Hydraulic Institute standards for the worst combination of fluid temperature and barometric pressure.

.4 Pumphead capacity curve to slope in one continuous curve with no point of reverse slope inflection.

.5 Design all pump components to safely withstand forces resulting from flow reversal up to 125 percent of maximum speed within the pump during shutdowns caused by power failure.

2.3 Materials

.1 Casing: cast iron, Class 30 with 2 to 3 percent nickel added.

.2 Wearing rings: stainless steel, Class C1144 or Grade 1045.

.3 Base: cast iron or steel.

.4 Impeller: Type 316 stainless steel.

.5 Shaft: stainless steel, Grade 303.

2.4 Equipment Components

.1 General:

.1 Provide cast iron pumps, Type 316 stainless steel fitted, end-suction, suitable for specified service.

.2 Operating parts shall be accessible without disturbing piping or motor connections.

.2 Casing:

.1 Construct pump casing of one-piece casting, single stage with integral suction and discharge nozzles.

.2 Provide tapped gauge openings on suction and discharge nozzles on flanged connection.

.3 Provide venting petcock at high point of volute.

.3 Wearing rings:

.1 Provide rear and front wearing ring for casing, attached by screwed fasteners.

.4 Base:

.1 Provide motor mounting blocks such that one size greater motor frame may be accommodated by replacing the mounting blocks.

.2 Provide jacking screws both at the motor and pump end to facilitate alignment.

.3 Mount pumps, along with associated drive appurtenances, on common fabricated steel channel type base with drip rim.

.5 Impeller:

.1 Statically and dynamically balance impellers.

.2 Provide enclosed, single-suction type impeller trimmed to meet specified conditions.

.3 Secure impeller to shaft with bolt and lockwasher.

.4 To accommodate higher capacities, provide pump with an impeller which is less than 85 percent of the volute cutwater diameter.

.6 Shaft:

.1 Pump shaft shall be suitably stress-relieved and turned to final dimensions.

.2 Calculate bearing loads based on the maximum hydraulic thrust encountered through the full operating range of the pump in the process fluid as well as any mechanical loading as applied by shaft weight.

.7 Bearings:

.1 Provide permanently lubricated ball bearing frame and bearing assembly which is completely removable without disturbing pipe connection or volute case.

.2 Bearing assembly shall be either of the following:

.1 Permanently lubricated and sealed rubber cushioned ball bearings to be Fafnir super quiet "O" series (or approved equivalent), mounted in heavy-duty gray iron frame.

.2 Bronze sleeve type bearings; oil lubricated with oil level indicator for motors up to 3.75 kW.

.8 Mechanical seal:

.1 Provide mechanical seals in accordance with Section 11300.

.9 Couplings:

.1 Provide flexible heavy-duty type couplings suitable for start-stop operation and to permit angular misalignment without transmitting backlash.

2.5 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 One (1) set of bearing assemblies.

.2 One (1) shaft sleeve.

.3 One (1) set of pump gaskets.

.4 One (1) set of mechanical seals.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory Acceptance Tests: Factory tests to be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

END OF SECTION

GEAR PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of horizontal, positive displacement gear pumps with a mating gear impeller as the driving mechanism.

1.2 Quality Assurances

.1 Manufacturer of pumps are to have a minimum of 10 operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Viking Pumps Inc.

.2 Roper.

.3 Or approved equivalent.

2.2 Materials

.1 Casing, head and idler: steel ASTM A216, Grade WCB.

.2 Bracket: cast iron, ASTM A48, Grade 35B.

.3 Rotor: cast iron, ASTM A48, Grade 35B or ductile Iron.

.4 Rotor shaft: steel, ASTM A108, Grade 1045, hardened steel.

.5 Idler pin: hardened steel, ASTM A108. Grade 1045.

.6 Idler bushings: carbon graphite.

.7 Canister: Type 316L stainless steel.

.8 Canister bushings: carbon graphite.

.9 Adapter plate: steel ASTM A216, Grade WCB.

.10 Adapter bushing: carbon graphite.

.11 O-rings:

.1 Kalrez.

.2 Or approved equivalent.

.12 Coupling magnets: neodymium iron boron.

2.3 Performance Criteria

.1 Gear pumps shall be designed for positive displacement requirements.

.2 Design to meet area classification in Section 01450.

.3 The operating characteristics for the following parameters shall conform to the Final Design:

.1 Capacity at rated head.

.2 Rated head.

.3 Pump speed.

.4 Minimum motor power.

2.4 Components, Configuration and Features

.1 Provide all equipment designed and built for twenty-four (24) hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and within vibration standards.

.2 Provide pumps designed to remain primed after extended shutdown periods.

.3 Design and proportion all parts of pump specially adapted for the service specified.

.4 Provide housings designed for removal of rotating parts without disconnecting suction and/or discharge piping.

.5 Provide all lubrication fittings brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

.6 Pump: rotary positive displacement gear pumps, internal gear-within-a-gear type.

.1 Provide all gear teeth cut to maintain a uniform seal across the full-face width.

.2 Provide pumps with peripheral end clearances kept to a minimum to reduce slip.

.3 Provide face width of rotors for specified capacity requirements.

.4 Provide pumps with ground and polished steel shaft supported by two (2) horizontal sleeve bearings designed to circulate the pumped fluid.

.5 Provide pumps magnetically driven and use no mechanical seals or packing of any type.

.6 Provide the internals of the pump serviceable without disturbing piping connections, and without the need for any special tools.

.7 Provide pumps driven by magnetic force transmitted through the containment shell from a driving magnet supported by bearings.

.8 Encapsulated the inner driving magnet in a laser welded stainless steel canister in a one (1) piece design with the inner pump shaft.

.9 Provide pumps to allow single point adjustable end clearance to allow for pump adjustments to maximize efficiency over different viscosities.

.10 Provide magnetic drive and driver (motor) designed and sized to cover the range of head, capacity and specific gravity of fluid as specified and indicated without overloading or decoupling during acceleration when pumping the product specified.

.11 Provide a temperature sensor and switch to protect the magnetic bearings from damaged due to temperature build up in the pumped fluid at low or no flow.

.12 Sensor: 100-ohm platinum four-wire RTD type with a thermowell to provide signal to temperature switch with indication.

.13 Provide pumps with an externally adjustable relief valve that can be adjusted while the pumps are in operation.

.14 Provide pumps dimensionally interchangeable in every critical dimension (includes connection locations, mounting feet, input shaft size and location), with mechanically sealed versions of the pumps, should a later conversion be required. Pumps that are not available with dimensionally interchangeable seal-less and sealed designs are not permitted.

.7 Pressure relief valve: Provide pumps with a built-in pressure relief valve and associated piping that relieves pressures at a set point above the rupture pin valve set pressure but below the pressure rating of motor selected for the pump.

.1 Provide the relief valve and connecting piping with full capacity of the pump.

.2 Provide external rupture pin type valve for each pump as specified in Section 15100.

2.5 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

ROTARY SCREW COMPRESSORS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of rotary screw compressors.

1.1 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Ingersoll Rand.

.2 Atlas Copco.

.3 Compare (Gardner Denver Group).

.4 Kaiser.

.5 Or approved equivalent.

2.2 Performance Criteria

.1 Rotary screen compressor to be designed to provide the required compressed air pressure and flow rate.

.2 Compressor to meet area classification requirements in schedule 01450.

.3 The minimum compressed air flow output shall conform to the Final Design.

.4 Conditions:

.1 Elevation above sea level: 230 m.

.2 The minimum ambient dry bulb temperature, maximum ambient dry bulb temperature, and maximum ambient dew point temperature shall conform to the Final Design.

.5 Performance shall be as required for the Final Design and in accordance with the following requirements:

.1 Net compressed air output to include all seal losses. Seal losses shall be considered internal and not included in the net output. Net compressed air output shall be plus or minus 2 percent of output indicated in the Final Design.

.2 Output pressure indicated shall be immediately downstream of aftercooler and shall be minus 0 plus 4 percent of the pressure indicated in the Final Design.

.3 Output air maximum temperature downstream of aftercooler: 38°C.

.4 Inlet air filtration efficiency: 99.9 percent of 0.5 micron size.

.5 Cooling water inlet temperature shall conform to the Final Design.

.6 Total cooling water flow rate shall conform to the Final Design.

.7 Maximum cooling water pressure drop through the compressor and any intercooler, aftercooler, or oil cooler shall conform to the Final Design.

.8 Unloaded compressor power (maximum) shall conform to the Final Design.

.9 Maximum sound levels 1 m horizontally from compressor and 1.5 m above floor as measured per ISO 2151 Test Code for the Measurement of Sound from Pneumatic Equipment: 80 dBA.

.10 Additional performance requirements:

.1 Critical Speeds: Actual critical speeds shall not encroach upon operating speed ranges at specified loads ranges. Rotors shall be stiff shaft construction with the first actual rotor bending critical speed at least 120 percent of the maximum operating speed.

.2 Vibration and Balance: Major parts of rotating elements, such as rotors, gears, and similar items shall be individually dynamically balanced. During the factory and site tests of the assembled machine at operating speed, the double amplitude of vibration in any plane measured on the shaft adjacent and relative to a radial bearing shall not exceed the limits of API Standard 619, paragraph 5. For shafts which are not accessible, the Manufacturer is to submit a testing procedure for the City Representative's review.

2.3 Components, Configuration and Features

.1 The air compressor shall be packaged, positive displacement rotary screw compressors. Include air compressor, electric motor driver, coolers, lubrication system, and regulation and control systems mounted on a common base frame, and completely enclosed for noise control.

.2 Compressor Design Features: The compressor shall be a single-stage oil-free rotary screw compressor, flanged to an integral speed increaser. Silencers, lubricating system, cooling system, control system, and driver shall be mounted as part of the package. Provide a common base frame for the compressor system and driver. Provide a sound enclosure over the compressor and driver. Equipment shall be designed for economical and rapid maintenance. Casing components, bearing housings, and other major parts shall be

shouldered, dowelled, or designed with other provisions to facilitate accurate alignment or reassembly. Shaft seals and bearings shall be accessible for inspection or replacement with a minimum of disassembly.

.3 Compressor Casings: Casings shall be cast iron, ductile iron, cast steel, or fabricated steel. Casing stresses shall be within the limits allowed by ASME BPVC SEC VIII D1. Casings, supports, and baseplates shall be designed and fabricated to preclude excessive and injurious distortion from temperatures, pressures, and forces encountered in service conditions. Provide jackscrews, lifting lugs, eyebolts, guide dowels, and casing alignment dowels to facilitate disassembly and reassembly. When using jackscrews for parting contacting faces, relieve one of the faces by counterboring or recessing to prevent marring the face, which result in leaking or improper fit. Provide lifting lugs or eyebolts for removable portions of the casings. Flanged casing connections for external piping is to conform to ASME B16.1 or ASME B16.5. Threaded connections for external piping is to conform to ASME B1.20.1. Air compression portion of the casing shall be one-piece and provided with integral coolant passages and a large inlet port. Gear cases shall be enclosed, accessible, force lubricated, and designed with seals and slingers to keep oil out of air system.

.4 Shafts: Shafts shall be of forged or rolled alloy steel and is to have a machined finish throughout their entire length. All rotating components shall be positively secured to shafts by acceptable mechanical means or interference shrink fits.

.5 Rotors: Rotors shall be high efficiency, steel, and of one-piece construction, with an asymmetric profile to minimize leakage losses. Rotors shall be treated for corrosion resistance. If rotors are welded to the shaft, the assembly shall be stress-relieved and heat-treated for proper strength. Rotors shall be dynamically balanced for vibration-free operation.

.6 Gears: Gears shall be of alloy steel, ANSI/AGMA 2009 and ANSI/AGMA 2011 Quality Number 12 or better for both bull and pinion gears. Gears shall be hardened to 275 Brinell for bull gear and 320 Brinell for pinion. Gears shall be ground to the required contours, checked for proper contact during assembly at the factory, and shall not require a break-in period in the field for proper operation. All gears shall be pressure lubricated. Timing gears shall be provided on the rotor shafts to maintain the rotors in correct relative position. The compressor design shall allow the timing gears to absorb no more than 10 percent of the total input power at full load.

.7 Seals: Separate air and oil shaft seals shall be provided to confine air in the casing and prevent contamination of the air stream by lubricating oil. Shaft seals shall be the restrictive ring type. The seal rings shall be stainless steel, brass, or carbon, and retainers shall be made of stainless steel. Provide an air space vented to the atmosphere between the air and oil seals. Seals shall be suitable for all operating conditions including suction throttling, start-up, and shutdown.

.8 Thrust bearings: Thrust bearings shall be anti-friction ball or roller type or hydrodynamic (fluid film) type. Anti-friction bearings to have an L-10 life of 80,000 hours in accordance with ABMA 9 or ABMA 11. Axial rotor thrusts due to air compression shall be absorbed by main thrust bearings or transferred to auxiliary thrust bearings by a load balancing arrangement. Hydrodynamic thrust bearings shall be Kingsbury type or other acceptable type and adequate to withstand all operating conditions. Speed increaser bull gear thrust bearings shall be sized for equal thrust in both directions and adequate for any axial loads transmitted through the driver coupling.

.9 Radial bearings: Radial bearings shall be anti-friction roller or ball type or hydrodynamic type. Anti-friction bearings to have an L-10 life of 40,000 hours in accordance with ABMA 9 or ABMA 11. Hydrodynamic bearings shall be precision-bored sleeve or pad type, designed for easy replacement by a split design or axially removable arrangement. High-speed hydrodynamic pinion bearings shall be anti-oil whip, tilting pad type. Hydrodynamic bearing design shall provide low vibration and sufficient damping at rated speed and all operating modes, including rated capacity and unloading down to 20 percent of unloaded power.

.10 Speed Increaser: The speed increaser shall be an integral part of the compressor unit and to include the main drive shaft and bull gear. The main drive shaft shall be supported through anti-friction bearings.

.11 Lubrication system: Include an integral sump, positive displacement pump, oil cooler, and twin filter\strainer (readily replaceable cartridges while operating). Provide a prelube lubrication oil pump for start-up and standby for hydrodynamic bearings or if required by the compressor design. System shall be factory assembled and tested. Lubricating oil shall conform to recommendations of the compressor manufacturer. Spray lubricate drive gear, anti-friction bearings, and timing gear in each stage. Pressure lubricate hydrodynamic bearings. Provide the oil sump with a level indicator and drain and fill connections.

.1 Prelubrication pump, if required, or motor-driven main lubrication pump shall be sized by air compressor Manufacturer for the requirements of the system, but meet the following requirements.

.1 Pump shall be positive-displacement gear pump in accordance with Section 11361 separately mounted with motor on a common base plate with drip lip and drain.

.2 Performance: Pump shall have separate safety valve bypass set at 172 kPa above peak expected pressure.

.3 Materials shall be hardened steel gears and shaft, cast iron case, bronze bearings, mechanical seal.

.4 Flexible coupling with shaft guard shall be provided, except that these items are not required for a close-coupled pump.

.5 Motor shall be NEMA MG 1, Design A or B, Class B insulation, of open drip-proof type. Furnish combination type starter for motor.

.12 Electric Motors:

.1 Main electric drive motor: The main drive motor for each compressor shall be a synchronous motor, having the capacity required for the Final Design, with a continuous service factor of 1.0. Size the motor so that the nameplate power rating is not exceeded under the entire range of operating conditions specified. Efficiency and losses shall be determined in accordance with IEEE 112. Unless otherwise specified, horizontal polyphase squirrel cage motors rated 0.75 to 93 kW shall be tested by dynamometer Method B as described in Section 6.4 of IEEE 112. Motor efficiency shall be calculated using Form B of IEEE 112 calculation procedures. Polyphase motors larger than 93 kW shall be tested in accordance with IEEE 112 with stray load loss determined by direct measurement or indirect measurement (test loss minus conventional loss). The efficiency shall be identified on the motor nameplate by the caption "NEMA Nominal

efficiency" or variation thereof. Electrical service shall be as required for the Final Design. Motor shall be designed for reduced voltage starting at 50 percent of full voltage, allowing for characteristics of the connected load, and shall start without undervoltage tripping. Provide RTDs shall be attached to or imbedded in motor winding for control system. The motor shall meet the requirements of NEMA MG 1 with Class F insulation. Provide space heaters for protection of windings during motor shutdowns.

.2 Accessory and Related Equipment Motors: Motors less than 0.375 kW shall be single-phase induction motors and is to conform to NEMA MG 1. Motors 0.375 to 3.75 kW shall be three-phase induction motors and is to conform to NEMA MG 1. Single-phase and three-phase motors shall have bimetallic disk thermostats attached to or embedded in the motor winding. Motors shall have NEMA MG 1 Class B insulation.

.13 Control Panel: Control unit panel shall conform to NEMA ICS 6, floor- or frame-mounted, factory designed, and assembled, and provided complete. The panel shall be fabricated of formed stretcher-leveled sheet steel, reinforced, and assembled into a rigid unit. Gasketed access doors shall be provided as required. Panel shall be factory finish painted. The panel shall meet NEMA 4X requirements.

.1 Panel shall contain electric and safety control work required, including either alarm annunciator or individual labeled pilot lights arranged in a group. Panel shall contain alarm device with light and silencing. Generalized arrangement shall be in accordance with the Final Design requirements.

.2 Panel shall include start and stop buttons (the stop button shall have a lockout), discharge air pressure gauge, control test switch and lights, reset button, running light, and control selector switch.

.3 Oil pressure gauges shall mounted separately from panel.

.4 Provide monitoring and alarm points to communicate with the automation system.

.14 Accessories:

.1 Control valves: Pneumatically- or hydraulically-controlled valves on inlet of compressor and on bypass or vent line.

.2 Intake Devices:

.1 Galvanized steel or aluminum alloy, minimum 20 gauge.

.2 Intake pipe, ASTM A36/A36M steel, galvanized, 12 gauge or Schedule 5 minimum, from intake weather hood to filter housing flange, welded construction.

.3 Filter housing by filter manufacturer shall include filter frames, access door(s). Material for housing shall be 1.65 mm thick, Class 5000 aluminum alloy. Unit shall be rigid and free from distress with all seams sealed.

.4 Intake pipe from filter enclosure to compressor: Aluminum alloy ASTM B 209M ASTM B 209, Alclad alloy 5052-H32, minimum 10 gauge, flanged, welded with 5XXX welding rod using TIG method and including expansion bellows.

.3 Outlet connectors: Compressor air outlet flexible connection of stainless steel bellows with braided steel cover jacket, with stainless steel liner sleeve, 457 mm nominal length bellows, flanged ends, Class 150. If air bypass connects separately to the compressor from the outlet line, provide a second flexible connection of stainless steel bellows with braided jacket for the bypass.

.15 Inlet air filters: Provide a three-stage filter system, complete with mounting racks (horizontal flow), interstage seals, and replaceable filters. Filter unit shall be complete including enclosure or housing, and frames. Enclosure shall be Class 5000 aluminum alloy with inlet and outlet flanges. Construction shall be welded or, where welding is not practical, close-riveted and caulked, weathertight, with access doors for filter replacement and cleaning. Access doors shall be reinforced, fully gasketed with continuous flexible neoprene gaskets, corrosion-resistant continuous hinges and quarter-turn latches, and air-tight. All internal ferrous surfaces, including galvanized, shall be factory-coated with epoxy prime and finish coat for corrosion resistance. Filters shall consist of three separate stages and sized to fit the available space.

.1 First stage filter shall be flat, 51 mm thickness, replaceable media, and rated for the specified air volume at 2.54 m/s nominal face velocity, friction clean 62 Pa gauge, efficiency 98 percent of 15 microns and 90 percent of 5 microns.

.2 Second stage filter shall be deep-pleated type, 229 mm nominal depth and rated for the specified air volume at 1.78 m/s nominal face velocity, friction clean 50 Pa water gauge, efficiency 98 percent of 5 microns and 90 percent of 3 microns.

.3 Third stage filter shall be deep-pleated type 305 mm minimum depth and rated for the specified air volume at 1.78 m/s nominal face velocity, friction clean 75 Pa water gauge, efficiency 99.9 percent of 0.5 micron.

.4 Filter media shall be rated and listed UL Class 2. Filter efficiencies shall be based on National Bureau of Standards (NBS) type discoloration gravimetric test method using atmospheric dust.

.16 A bypass or vent line silencer shall be furnished with each compressor as selected by compressor manufacturer for sufficient noise attenuation to meet OSHA sound level criteria, but not greater than 84 dBA measured at adiatances of 1.5 m above and 3.0 m horizontally from the silencer.

.17 Sound-reducing enclosure: The compressor package, including the driver motor, shall be contained within a noise-reducing enclosure. The enclosure shall limit noise transmission to 80 dBA or less at a distance of 1 m from the compressor in any direction.

.18 Enclosure frame: The enclosure frame shall be designed to support the weight of the sound suppression panels and easily removable. Connections to the base frame shall allow the enclosure frame to be detached and lifted away without damage to the connections, enclosure frame or base frame, and to allow access to and replacement of any component.

.19 Panels: The panels shall be rigid to allow repeated access without damage or distortion. Sound-absorbing material shall be mineral fibre, treated to preclude shedding of fibres. Other acceptable insulation may be used, with the exception of polyurethane foam. Top panels shall be secured to the enclosure frame with quick disconnect fittings and fabricated to allow removal by hand. End-and side-panels shall be hinged or lift out with positive

closure latches. Panels shall be designed to provide the largest possible access area when opened. Provide acoustic seals as required. Controls and instrumentation mounted on the panels shall have flexible connections for panel opening and disconnects for enclosure removal. Disconnects shall be male-female plug type. Split panels around all piping connections to allow enclosure removal without detaching piping. Controls shall be visible and operable from outside the enclosure.

.20 Ventilation: fan(s) and sound-baffled ventilation grilles shall be provided as part of the enclosure. Ventilation shall be sufficient to limit interior temperature to that required for cooling the motor.

.21 Isolating pad: If specifically recommended by the compressor manufacturer, each compressor steel or iron base frame shall be mounted on a neoprene waffle-or rib-type isolator pad extending uniformly and continuously along the base mounting surface. The neoprene shall be of bridge-bearing pad quality and formulated for 40 durometer hardness. The maximum bearing pressure on the isolating pad shall be 345 kPa.

.22 Compressor controls: Provide a complete load regulation and control system with the compressor. Provide additional electrical, electro-pneumatic, or solid state electronic controls for other specified control and monitor functions. All electrical controls shall conform to NEMA ICS 2 as selected by the compressor manufacturer. Control system enclosure shall conform to NEMA ICS 6. Controls shall be suitable for individual operation of the compressor or parallel operation of multiple compressors.

.1 Compressor start-up: The compressor shall start unloaded. The manual starting circuit for the compressor shall have interlocks to prevent the compressor drive motor from starting until pre-lubrication pump (if provided), oil pressure, and cooling water pump water flow have been established to the required levels for safe operation as determined by the compressor manufacturer.

.2 Load regulation: The compressor shall operate continuously at constant speed after being started. Provide means to load and unload the compressor automatically at preset minimum and maximum pressure settings. Minimum pressure and maximum pressure shall conform to the Final Design. Unloading shall be by a combination of closing the inlet valve and bypassing or venting the outlet of the compressor; however, input power at fully-unloaded operation shall not exceed 20 percent of full load input. Bypassed air shall be cooled by the bypass cooler and if returned to the inlet of the first stage through an internal loop and limited to the minimum flow required to maintain compressor cooling. Air vented to the atmosphere when unloading does not need to be cooled.

.3 Monitor and safety controls: Provide supplementary electric, electro-pneumatic, or solid state electronic controls to provide alarm and shutdown requirements, plus interlocks with accessories. Requirements are as follows:

.1 Shutdown requirements shall cause the controlled compressor to shut down, energize alarms, and light labeled red lights.

.2 Alarm only requirements shall sound the same alarms and light labeled amber lights but not cause the controlled compressor to shut down.

.3 Light only requirements shall light labeled amber lights but not cause the controlled compressor to shut down.

.4 The individual monitor and safety controls shall be as shown in the following table.

Condition	Shutdown	Light & Alarm	Light
High discharge air temperature 135°C	Yes	Yes	-
High intercooler discharge water temperature, each intercooler	No	Yes	-
High aftercooler discharge water temperature	No	Yes	-
High cooling water supply temperature	No	Yes	-
High lube oil temperature	Yes	Yes	-
Low lube oil pressure	Yes	Yes	-
Low cooling water flow	No	Yes	-
Low oil reservoir level	No	Yes	-
High condensate level intercoolers (wired to one light)	No	No	Yes
High bleed-off air pressure	Yes	Yes	-
High motor stator temperature	Yes	Yes	-
High condensate level aftercooler	No	No	Yes
High inlet pressure drop across inlet air filters (combined, 3 stage)	No	Yes	-
High CO	Yes	Yes	-

.5 Oil cooler outlet temperature gauges for oil.

.6 Oil cooler inlet temperature gauges for water.

.7 Lubrication oil bearing supply pressure gauge.

.8 Compressor seal air pressure gauge (if applicable).

.9 Inlet air filter differential pressure gauge. Provide selector valve, tubing, and tap to measure static gauge pressure downstream of each filter stage.

.10 Total running time readout.

.11 Cooling water supply to compressor pressure gauge.

.12 Cooling water return from compressor pressure gauge.

.13 Interstage air pressure gauges for each interstage.

.14 Compressed air pressure downstream of aftercooler pressure gauge.

.15 Compressed air temperature downstream of aftercooler temperature gauge.

.16 Compressed air temperature at discharge of each stage of compression before cooling temperature gauges.

.17 Interstage air temperature after intercooler of each stage temperature gauges.

.18 Compressor inlet air temperature gauge.

.19 Cooling water to compressor temperature gauge.

.20 Cooling water outlet temperature at each outlet of each intercooler, aftercooler, and bypass air cooler temperature gauges.

2.4 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following:

.1 Two (2) thrust bearings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on compressor and motor assembly to verify equipment performance through complete operating range. Submit copies of all shop test data and interpreted results.

.4 Noise survey to confirm sound rating of equipment enclosure.

END OF SECTION

DIAPHRAGM CHEMICAL METERING PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of hydraulic diaphragm metering pumps with motors and drives, with associated relief valves, regulating valves, pulsation dampeners, and calibration columns.

1.2 Standards

.1 CSA C747 – Energy Efficiency Test Methods for Small Motors.

.2 IEEE:

.1 IEEE 114 – Standard Test Procedures for Single-Phase Induction Motors.

.2 IEEE 519 – IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power systems.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Pump performance data including curves showing flow rate verses pump stroke setting in percent at specified maximum and minimum pump speeds in strokes per minute.

.3 Pump data sheet confirming pump capacity and pressure, minimum pressure regulating valve setting, pumped chemical characteristics, pipe connection sizes, stroke rate, materials, testing requirements, and hydraulic fluid type.

.4 Pulsation dampener, regulating valve, relief valve, and calibration column data sheets.

.5 Material Certification:

.1 Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions in the Final Design including an installation list of a minimum of 10 installations in operation for a minimum of five (5) years.

.2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions in the Final Design.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Pulsar.

.2 Hayward Gorden.

.3 Prominent.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Provide diaphragm chemical metering pumps designed for the required flow, fluid characteristics, and pressure and equipment classification according to Section 04150.

.2 Area exposure per Section 01450.

.3 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid temperature.

.2 Fluid type.

.4 The performance requirements for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Maximum capacity.

.3 Maximum discharge pressure.

.4 Horsepower.

.5 Turndown.

2.3 Materials

.1 Select pump materials suitable for the chemical service.

2.4 Configuration, Components and Features

.1 Positive displacement, self-compensating, hydraulically-actuated diaphragm pump, with internal automatic pressure relief valve.

.2 Drive Mechanism:

.1 Helical gear drives with a simplex head arrangement capable of specified turndown on speed only. Conventional worm gear drives are not permitted.

.2 Provide a high efficiency helical or bevel spur gear using a scotch yoke design capable of operating at low speed.

.3 Use a maximum stroke length operation to achieve a full forward scavenging design of the displacement chamber head on each stroke cycle and to minimize/prevent vapor lock condition during intermittent operation of metering pump service on gas bearing fluids.

.3 Diaphragm: flat disk style with internal O-ring seal.

.4 Bearings: tapered roller or needle type. Mount bearings and internal working parts in weather-resistant gear box with oil-flooded moving parts.

.5 Prevent leakage through hydraulically-actuated balanced diaphragm design.

.6 Provide adjustable, spring-loaded internal pressure relief valve to protect pump against excessive hydraulic pressure.

.7 Provide SHS pumps specifically designed for use with sodium hypochlorite.

.8 Power supply: 120 VAC, 1-phase, 60 Hz.

.9 Manufacturer shall provide motor and motor controller.

2.5 Valves

.1 Pressure regulating valve: backpressure sustaining diaphragm valve, externally adjustable between 0 and 1000 kPa; match pipe diameter specified in the Final Design.

.2 Pressure Safety Valve: diaphragm valve, externally adjustable between 0 and 1000 kPa; match pipe diameter specified in the Final Design.

2.6 Pulsation Damper

.1 Provide one (1) pulsation dampener per pump.

.2 Single-diaphragm type for pneumatic-hydraulic pulsation dampening. Size for maximum stroke volume. Provide air charging valve and pressure gauge.

2.7 Calibration Column

.1 Provide one (1) calibration column per pump or pump skid.

.2 Size for minimum 30 second draw-down time at maximum pump capacity.

.3 Graduated in mL.

2.8 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 One (1) spare pump, complete with motor and motor controller.

.2 Two (2) complete spare diaphragm heads.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpreted results.

END OF SECTION

PERISTALTIC PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of peristaltic metering pumps and appurtenances.

1.2 Quality Assurances

.1 Manufacturer of pumps to have a minimum of 10 operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Watson-Marlow.

.2 Hayward Gordon.

.3 Blue-White Industries.

.4 Or approved equivalent.

2.2 Materials

.1 Material selection shall be confirmed for designated service.

.2 Provide pump that is chemically compatible with all expected commodities that may come into contact with the pump.

.1 Housing: cast iron, ASTM A48 Class 35.

.2 Cover: carbon steel, ASTM A570 GR36.

.3 Hose: Reinforced Nylon.

.4 Shaft: alloy steel ASTM A322/4140, minimum.

.5 Rotor: cast iron, ASTM A48 Class 40.

2.3 Performance Criteria

.1 Provide peristaltic pumps for the appropriate flow, pressure, fluid characteristics and equipment classification according to Section 01450.

.2 Area exposure per Section 01450.

.3 The service conditions for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Fluid temperature.

.4 The performance requirements for the following parameters shall conform to the Final Design:

.1 Fluid type.

.2 Maximum capacity.

.3 Maximum discharge pressure.

.4 Power.

.5 Turndown.

2.4 Components, Configuration and Features

.1 Provide systems constructed of components which are compatible and suitable for intended service.

.2 Peristaltic metering pumps (maximum pressure 207 kPa (30 psi)):

.1 Pumps shall be positive displacement peristaltic type complete with spring-loaded pumphead, self-contained variable speed drive, and flexible extruded tube.

.2 Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and to have a maximum suction lift capability of up to 9 m vertical water column. Maximum pressure rating: 207 kPa (30 psi). Pump is not to use check valves or diaphragms and is not to require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and not directly contact any rotary or metallic components.

.3 Pumphead to consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism. At all times, one (1) roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Provide high corrosion-resistant and high-impact resistant materials as specified.

.1 Track construction: PPS (or approved equivalent).

.2 Guard construction: hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.

.3 Rotor construction: PPS (or approved equivalent).

.4 Tube retainer mechanism: Provide a two spring–loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pumphead.

.5 Rotor assembly: compressing rollers shall be 316 stainless steel with low friction stainless steel bearings and PTFE seals. Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading.

.6 Pumpheads requiring disassembly or special tools for tube changing shall not be permitted.

.7 Pumphead shall accept tubing sizes 1.6 mm, 3.2 mm, 4.8 mm, 6.4 mm, 8.0 mm and 9.6 mm with 2.4 mm wall thickness, made of materials including Marprene, Bioprene, Silicone, Sta-Pure & Chem-Sure (or approved equivalent). Pumps shall not require tools for adjustment or changing pumpheads to accept different tubing materials or sizes.

.8 Pump tubing shall be constructed of Marprene II (or approved equivalent), a thermoplastic elastomer with 64 Shore A durometer and minimum 2.4 mm wall thickness. If required for chemical compatibility, pump manufacturer shall recommend an alternate tubing material.

.9 Drive rating: Continuous twenty-four (24) hour operation, 40°C ambient.

.10 Power supply: 110-120 V, 50/60 Hz, single phase. Supply 2.7 m minimum length power cord with standard 115 V three-prong plug. Maximum drive power consumption: 135 VA.

.11 Housing: enclosure: NEMA 4X. Unpainted housings, including Type 316 stainless steel shall not be permitted.

.12 Pumps shall meet the following minimum requirements for operator interface functionality:

.1 Backlit graphical LCD capable of up to four (4) lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions.

.2 Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.

.3 Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.

.4 Programmable “Auto Restart” feature to resume pump status in the event of power outage interruption.

.5 Programmable “Keypad Lock” to allow operator lockout of all keys except emergency stop.

.6 Programmable “Maximum Speed” to allow operator to set the maximum speed of the pump within 0.1 to 220 RPM.

.13 Supply auto control features to meet the following minimum functionality requirements.

.1 Remote control inputs

.1 Speed control.

.2 Primary analog 4-20 mA speed input, with input signal trimmable and speed scaleable over any part of the drive speed range.

.3 Secondary analog 4-20 mA or 0-10 VDC scaling input, with input signal trimmable and programmable scaling factor.

.4 Start-Stop control: dry contact. Configurable command sense allowing open to equal run or open to equal stop.

.5 HOA Control: dry contact.

.2 Status outputs:

.1 Four relay contacts rated for a 30 VDC with a maximum load of 30 W, Software configurable to indicate the following:

.1 Running-Stopped status.

.2 Forward-Reverse status.

.3 HOA status.

.4 General alarm status.

.5 Speed output: analog 4-20 mA.

.14 Drive motor:

.1 Brushless DC motor with integral gearbox and tachometer feedback.

.2 Speed control range of 2200:1 from 0.1 to 220 RPM plus or minus 0.1 RPM throughout the range.

.3 Closed-loop microprocessor-controlled drive with pulse-width modulation at speeds above 35 RPM and synchronous mode with magnetic field rotation control below 35 RPM.

.4 Circuitry complete with temperature and load compensation and protection.

.15 Pump fittings:

.1 Provide each metering pump with tubing fittings to allow connection to hard piping.

.2 Fittings shall be reusable one-piece requiring no clamps or tools to install.

.3 Peristaltic metering pump, maximum pressure 860 kPa (125 psi):

.1 Pump: Positive displacement, peristaltic-type tubing pump with a brushless variable-speed motor, non-spring loaded roller assembly located in the pumphead, integral tube failure detection system, and flexible tubing with attached connection fittings.

.1 There shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact only the pump tubing assembly and connection fittings.

.2 Capable of self-priming at the rated maximum pressure of 860 kPa (125 psi).

.3 Capable of running dry without damage.

.4 Pump rollers shall be capable of operating in either direction at the maximum rated pump pressure.

.5 Pump rollers shall be capable of operating in either direction without output variation.

.6 Suction lift shall be a minimum of 9 m of water.

.7 Repeatability: plus or minus 0.5 percent.

.8 Accuracy: plus or minus 0.5 percent.

.2 Pumphead: A single, unbroken track with a clear removable cover.

.1 Tube failure detection sensors shall be wholly located in the pumphead. Tube failure detection system shall not trigger with water contact. Float- type switches shall not be used. Process fluid waste ports or leak drains shall not be provided.

.2 Squeeze rollers with encapsulated ball bearings shall be directly coupled to a one-piece thermoplastic rotor. Four polymeric rollers shall be provided; two squeeze rollers for tubing compression placed 180 degrees apart and two guide rollers that do not compress the tubing placed 180 degrees apart. The roller diameters and occlusion gap shall be factory set to provide the optimum tubing compression; field adjustment shall not be required. Spring loaded or hinged rollers shall not be used.

.3 Rotor assembly shall be installed on a D-shaped, chrome-plated motor shaft and removable without tools.

.4 For tubing installation and removal, rotor assembly shall be rotated by the motor drive at 6 RPM maximum when the pumphead cover is removed. Hand cranking of the rotor assembly shall not be required.

.5 Pumphead and tubing compression surface shall be corrosion-resistant Valox thermoplastic.

.6 The pumphead cover shall be clear, annealed acrylic thermoplastic with an integral ball bearing fitted to support the overhung load on the motor shaft. Cover to include an embedded magnetic safety interlock which is to limit the motor rotation speed to 6 RPM when removed.

.7 Cover shall be positively secured to the pumphead using four thumb screws. Pump is not to require tools to remove the pumphead cover.

.3 Pump tube assembly:

.1 Only tubing provided by the manufacturer shall be acceptable.

.2 Pump tube shall be assembled to connection fittings of PVDF.

.3 Connection fittings shall be permanently clamped to the tubing with stainless steel clamps. To prevent tubing misalignment, fittings shall insert into keyed slots located in the pumphead and secured in place by the pumphead cover.

.4 Connection fittings shall be 12 mm M/NPT. Alternate fittings to accept 6 mm ID x 8 mm OD flexible tubing.

.5 Tube sizes and connections shall be metric.

.6 Tube assembly shall be resistant to the pumped commodity.

.4 Drive system: factory installed and totally enclosed in a NEMA 4X, (IP66) wash-down enclosure, capable of operating on any input power from 110-240 VAC, 50-60 Hz single phase supply without user configuration or selection switches.

.1 Motor:

.1 Reversible, brushless DC gear motor rated for continuous duty.

.2 Motor to include overload protection.

.2 Enclosure:

.1 Pressure cast aluminum with acidic liquid iron phosphate three-stage clean and coat pretreatment, and exterior grade corrosion-resistant polyester polyurethane powder coat.

.2 Rated NEMA 4X (IP66).

.3 Provided with 316 stainless steel floor and shelf level mounting brackets and hardware. Optional: provide extended height brackets for mounting pump 212 mm above grade level.

.4 Provide 1.8 m minimum length power supply cord with NEMA 5/15 U.S. 115 VAC attachment plug. Optional: power supply cord with NEMA 6/15 U.S. 230 VAC attachment plug.

.5 A wiring compartment shall be provided for connection of input-output signal wires, and alarm output loads.

.3 Control circuitry:

.1 Provide front panel user touchpad controls for stop, start, configuration menu access and navigation, operating mode selection, auto priming, and reverse direction.

.2 Provide LCD display for menu driven configuration settings, pump output value, service alerts, tube failure detection (TFD) system and flow verification system (FVS) alarms status, remote input signal values, tubing life timer value.

.3 Provide for manual control of pump output volume via speed percentage, cycle timer, manual dispensing, and parts per million (ppm) calculator operating modes.

.4 Provide for remote control of pump output volume via 4-20 mA, 0-10 VDC, 0-1000 Hz pulse, and contact closure pulse batching, and parts per million (ppm) calculator operating modes.

.5 Provide for remote stop-start pump via 6-30 VDC powered loop or contact closure loop.

.6 Provide a 4-20 mA or 0-1000 Hz output signal, scalable and proportional to pump output volume.

.7 Provide four contact closure alarm outputs. Three rated at 1 A - 115 VAC, 0.8 A - 30 VDC and one rated at 10 A - 250 VAC, 8 A - 30 VDC. Each alarm output shall be assignable to any of the following pump functions: TFD system, FVS system, motor run-stop, motor failed to respond to commands, input signal failure, or output signal failure.

.8 Provide a four (4) digit password protected configuration menu.

.9 Provide a FVS with programmable alarm delay time from 1 to 255 seconds. FVS system to monitor the FVS flow sensor while pump is running only. System shall not monitor pump while not running.

.4 Safety:

.1 The pump shall be listed to UL standard 778 as a motor operated pump and CSA standard C22.2 as process control equipment.

.2 TFD system sensors shall be wholly located in the pumphead. TFD system shall stop the pump within three (3) seconds of leak detection. To prevent false alarms from rain, wash-down, condensation. Tube failure detection system shall not trigger with water contact. Process fluid waste ports or leak drains shall not be provided.

.3 Pumphead cover shall include an imbedded magnetic safety interlock which shall stop the pump when removed. Pump rotor speed shall be limited to 6 RPM when cover is removed.

.4 User confirmation shall be required for motor reversal, tube life timer reset, and factory default configuration reset.

.4 Hose metering pumps:

.1 Pumping assemblies, including pump and driver, shall operate within vibration and bearing temperature limits specified over the full operable range of the pump assembly.

.2 Design and proportion all parts of pump as required for the Final Design and for the service specified.

.3 Provide room for inspection, repair and adjustment.

.4 Apply a never-seize compound to all bolts.

.5 Pumps driven as indicated shall be with explosion-proof VFD drives.

.6 Pump type:

.1 Positive displacement, hose pump.

.2 Capable of operation in either direction without flow variation or change in metering capability.

.3 Capable of running dry without damage to pump or hose.

.4 Capable of pulling 95 percent of full vacuum throughout life of hose.

.5 Metering accuracy: plus 5 percent, repeatability: plus 1 percent, both throughout life of hose.

.6 Valveless with no dynamic seals in contact with the pumped product.

.7 Minimum pressure rating:

.1 25 mm and larger, 1520 kPa.

.2 18 mm and smaller, 750 kPa.

.7 Pump housing and cover:

.1 Material:

.1 Housing: cast iron, ASTM A48 Class 35 (DIN GG25).

.2 Cover: 25 mm and larger carbon steel, ASTM A570 GR36, 18 mm and smaller, polycarbonate or carbon steel.

.2 Provide housing capable of rotation in 90-degree increments.

.3 Provide ribs for strength and for heat dissipation.

.4 Provide a housing cover O-ring seal.

.5 Chemical Services: Material as recommended by the pump manufacturer for the Final Design and service conditions specified.

.6 Fill approximately 40 to 50 percent of the pump housing with hose lubricant containing a combination of 99.5 percent pure glycerine and mono-propylene glycol to provide a medium for cooling and lubrication. Lubricant shall be food grade.

.7 Support pump housing by means of a welded ASTM A36 structural steel frame and baseplate.

.8 Connections:

.1 Provide flanged suction and discharge connections for all pumps, faced and drilled to Class 150 ANSI.

.1 Chemical services: Provide flange, hardware and hose insert material to suit commodity.

.2 Hose clamps and hardware: Type 316 stainless steel.

.9 Hose:

.1 Two- or four-layer braided nylon-reinforced, three-layer elastomer compatible with the service specified. Other hose constructions are acceptable provided all requirements specified are met. Chemical Services: Material as recommended by the pump Manufacturer for the service conditions specified.

.2 Burst Pressure Rating: 440 kPa.

.3 Shore A Durometer scale: 53-68.

.4 Machine hose outside diameter to a wall thickness tolerance of plus 0.3 mm tolerance.

.5 Maximum Working Pressure:

.1 Pumps 18 mm and smaller: 750 kPa.

.10 Shafts:

.1 Alloy steel ASTM A322/4140, minimum.

.2 Provide shafting adequate to operate pumps at maximum pressure specified or maximum pressure capability of drive whichever is greater.

.3 For pumps 25 mm and larger provide two-way seals. Provide lip seals for rotor shaft for pumps 18 mm and smaller.

.11 Rotor assembly:

.1 Material:

.1 Rotor: Cast Iron, ASTM A48 Class 40 (DIN GG25).

.2 Rotor Shoe: Polished Aluminum BS1490. Provide ability to shim for compression adjustment. Mount Shoes 180 degrees apart.

.3 For pumps 18 mm and smaller, provide separate shoes as specified above or a one piece rotor design with integral shoes.

.4 Shims: Galvanized steel. Non-metallic shims are not permitted.

.5 Hose shall be replaceable without cover or pump removal.

.6 Shoes shall be adjustable for shimming without removing the pump housing cover.

.12 Bearing frame:

.1 Use antifriction type, minimum L-10 life of 100,000 hours at maximum operating speed and pressure. In accordance with ABMA references.

.2 Provide permanently greased bearing. Provide a plugged grease fitting.

.3 Pumps without bearing frames shall be unacceptable.

.13 Coupling:

.1 High-torque, all-metal gear couplings with external grease fittings.

.2 Service Factor: 1.50 based on motor nameplate rating.

.14 Leak detection systems:

.1 Provide one (1) sensor on each pump to detect leakage of pumped product into pump housing, hose failure.

.2 Provide a float-type device or capacitance sensor near the top of the pump housing for hose failure alarm and pump shutdown. Install on back side of pump housing.

.3 Sensor shall send a signal to sound an alarm and automatically shut down the pump. Provide sensor with NO contact.

.4 Sensor: 24 V.

.15 Hose pump drive system:

.1 Motor:

.1 Provide squirrel cage induction motor with C-face design, integral gear reduction units are not permitted.

.2 Provide maximum motor RPM as required for the Final Design.

.3 Provide motor with adequate cooling at lowest operating speed.

.4 Enclosure: as required for the Final Design.

.5 Service Factor: 1.15.

.6 Provide capacity sufficient to start and operate pumps at maximum Final Design speed without exceeding nameplate ratings for current and power and without operating in the service factor.

.7 Provide ball or roller bearings, in accordance with ABMA Standard 9-90 and Standard 11-90; minimum L-10 life of 100,000 hours.

.8 Premium efficient motors, nominal and minimum motor efficiencies in accordance with NEMA MG1.

.9 Provide inverter duty rated motors for use with VFDs. Provide vector-duty rated motors for use with vector-type VFDs.

.2 Gear reducer:

.1 Provide helical or planetary arrangement classified for continuous, AGMA Class II, twenty-four (24) hour duty.

.2 Provide ASTM A48 Class 30 cast iron housing.

.3 Gears: Case-hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.

.4 Provide horizontal parallel or bevel right angle shafting, arrangement as required for the Final Design.

.5 Design reducer to match output speed requirements of pumps; double or triple reduction.

.6 Match torque-rating of pumping equipment.

.7 Minimum gear reducer service factor 1.50 minimum, based on peak running torque of pump.

.8 Gear reducer minimum efficiency:

.1 Double reduction: 97 percent.

.2 Triple reduction: 95 percent.

.3 VFDs:

.1 Provide VFDs with two (2) adjustable torque or current limit settings, one (1) for pump starting and one (1) for pump and system over-pressure protection. Field set system over pressure protection above setting of discharge pressure switch.

.2 Provide VFDs capable of pump starting torque and current.

.16 Hose pump baseplates:

.1 Bolt pump and drive to a common baseplate and frame.

.2 Fabricate baseplate of ASTM A36 fabricated structural steel.

.3 Bent form baseplates shall not be permitted for pumps 50 mm and larger. For pumps 80 mm and larger provide a balance foot on pump base placed under pump housing.

.4 Provide at least one (1) 100 mm minimum diameter grout hole and provisions for anchor bolts. Provide base drilling for anchor bolt holes readily accessible from exterior width dimension of the base. Anchor bolt holes shall not be wholly or partially concealed by channel base frames.

.5 Design baseplate with adequate strength to support pump and driver.

.6 For pumps 50 mm and larger: Provide Type 316 stainless steel jacking bolts on each side of gear reducer.

.7 Provide machined surfaces for bearings pads for pumps 65 mm and larger.

.8 Provide Type 316 stainless steel or rigid fibreglass guard in conformance with applicable OSHA requirements.

.9 Pumps shall be installed on concrete foundations.

.5 Metering pump appurtenances:

.1 Back pressure valves:

.1 Provide back-pressure regulating valves where required for the Final Design. Provide back-pressure regulators of PVC or CPVC construction, with CSM or PTFE diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting shall be minimum pressure to occur upstream of the valve, as installed in system, while pump is operating.

.1 Provide materials of construction compatible with the service specified.

.2 Pulsation dampeners:

.1 Provide discharge pulsation dampeners on metering pumps suitably sized for displacement of each pump to limit discharge pressure to plus/minus 10 percent. Provide pulsation dampeners which have a diaphragm separating the air chamber from the liquid chamber. Provide diaphragm of molded construction and which prevents air charge from being dissolved in process fluid. Provide lower chamber lined with Type 316 stainless steel of inert plastic to prevent corrosion by process fluid. Provide materials suitable for intended service. Charge air chamber with compressed air to pump Manufacturer's recommended charging pressure. Equip upper chamber with charging valve and air pressure gauge with shutoff valve.

.2 Furnish an airline and air hose with pressure regulator and hand-operated, lever-type valve, suitable for charging pulsation dampeners. Provide air hose long enough to reach pulsation dampeners.

.3 Pressure relief valves:

.1 Provide pressure relief of PVC or CPVC construction, and having CSM or PTFE diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting shall be the maximum pressure exerted downstream of the valve, as installed in system, while pump is operating.

.4 Calibration standpipes:

.1 Equip each group of pumps with calibration standpipe for measuring pump output.

.2 Provide standpipes of Schedule 40 clear PVC pipe with Schedule 80 fittings. Thin-wall tubing and acrylic plastics shall not be permitted.

.3 Equip each standpipe with flanged connection to suction piping, and fitted with ball valve for air venting. Provide socket-weld type filttings. Provide valves and fittings as specified under other sections referenced.

.4 Provide one (1) calibration standpipe for each group of pumps and of a diameter such that the measurable capacity of the standpipe is approximately one and one-half minutes maximum discharge of each pump. Length of the standpipe shall be the length of clear observable pipe not including the length of fittings or connections. Permanently calibrate each standpipe in litres and tenths.

.5 Provide valves and flanges at each pump suction for attachment of calibration standpipes. Pump suction and discharge piping shall not interfere with installation and use of standpipes.

2.5 Spare Parts

.1 Provide spare parts in accordance with Technical Requirements and the following for each pump size:

.1 For each chemical metering pump provide:

.1 Three (3) replacements for each size of tube or hose.

.2 Two (2) complete sets of gaskets.

.2 One (1) of each type and material back-pressure regulator with one (1) spare diaphragm and spring for each.

.3 One (1) spare diaphragm and air valve for each discharge pulsation dampener.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpreted results.

END OF SECTION

SUBMERSIBLE TUBE MOUNTED SOLIDS HANDLING PUMPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of submersible, tube mounted, solids handling axial flow pumps, motors, variable frequency motor controllers and appurtenances for pumping primary effluent.

.2 Pumping units shall consist of pump, electric motor, discharge tube, and variable speed drive.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Predicted variable speed pump performance curves showing total dynamic head, power, efficiency, and NPSH required plotted against capacity for the following, at a minimum:

.1 Average dry weather flow at max static head.

.2 Average dry weather flow at min static head.

.3 Maximum capacity of the secondary process at max static head.

.4 Maximum capacity of the secondary process at min static head.

.5 Minimum capacity of the secondary process at max static head.

.6 Minimum capacity of the secondary process at min static head.

.7 Minimum flow at min static head.

.8 Minimum flow at max static head.

All curves shall clearly display the specified operating conditions and the Manufacturer’s limits for the POR and AOR. If the submittal does not include boundaries of the AOR and POR it will be rejected.

.3 Complete description and sketch of proposed test setup for factory test. Provide sample calculations and proposed test log format.

.4 Vibration and critical speed analysis in accordance with Section 11020.

.5 Test report summarizing certified factory test procedures and results, including not less than eight (8) test points documenting peak efficiency at full speed within a tolerance of minus 0 percent.

.6 Documentation providing detailed procedures/sequence of operation for conducting a cleaning cycle of the wet well. The details of this sequence shall be confirmed during commissioning.

1.3 Standards and References

.1 Products provided under this specification must comply with all regulations and codes in effect in Manitoba.

.2 Electrical work shall be in accordance with the Canadian Electrical Code and with applicable standards of the EEMAC and the CSA).

.3 The pump/motor assembly shall have CSA approval as one unit, per CSA standard C22.2-108. Proof of this approval shall be submitted by the pump Manufacturer with the approval drawings. An approval of the motor unit only will not be acceptable.

.4 The pump/motor shall also be approved by CSA for service in Class1, Division I, Groups C or D hazardous locations.

.5 ABMA:

.1 ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

.2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.6 ANSI/HI:

.1 ANSI/HI 1.1-1.5 – Centrifugal Pumps.

.2 ANSI/HI 9.1-9.5 – Pumps - General Guidelines.

.3 ANSI/HI 9.6.1 – Centrifugal and Vertical Pumps for NPSH Margin.

.4 ANSI/HI 9.6.3 - Centrifugal and Vertical Pumps Allowable Operating Region.

.5 ANSI/HI 9.6.4 - Centrifugal and Vertical Pumps, Vibration Measurements and Allowable Values.

.6 ANSI/HI 9.8 – Pump Intake Design.

.7 ANSI/HI 14.6 –Hydraulic Performance Acceptance Tests.

1.4 Performance Testing

.1 Certified witnessed performance tests shall be conducted in accordance with ANSI/HI 14.6. The test setup shall duplicate as closely as possible the inlet conditions in the Final Design.

.2 A minimum of 10 test points shall be taken, including a minimum of four (4) within plus or minus 8 percent of individual pump flow at average dry weather flow, and a minimum of two (2) within plus or minus 4 percent of the pump's best efficiency point at test speed. Head and power requirements at shut off head shall be determined by one (1) test point.

.3 NPSH3 tests shall be performed using the method described in ANSI/HI 14.6. All NPSH3 tests shall extend from 30 to 140 percent of best efficiency flow at full speed, or to not less than 10 percent in excess of the maximum capacity of the secondary process, whichever is greater.

.4 Any pump not included in the certified witnessed factory performance tests shall undergo non-witness factory certified performance tests.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 The following manufacturers are acceptable provided they are able to demonstrate compliance with the specified requirements. The manufacturers' standard products may not comply.

.1 ABS/Sulzer.

.2 KSB.

.3 Xylem/Flygt.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Pumps shall be designed and tested in accordance with applicable portions of ANSI/HI 1.1 1.5, 9.1-9.6, and 14.6 and the requirements of this section and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

.2 All operating conditions listed in Item 1.3.1.3, above, shall lie within the Manufacturer's AOR, as defined under ANSI/HI 9.6.3.

.3 Guarantee performance at average dry weather flow and average annual flow in accordance with tolerances set forth in the test standards of the Hydraulic Institute, except that any increase in head or capacity or both which results in a power requirement greater than the pump motor's nameplate rating is cause for rejection.

.4 Pumphead capacity curves shall have no points of reverse slope inflection within the specified operating range.

.5 NPSH required at any operating condition within the range specified shall be as per Design Builder's curves submitted in accordance with clause 1.3, with a tolerance of plus 0 percent, minus unlimited.

.6 Pumps shall function without damage or disassembly at reverse rotational speeds up to 125 percent of maximum operational speed during flow reversals through the pump.

.7 Provide pumps which operate without cavitation; provide motor and pump combination which operates without excess vibration over the specified range of conditions in accordance with ANSI/HI 9.6.4.

.8 Provide non-overloading pumps and motors at any point on the pump's full speed operating curve.

2.3 Components, Configuration and Features

.1 Pumps: Submersible solids handling axial flow pumps. Driven as required for the Final Design.

.2 Pump configuration: As required for the Final Design.

.3 Design and proportion all parts of pump specially adapted for the service in the Final Design.

.4 Each pump and discharge tube shall be designed and installed so that the pump and motor can be removed without disturbing the discharge tube or other equipment.

.5 Pumps shall be self-centring in the discharge tube and self-sealing due to the pump and motor's own weight, allowing for leakage free operation.

.6 Install pump and discharge tube in strict accordance with the pump Manufacturer's recommendations.

.7 Pump Casing:

.1 Provide a diffuser casing with a self-centring, force-locked seating for installation in a discharge column. Designs requiring additional anchoring or rotational protection shall not be acceptable.

.2 Pump diffuser casing, motor casing, bearing housing, and bearing cover of cast iron ASTM A48 Class 40.

.3 Casing wear ring of stainless steel ASTM A276 Type 316 Ti.

.4 Provide lifting devices on pumps for handling.

.8 Lining:

.1 Acceptable Products:

.1 Belzona Supermetalglide.

.2 Devcon Brushable Ceramic Blue.

.2 Type: Ceramic filled epoxy.

.3 Percent Solids by Volume: 100 percent.

.4 Provide two coats 8 to 15 mils (200 to 380 microns) thick with total minimum DFT of 20 mils (500 microns).

.5 Cured Hardness: 90D in accordance with ASTM D2240.

.6 Surface preparation, mixing and application and safety requirements shall be in accordance with the lining Manufacturer's printed instructions and as specified.

.9 Impeller:

.1 Type: Cast centrifugal, closed, non-clogging design capable of handling solids, long fibres, sludge, and other materials as may normally be found in wastewater.

.2 Provide pumps capable of passing a solid sphere size.

.1 Pumps capable of only passing a deformable sphere shall not be permitted.

.3 The impeller shall be securely fitted to the pump shaft in such a manner that it does not loosen or become detached if the pump is operated in the wrong direction. Statically and dynamically balance each impeller.

.4 Provide cast duplex stainless steel ASTM A890 Grade 1A, Type 25Cr-5Ni-Mo-Cu CD 4 MCu impellers for all pump services except as specified herein.

.10 Shafts and Shaft Seals:

.1 Provide shaft of ASTM A276 Type 420 stainless steel.

.2 Shaft shall be of sufficient size to transmit full driver output with a maximum deflection of 0.05 mm (0.002 inches) measured at the lower mechanical seal.

.3 Independent tandem mechanical seals consisting of the following materials:

.1 Pump-side: Silicon carbide/Silicon carbide.

.2 Bearing-side: Carbon/Silicon Carbide.

.4 Sealing performance shall not depend on direction of rotation.

.5 Primary and secondary seal faces shall be capable of extended periods of dry-running operation without the need for external seal lubrication or cooling systems.

.6 Seals shall require neither routine maintenance nor adjustment, but be capable of being easily inspected and replaced.

.11 Motors:

.1 The motor and pump set complete shall be designed and manufactured by the same company.

.2 Max 900 RPM.

.3 Motors shall be IP68 rated, having insulation class H.

.4 Motors furnished with pumps intended for variable speed operation shall be inverter duty type.

.5 No power requirement at any head on the full speed head capacity curve shall exceed the motor nameplate rating, using a 1.0 service factor.

.6 The motor shall be capable of withstanding at least 10 evenly spaced starts per hour.

.7 Allowable maximum submergence shall be not less than 30 m.

.8 Stator windings shall have a winding fill factor of at least 95 percent.

.12 Moisture and Temperature Probes:

.1 Provide two (2) moisture detection probes to detect moisture in the seal and stator cavity.

.2 Provide moisture detection panel and one piece cable from pump to panel.

.3 Provide PTC thermistors in winding to provide over temperature protection.

.4 Moisture detection to alarm, over-temperature to shut down pumps, indicate condition and alarm.

.5 Provide NEMA 4X Type 316L stainless steel panel with moisture detection system.

.13 Bearings:

.1 Provide a minimum of two (2) bearings permanently lubricated but capable of being regreased.

.2 Provide a 100,000 hour L-10 life for pump bearings including for motors and shafts in accordance with ABMA 9 or 11.

.3 Provide RTD for thrust bearing.

.14 Provide a Type 316 lifting attachment capable of lifting the entire pump and motor assembly.

.15 Provide a motor resistance monitor.

2.4 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each pump size:

.1 Complete set of gaskets and O-rings.

.2 Two (2) sets of wearing rings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Factory Acceptance Testing:

.1 Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Submit copies of all shop test data and interpreted results.

.4 Run pump under simulated peak conditions and through complete range of operation conditions to verify ability to meet vibration, temperature and capacity requirements. Record flow, head, vibration, temperature, and motor inputs.

END OF SECTION

VACUUM EDUCTORS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of vacuum eductors for priming pumps.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Pemberthy Inc.

.2 Or approved equivalent.

2.2 Materials

.1 Fabricate of materials suitable for the intended service.

2.3 Performance Criteria

.1 Provide eductors with the required liquid stream and for the level of vacuum required.

.2 Design eductor to be non-plugging and provide method of removal for cleaning.

.3 The design criteria for the following parameters shall conform to the Final Design:

.1 Suction lift.

.2 Time to evacuate.

.3 Water supply pressure.

.4 Inlet, suction, and discharge size.

2.4 Components, Configuration and Features

.1 Provide equipment with pipe connections and adaptors to match inlet, suction and discharge piping as specified in Section 15055.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 One (1) complete eductor for spare parts.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

AIR DRYER AND FILTERS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of compressed air dryers and filters.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Quality assurance and quality control records.

.1 Air dryer fabrication details including pressure vessel and support construction.

.2 Air filter fabrication details, connection details, media data, performance criteria including pressure drop with clean and fouled media, and particulate/aerosol removal performance.

2. PRODUCTS

2.1 Description

.1 The air dryers and filters condition compressed air so that it is suitable for use in the instrument air and service air systems.

2.2 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Desiccant air dryers:

.1 Ingersoll Rand.

.2 Pure Aire.

.3 Xebec.

.4 Atlas Copco.

.5 Or approved equivalent.

.2 Refrigerant air dryers:

.1 Atlas Copco.

.2 Ingersoll Rand.

.3 Pure Aire.

.4 Or approved equivalent.

.3 Air filters:

.1 Atlas Copco.

.2 Ingersoll Rand.

.3 Pure Aire.

.4 Or approved equivalent.

2.3 Performance Criteria

.1 Provide air dryers and filters shall meet the specified criteria for moisture, oil and particulate matter, as follows:

.1 Instrument Air: Dewpoint, less than minus 40°C; oil, less than 1 ppm; particulate, 99.5 percent of 0.01 micron removed.

2.4 Materials

.1 Fabricate of materials suitable for the intended service.

2.5 Aerosol and Particulate Filters

.1 Provide coalescing type filters with automatic drain traps, and pressure drop indication.

.2 Provide vertical in-line type filters, metal fabrication.

2.6 Instrument Air Dryers and Controls

.1 Provide two (2) fully-automatic dual-tower regenerative desiccant air dryers arranged for duty-standby operation.

.2 Provide a purge line from the dried air discharge to each tower to regenerate the saturated tower.

.3 Air drying in the duty unit shall be by downflow through the first tower. Regeneration of the second tower shall be by upflow of air from the purge line.

.4 Desiccant towers shall be 1000 kPa ASME code stamped, with a stainless steel desiccant support.

.5 Provide an operating panel on the enclosure of the dryer with the following instrumentation and controls:

.1 On-Off switch.

.2 Inlet and outlet pressure gauges.

.3 Dew point indicator.

.6 Provide a control device to minimize the quantity of air used for reactivation. The control device shall time the cycling mechanism to match purge air usage to actual moisture loads on the desiccant bed.

.7 The maximum purge air flow shall not exceed 15 percent of the rated capacity of the dryer during maximum instrument flow.

.8 Provide for remote monitoring of dryer run status and pressure dewpoint.

.9 Provide a pressure relief valve on each tower.

2.7 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Provide enough desiccant to replace the material in place two (2) times.

.2 Provide additional items that are normally required for two (2) years of operation.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

ROTARY LOBE PUMPS

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation, testing and commissioning of positive displacement lobe-type pumps complete with electric motors and all specified appurtenances and mounted on a common baseplate.

1.2 Standards

.1 ASTM A532, Abrasion Resistant Cast Iron.

1.3 Submittals

.1 Provide submittals in accordance with Section 11000 and 01300 provide the following:

.1 Detailed information on lobe material, anticipated service life, acceptable temperature range, and compatibility with municipal wastewater sludge and scum.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Vogelsang.

.2 Borger.

.3 Netzsch.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Select and install pumps specifically for continuous or intermittent duty pumping of municipal wastewater sludge or scum without clogging or fouling caused by material in the pumped fluid at any operating point within the range of service specified.

.2 Fluid passing through these pumps is expected to include primary and secondary thickened sludge containing organic and inorganic solids, H_2S gas, grease, scum (containing hydrocarbons including SAE motor oil, gasoline and diesel), and trash (such as hair, cigarette butts, grease balls and plastics), grit, polymer,and dissolved or suspended solids up to 8 percent.

.3 The pump materials, including lobes, shall be compatible with hot water used to flush piping and pump internals from build-up of congealed scum. Hot water temperatures may range up to 95ºC.

.4 The pump must be capable of running dry without damage to the pump or drive unit.

.5 The rotary lobe pumps have the following operating conditions:

.1 Condition A is the rated, continuous-duty operating condition.

.2 Condition B indicates operating conditions when the pump is operating against minimum anticipated pressure.

.3 Condition C indicates operating conditions when the pump is operating against maximum anticipated pressure.

.4 Condition D indicates operating conditions when the pump is operating at the maximum anticipated discharge flow rate.

.5 The operating characteristics of each operating condition for the following parameters shall conform to the Final Design:

.1 Rated pressure.

.2 Capacity at rated head.

.3 Motor power.

.4 Inlet/outlet size.

.6 Maximum pump speed for all operating points shall be 300 rpm.

.7 Rated pressure in the above list is the algebraic difference between the total discharge pressure and total suction pressure.

.6 Supply rotary lobe pumps under this specification suitable for continuous operation.

2.3 Materials

.1 Fabricate of materials suitable for the intended service.

2.4 Equipment Components

.1 Pump:

.1 The pumps shall use two (2) quad-lobe rotors which are driven through positive timing gears running in oil. Rotor cores shall be covered with a layer of elastomer. The geometry of the rotor cores shall be the same as that of the finished rotor. Rotor vane geometry shall be convoluted to provide pressure-pulse free operation. Designs with rotor vanes parallel to the shaft centreline are not permitted. The front cover must permit removal of the rotors without disturbing piping, bearings, and mechanical seal and shall be hinge-mounted to the housing. Both front and rear rotor case cover plates shall be fitted with a renewable hardened wear surface, 500 Brinell. Rotors shall be positioned on the shaft by keys and secured to the shaft by internal/external expansion clamp sleeves and flush disks requiring no recesses in the end cover. Pumps using

lobe designs with fewer than four (4) tips are not permitted. Designs with replaceable lobe tips are not permitted.

.2 The pump case top and bottom castings are to have an adjustable feature which permits the castings to be repositioned to three (3) distinct position pairs. Repositioning shall be by simple field relocation of casing bolt sleeves. Renewable 500 Brinell wearing surfaces shall be provided on the top and bottom castings. The use of one-piece, block, cast housings or the use of radial wear plates are not permitted as their ability to be hardened is limited and may require frequent replacement when a rebuild is required. The casting inlet shall have solids injection ramps on the top and bottom of the casting so that solids are injected into the solids passing area of the lobe to prevent damage from the solids.

.3 The pump timing gears shall run in oil and shall be mounted in a gear case contiguous with the pump case. The gear case shall be fitted with a sight gauge and oil fill and drain connections.

.4 Cartridge mechanical seals shall be provided of blockring in chrome oxide and Duronite for each positive displacement pump. Seal shall include the mechanical seal faces, the seal holder and carrier, all applicable O-rings, the mechanical seal faces, and stainless steel shaft sleeve. The use of manual pre-load mechanical seals is not permitted. A blocking chamber located behind the mechanical seal, and in front of the bearing housing lip seal shall be fitted into the cartridge seal of the pump to prevent contamination of the bearings on the event of a seal failure. This chamber shall be suitable for fill, from the top of the pump, and have an optional external pressurized oil bottle to review the status of the mechanical seals operation, mounted on the top of the pump, in easy view and reach of the operator. Pumps with open-to-air cavities behind the mechanical seal housing, those that require water flush or quench are not permitted. Designs that do not use blockring style rotating mechanical seal faces are not permitted due to high fiber compaction around the seal faces, and low heat dissipation properties.

.5 The shafts shall be of carbon steel fitted with replaceable stainless steel sleeves where passing through the seal area. They shall be timed in their rotation by straight cut timing gears running in a separate oil chamber which also contains the ball and roller bearings for each shaft. Pumps requiring external re-timing in the event of blockage are not permitted. The shaft shall be a minimum of 85 mm in diameter where the rotors, bearings, and mechanical seals contact the shaft, to decrease the potential of torsional shaft fatigue. The use of step down, angular v-notch cut, or threaded, shafts are not permitted due to shaft fatigue and potential of breakage. The shaft sleeves where the mechanical seal rides shall be removable through the front of the pump when removing the cartridge mechanical seal, and without disturbing the surrounding piping. Maximum shaft deflection at operating pressure shall be 0.1 mm.

.6 Bearings shall have a minimum L-10 rating life of 100,000 hours. Bearings and timing gears for pump sizes 100 mm and smaller to run in an oil chamber provided with a sight glass level with the centreline of the lower shaft. For pump sizes 125 mm and greater, a separate oil reservoir shall be provided for the bearings on each shaft with a level sight glass provided for each reservoir, or a forced feed and lubrication system shall provide adequate upper bearing lubrication.

.7 Goose neck, up-turned 90°, or straight type suction and discharge piping connections shall be provided as shown on the Drawings.

.8 Suction and discharge piping connections shall have minimum 25 mm diameter flush and drain connections complete with threaded isolation ball valves.

.2 Mount each pump and drive on a common base.

.1 Provide planed surfaces of bearing pads for pumps and drives. Bases shall have square corners in three (3) perpendicular directions, with parallel surfaces.

.2 Provide motor mounting blocks so that one (1) size greater motor frame may be accommodated by replacing the mounting blocks.

.3 Lubrication:

.1 Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not to require attention during start-up or shutdown and shall not waste lubricants.

.2 Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, start-up, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants is not permitted.

.3 Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Provide drains to allow convenient collection of waste oil in containers from the operating area or platform without removing the unit from its normal installed position.

.4 Drive Units:

.1 Pumps shall be provided with gear reduction units to meet specified operating conditions.

2.5 Spare Parts

.1 Provide the following spare parts for each pump size:

.1 One (1) set of mechanical seals and O-rings.

.2 One (1) set of lobes and O-rings.

.3 One (1) set of rotor case cover plates

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Testing:

.1 Factory Acceptance Test: Factory tests shall be conducted on pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpreted results.

.2 Pressure test the pump casing to 150 percent of the pump shut off head at maximum speed.

END OF SECTION

SEAL WATER CONTROL UNIT ASSEMBLIES

1. GENERAL

1.1 Summary

.1 This Section specifies assemblies to control the flow of water to pump bearings or seals.

.2 Supply seal water control unit assemblies as a pump component; seal water control units do not have separate equipment numbers.

1.2 Standards

.1 FSA-MSH, Fluid Sealing Association Mechanical Seal Handbook.

1.1 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

1.2 Definitions

.1 Mounting stand: A custom-fabricated plate and section assembly for mounting seal water control unit.

.2 Seal water control unit type:

.1 S: bearing flush control.

.2 D: double mechanical seal flush control.

.3 PRV setting: seal water operating pressure.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Provide seal water units form a single manufacturer, regardless of the manufacturer of the mechanical seal or other equipment receiving seal water.

.2 Acceptable Manufacturers and Acceptable Products:

.1 John Crane, Safematic Safe Unit:

.1 Potable water: Model SFP.

.2 Non-potable water: Model SFD.

.3 Or approved equivalent.

.2 The Flow Techno:

.1 Potable water: The Flow, Model TFT/W02.

.2 Non-potable water: The Flow, Model TFT/W03.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Service conditions:

.1 Area exposure: see Section 01450.

.2 Fluid type: Non-potable water.

.2 Provide seal water control units appropriate to the fluid, the seal characteristics, the flow, and pressure.

2.3 Materials

.1 Fabricate of materials suitable for the intended service.

2.4 Configuration, Components and Features

.1 Select seal water control unit flow and size in accordance with equipment Manufacturer's recommendations.

.2 Coordinate necessary flow range, pressure range, pressure regulating valve settings, and low flow switch set point with pump or equipment Manufacturer in accordance with submittal information furnished with each pump or equipment submittal.

.3 Adjust seal water pressure to equipment Manufacturer's recommendations.

.4 Adjust seal water flow to equipment Manufacturer's recommendations.

.5 Adjust low-flow switch set point to equipment Manufacturer's recommendations.

.6 Seal water control unit assembly: flow switch, flow indicator, flow and pressure regulation adjustment, and pressure gauge furnished in a common assembly.

.7 Flow monitor and control: flow regulating valve and integral flow indicator with memory pin. Flow range shall be as recommended by pump or equipment Manufacturer.

.8 Pressure monitor: Integral, liquid glycerin or silicone filled, pressure gauge with memory pin. Select for operating pressure range indicated by pump manufacturer. Set seal water supply operating pressure within 20 percent to 80 percent of gauge range.

.9 Cleaning mechanism: push-clean button or other appurtenance that allows unit to be cleaned while equipment is running without triggering alarm.

.10 Mounting: Angle bracket for wall or stand mount, as specified, with clearance for installation and maintenance of low flow alarm assembly.

.11 Process connections: 15 mm Type 316 stainless steel hose barb, bottom connection.

.12 Supply connection: 15 mm Type 316 stainless steel hose barb connection.

.13 Pressure regulator for influent line.

.14 Y-pattern water strainer with blow off valve for influent line with 50 micron opening stainless steel screen, as specified in Section 15050.

.15 Solenoid valve for influent line, as specified in Section 15105.

.16 Mounting stand:

.1 Low Flow Switch: inductive type, with adjustable setpoint, not affected by process fluid temperature changes in the range of 0 to 40°C. Switch action on low flow causes normally closed (NC) contact to open.

.2 Signal Output: SPST contact rated 0.35 A at 120 VAC resistive.

.3 Indicator: Integral LED providing local indication of flow switch alarm state.

.4 Enclosure: NEMA 4 or UL listed for Group D, Class I, Division 1 & 2.

.17 Fit seal water control units for double mechanical seals with pressure regulator and additional process connections for return of the seal water flow back to the seal water control unit from the double mechanical seal and then to drain.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Five (5) rotameters.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Provide dielectric connections between dissimilar metal piping, including copper to stainless steel.

.4 Mount seal water control units on specified mounting stand at each pump or piece of equipment.

.5 Mount solenoid valve, strainer and regulator at equipment.

END OF SECTION

ROTARY LOBE BLOWER

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of rotary lobe positive displacement blowers.

1.2 Definitions

.1 Continuous Operation: 24 hour-per-day operation for design life of not less than 20 years, or 175,200 hours.

.2 Intermittent Operation: Periodic operation, including starts and stops; including extended periods of time when not in use.

.3 kPaV: kilopascals, vacuum.

.4 Standard cubic metre per minute (SCMM): the volumetric flow rate in cubic meters per minute at standard conditions. Standard conditions defined as 20°C, one (1) atmosphere (101.3 kPa), and 36 percent relative humidity.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Blower curves showing discharge pressure, capacity, and horsepower demand over entire range from shutoff to maximum capacity, blower and overall efficiency, and wire power and shaft power at site conditions including specified inlet pressure, minimum and maximum temperatures and relative humidities, and at normal conditions.

.3 Provide a statement describing the rotating speed and critical speeds of the blower system.

.4 General description of blower with all performance data including noise levels in dBa at operating conditions.

.5 Details of VFD and LCP including but not limited to layout drawings, wiring diagrams, schematic diagrams, parts lists.

.6 Operating description for the local control panel covering all logic and sequences of operation. P&IDs of the complete blower system. Illustrate the approach implemented to coordinate controls through all operating scenarios with the existing blower installation.

.7 Description of operation and a full description of the control elements included with the blower package to implement that control.

.8 Blower Testing – Submit a detailed test plan with complete piping and instrumentation configuration diagram per showing inlet and discharge air test pipe size. The location, type, and quantity of all major instruments necessary for performance data with

corresponding distances from reference points shall be identified. As a minimum, the detailed test plan shall include:

.1 Quality control procedures.

.2 Functional testing of entire package including instrumentation, ancillary components and LCP.

.3 Following the testing, provide test results including performance curves with unit serial numbers indicated, original test log, data sheets and sample calculations.

.9 Description of insulation system.

.10 Vibration and critical speed analysis in accordance with Section 11020.

1.4 Quality Assurance

.1 Single Source Responsibility: All blowers and appurtenances furnished under this Section shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. Blower manufacturer to provide a written warranty for the blower and blower package and state that they have reviewed the design and application and that the equipment has not been misapplied.

.2 The manufacturer of the blowers shall be completely responsible for the proper design or selection of their system components, including but not limited to; blowers, VFDs, blow-off valves, and controls. All equipment to perform as specified and the completed installation is to operate in accordance with the requirements of the Final Design.

.3 This Section represents the minimum acceptable standards for the blower equipment for this project. Equipment which is a "standard product" with the manufacturer to be modified, redesigned from the standard mode for this specific project, and to be furnished with special features, accessories, materials of construction or finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of the specification.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 Aerzen.

.2 Kaeser.

.3 Gardner Denver.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 Provide the blowers equipment to meet the capacities and operating data are set out in the Technical Requirements.

.2 Provide rotary lobe blower for the appropriate pressure, airflow requirement and temperature.

.3 Design in accordance with Section 01450 for area classification.

.4 The design requirements for the following parameters shall conform to the Final Design:

.1 Area exposure.

.2 Fluid type.

.3 Fluid temperature.

.4 Location.

.5 Site elevation.

.5 The operating conditions for the following parameters shall conform to the Final Design:

.1 Capacity.

.2 Inlet pressure.

.3 Atmospheric pressure.

.4 Relative humidity.

.5 Discharge pressure.

.6 Inlet air temperatures.

.7 Continuous or intermittent operation.

.8 Turndown from rated condition.

.9 Minimum efficiency at full speed.

.10 Minimum inlet and discharge piping connection size.

.11 Operating speed.

.12 Casing pressure.

.13 Air seal.

.14 Bearings.

.15 Drive type.

.16 Vibration limits.

.6 The electric motor operating conditions for the following parameters shall conform to the Final Design (see Section 16223):

.1 Type.

.2 Maximum power.

.3 Speed.

.4 Enclosure.

.5 Power supply.

.6 Service factor.

.7 Configuration.

.8 Minimum efficiency at 0.75 load and above.

.9 NEMA design rating.

.10 Insulation.

.11 Lubrication.

.7 Design Requirements:

.1 Free-field noise at 1 m: 80 dBa outside acoustic enclosure:

.2 Overall noise level from assembled blower and silencers in acoustic enclosure shall not exceed 80 dBa at 1 m from equipment. Noise level shall be measured according to DIN45635 and supported by certified, published data from the manufacturer covering the entire machine package.

2.3 Materials

.1 Fabricate of materials suitable for the intended service.

2.4 Configuration, Components and Features

.1 All of the equipment specified herein is intended to be standard equipment for use in an aeration system.

.2 Provide lobe-type blowers with side-mounted suction and discharge connections.

.3 Equip each blower with an inlet filter, inlet and outlet silencers, discharge pressure transmitter, check valve on the discharge piping, discharge butterfly valve, temperature transmitters to measure suction and discharge temperature, and expansion joints for the inlet and outlet.

.4 Design the blowers for continuous service. Mount on a common baseplate with the electric motor drive.

.5 Specified design suction and discharge conditions are at the flanged connections. Include pressure loss consideration for the intake filter, discharge check valve and intermediate piping.

.6 Blower casing:

.1 Blower casing of one-piece construction with separate sideplates shall be bolted and pinned to the housing, and suitably ribbed to prevent distortion under the specified operating conditions.

.2 Arrange casing to incorporate a proven means of pulsation cancellation such that the noise measured at the outline of the blower package does not exceed 80 dBa.

.1 Blowers that do not incorporate pulsation cancellation shall provide design and sizing calculations for discharge silencer to comply with this noise requirement for the entire range for the blower.

.2 The vibration level measured at the blower casing, in the X and Y planes of the bearings, shall not exceed 12 mm/s RMS when operating at the specified maximum operating pressure and speed in the actual blower package.

.7 Impellers:

.1 Provide straight, three-lobe type impellers designed to operate without rubbing or liquid seals or lubrication. Machine impellers on all exterior surfaces for operation at close clearances.

.2 Design blower to operate below the following maximum rotating speeds:

.1 Less than or equal to 7.5 kW: 2700 RPM.

.2 Greater than 7.5 kW and less than or equal to 37.5 kW: 1800 RPM.

.3 Greater than 37.5 kW: 1600 RPM.

.3 Each impeller shall be of rigid design with first lateral critical speed at least 120 percent of the maximum allowable operating speed.

.4 Shaft shall be drop-forged in one single piece of ASTM 1043.

.5 Cast hollow rotors shall be capped, dust-tight. Open rotors are not permitted.

.6 The impellers shall be statically and dynamically balanced in accordance with ISO1940/ANSI S2.19 G6.3.

.7 Each impeller and shaft shall be supported by cylindrical roller bearings, and fixed to control the axial position of the impeller and shaft in the unit. A double sealing arrangement shall prevent lubricant from contaminating the air stream but shall not utilize any type of lip-type seal.

.8 Timing gears:

.1 Design gearbox to AGMA standards for heavy duty, continuous operation.

.2 Finish machine gears on all surfaces and attach to shafts in such a manner as to permit easy retiming of the unit.

.3 Enclose timing gears and gear end bearings in an oil-tight housing.

.4 Splash-oil lubricate the timing gears. Grease lubrication shall not be acceptable.

.9 Bearings:

.1 Provide grease lubricated or oil-lubricated anti-friction bearings, designed to withstand all stresses for the service specified.

.2 Provide bearings with L-10 bearing life of 40,000 hours.

.1 Notwithstanding the theoretical bearing life calculations, the bearings shall be sized for a minimum of five (5) years of continuous duty between overhauls.

.3 Design so that inspection or replacement of bearings is possible without disconnecting piping or disassembling the blower.

.4 Design bearing housings to effect a complete separation between the bearings and casing to isolate bearings from heat generated by the blower.

.10 Motor:

.1 Provide a TEFC electric motor.

.2 Frame size shall be suitable for overhung belt drive.

.3 Electrical:

.1 Provide inverter-rated motor suitable for VFD speed control.

.2 Motor shall be suitable for continuous duty in ambient temperatures ranging from 0°C to plus 45°C at the rated service factor.

.3 Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor.

.4 All motors for use with VFDs to use copper stator windings with minimum double coated Class H Amid-Imid type 200°C varnish insulation. Full phase insulation shall be on all motors. Motor leads shall be stranded copper and be permanently identified.

.5 Motors shall be capable of performing with inertia loading as follows:

.1 TEFC: plus 200 percent of values in NEMA/ANSI MG1-12.50 Table 12.3.

.2 ODP: plus 50 percent of values in NEMA/ANSI MG1-12.50 Table 12.3.

.6 Motor lamination must be of C5 type, C3 is not permitted.

.7 Provide RTDs (1 per phase) for all blower motors (process air blowers and soda ash unloading blower).

.4 Mechanical:

.1 Bearings shall be either ball bearings or cylindrical roller bearings, drive end and opposite drive end.

.2 Bearings shall be selected to provide an L-10 rated life of 40,000 hours per ABMA standard V-belt drive applications with external load factors per NEMA MG1-14.42 and 100,000 hours L-10 rated life in direct-coupled applications.

.3 Bearings to have a maximum of 45°C rise at rated power for 4-pole, 6-pole and 8-pole motors and a maximum of 50°C rise for 2-pole motors.

.4 All motors with 280 frame and larger shall be regreasable while in operation. Regreasable bearings shall be complete with cast iron inner bearing cap. Smaller frame motors shall be supplied with sealed bearings.

.5 Frame and end brackets shall be a minimum of grade 25 cast iron construction.

.6 External cooling fans shall be of non-sparking corrosion-resistant material such as fibreglass reinforced Nylon 66 on all motors including 2-pole.

.7 Shaft slingers are required on all TEFC motors to minimize entry of moisture and contaminants into the bearing chamber.

.8 The terminal box volume shall be one size larger than NEMA requirements and shall be rotatable in 90-degree increments. Gaskets shall be provided between the T-box and frame and the T-box base and cover. Terminal boxes can be supplied as either pressed steel or optional cast iron.

.9 Two breather holes shall be provided at the lowest points in the motor frame.

.10 Lifting bolts, with safety factor of 10, shall be provided on 180T frames and larger.

.11 All hardware shall be zinc-dichromate plated.

.12 The motor nameplate shall be engraved or stamped on 304 stainless steel and fastened to the motor frame with four (4) stainless steel drive pins.

.13 The motor (2-pole, 4-pole, 6-pole, and 8-pole) shall be dynamically balanced to a maximum of 12.5 microns peak to peak maximum displacement at the bearing housing. Balance washers shall be permanently fixed stainless steel.

.14 Motors shall be capable of all position mounting and operation including vertical foot mount belt drive applications.

.15 All motors to have their exterior prepared with a rust prohibiting primer with an environmentally responsible waterborne acrylic enamel paint top coat on all exposed surfaces. The paint shall be suitable to withstand harsh environmental conditions.

.16 Motors shall be individually boxed or crated to protect product during shipment and storage. Packaging shall allow stacking of motors.

.11 Belts:

.1 Connect the positive displacement blower to the drive through V-belt and sheaves.

.2 Provide high-capacity type, oil- and heat-resistant, and static-dissipating V-belts.

.3 Design the drive for a minimum service factor of 1.4 times operating brake horsepower or 1.1 times the motor nameplate power, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower brake horsepower.

.12 Drive guard:

.1 Provide OSHA-compliant belt guards for each belt drive.

.2 Fabricate the V-belt drive guard of steel no thinner than 1.5 mm.

.13 Drive shaft:

.1 Fabricate drive shafts from hot-rolled steel bar, ground and polished, of sufficient diameter to prevent deflection or whip at design operating speed.

.2 Size the shafts so that the rotating assembly operates a minimum of 20 percent below the first critical speed.

.3 Where the blower shafts pass through the impeller casing, provide suitable seals to minimize air leakage and maintain operating efficiency.

.4 Extend the shaft to permit connection to a V-belt drive.

.14 Mounting:

.1 Factory mount the blower and motor unit together with all accessories and appurtenances, including V-belt drive, inlet filter, inlet silencer, discharge silencer, pressure relief valve, check valve, vibration isolation, inlet and discharge flexible connections/expansion joints, and instrumentation, on a single heavy full-length steel frame, properly cross braced to form a rigid support for the entire unit. Design the frame to have a safety factor of 2.0 for all dead and live loads. Provide vibration isolation between the blower and base plate and the floor to prevent noise and vibration transmission to the floor or piping.

.15 Accessories:

.1 Sound Enclosure:

.1 Each blower shall be supplied with a sound enclosure covering the entire blower package including the drive motor. Design the sound enclosure for easy inspection and maintenance of all blower package components. Panels shall be made of galvanized steel sheet, coated on all sides.

.2 Mount the enclosure and the blower package on a skid/oil-drip pan designed for meeting environment protection standards and for easy transportation and installation. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts.

.3 Provide a cooling fan for sufficient heat removal from the sound enclosure.

.4 Electrical components, instrumentation, and instrument connections shall not interfere with moveable panels of the sound enclosure.

.2 Pressure relief valve:

.1 Supply one adjustable spring loaded or weighted pressure relief valve for each blower, set to open at a pressure suitable to prevent overloading of the blower and driver.

.2 Mount the pressure relief valve on the discharge side of the blower mounted after the discharge silencer and before the check valve.

.3 Select a relief valve capable of passing 100 percent of the design flow to prevent overload on blower and driver.

.4 The pressure relief valve shall also be housed by the sound enclosure with a relief into a segmented section of the sound enclosure.

.3 Expansion joints:

.1 Provide each blower package with a flexible connector at the inlet and the discharge of the package.

.2 The flexible connectors shall be sized for a standard Schedule 40 pipe diameter to prevent the transmission of noise and vibrations from the blower package into the piping.

.3 Configure the flexible section as a single convolution able to withstand longitudinal and radial stresses developed during the blower operation.

.4 Select the material of the flexible section of the expansion joint to withstand continuous duty operating pressure of 80 kPa and 150°C temperature.

.5 Furnish retaining rings and control rods with each expansion joint to allow maximum concurrent longitudinal movements, hoop stress, and flange sealing.

.6 Provide expansion joints with flat-faced flanged end connections to ANSI Class 125 standard.

.4 Inlet filter:

.1 Provide cleanable and replaceable dry type line size, inline air filters suitable for 120 percent of the design volume, and capable of retaining at least 98 percent of particles 10 microns or larger.

.2 Inlet filter shall be suitable for indoor installation.

.3 Filter element shall be washable.

.4 Filter performance losses shall be included by the blower manufacturer in the blower performance calculation.

.5 Inlet silencer:

.1 Provide each blower with a combination chamber and absorptive design inlet silencer.

.2 Silencer performance losses shall be included by the blower manufacturer in the blower performance calculation.

.6 Discharge silencer:

.1 Each blower shall be supplied with one combination base frame discharge silencer. The silencer shall be a chamber type design for maximum sound attenuation without the use of fibrous materials or any absorption materials or internal diffusers.

.2 Provide a silencer with a single shell of pressure vessel quality steel with continuous welds. The silencer must be subject to a pressure test for tightness and strength at a minimum of 1.65 times the pressure setting of the pressure safety valve.

.3 The temperature rating shall be 150°C.

.4 The design of the silencer shall accommodate being bolted directly to the blower discharge flange with no intermediate pieces as well as to prevent pipe beating noise or pipe harmonics whether one blower or multiple blowers are running.

.5 The discharge silencer shall reduce the noise emitted by the piping leaving the blower package to over the entire range of operation, based on carbon steel, schedule 40 piping of a diameter equal to the blower package nominal connection size. A grounding lug fully welded to the base shall be supplied by the blower manufacturer.

.6 Discharge silencer performance losses shall be included by the blower vendor in the blower performance calculation.

.7 Gauges:

.1 Provide gauges on the discharge piping of each blower.

.2 Provide glycerin filled type with 60 mm dial, 6.35 mm bottom connection, stainless steel movement Bourdon tube gauges.

.3 For the discharge gauge select a range of 0 to 150 kPa. For the suction gauge select a range 600 mm water column vacuum to 600 mm water column positive pressure. Indicate the units of measurement on the face of the gauge.

.4 Provide a differential pressure indicator transmitter for the inlet filter.

.8 Check valve:

.1 Comply with requirements in Section 15100.

.2 Each blower shall be supplied with one check valve factory-installed on the discharge line.

.3 Provide a check valve of the full bore low pressure drop, flapper type design with a cast aluminum body, valve plates of aluminum bronze or other corrosion-resistant material and an EPDM flat full-contact seal.

.4 The valve shall be removable without disturbing the piping.

.5 Check valve performance losses shall be included by the blower vendor in the blower performance calculation.

.9 Temperature transmitters:

.1 For the inlet, discharge, and enclosure provide Type 304 stainless steel, bimetallic element temperature indicators dampened with silicone for vibration reduction. Unit shall have digital readout and stainless steel thermowell.

.2 Provide minus 50°C to 50°C range on inlet, 0°C to 150°C range on discharge.

.10 Switches:

.1 Inlet vacuum switch with brass thermowell, NEMA 4X.

.2 Discharge pressure switch with brass thermowell, NEMA 4X.

.3 Blower vibration switch and mounting hardware for blowers with motors greater than 150 kW.

.4 Motor vibration switch and mounting hardware for motors greater than 150 kW.

.11 Junction panel:

.1 Each blower shall be supplied with a NEMA 4X junction panel in compliance with Division 16.

.2 Permanently mount the panel to the equipment base frame with the top of the panel approximately 1600 mm above floor level.

.3 Make the panel accessible for viewing and maintenance without interfering with, or requiring removal of the acoustic enclosure.

.4 Install and pre-wire all instrumentation, control devices, and cooling fan, and other equipment from the blower to terminal strips in the panel.

.5 Segregate control wiring, power wiring, and respective terminals into separate groups based on voltage and function.

.6 Two 120 VAC power circuits shall be provided to the panel for control power and the enclosure cooling fan, respectively.

.16 Acoustic air intake box:

.1 Provide galvanized steel acoustic air intake box for each blower. Box shall be externally mounted on blower building wall. Box to include duct transition, aluminum louvres, and acoustic foam.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each size of blower:

.1 Set of belts.

.2 Set of filter elements for each air inlet filter.

.3 Two (2) bearings.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Complete the following Factory Acceptance Testing:

.1 Submit a detailed Factory Testing Plan at least two (2) months in advance of the Factory Testing. The plan must include, at a minimum:

.1 Pass and fail criteria for all factory tests.

.2 Detailed descriptions of testing procedures and methodologies.

.3 Quality control procedures to be employed.

.4 Detailed description of all testing equipment to be used.

.5 Proof that the equipment tested is the same as the equipment to be shipped to site.

.6 Format for presenting testing results, clearly indicating outcome of all testing performed, and comparison of results to the pass and fail criteria.

.7 Test the actual assembled unit being supplied. Prototype model tests and calculated or interpolated data based on previous model testing are not acceptable.

.8 Blower test:

.1 Mechanical Test: Conduct a factory mechanical test to prove mechanical integrity. If the test indicates that adjustments are necessary to conform with Specifications, make these adjustments prior to shipment. Unless otherwise specified, provide a certified report of a mechanical test of each blower furnished. For the mechanical test, operate the units at or near peak design conditions for a minimum of one (1) hour after blower temperatures are stabilized. Record test data including: duration of the test, bearing temperatures, speed, brake horsepower, pressure and temperature rise and vibration level.

.2 Performance Test: Conduct and submit a certified report of a performance test of the blowers furnished for review. Perform the performance test in accordance with the proposed Annex G to ISO-5389. Consider the overall power draw in the testing, including losses through transformers, drives,

filters, and all ancillary equipment and equipment necessary to the operation of the blower, as well as parasitic loads.

.9 Motor Test:

.1 Perform tests in accordance with the ANSI/IEEE Standard 112 and ANSI C52.1 Parts 12 and 20 NEMA No. MG1).

.2 Routine Test: Conduct and submit a certified report of a routine test of each motor furnished for review. Test to include running light current, power input, and high potential.

.3 Certified data: Furnish certified data for motor efficiency and power factor at 100, 75, and 50 percent of full load based on test data of a motor of identical design.

.4 Blower Package Testing: On completion of final assembly of the packaged blower and prior to shipment, run each packaged blower for a minimum of 30 minutes to prove compliance with the Specifications.

.10 In the event the blower equipment fails to meet the performance requirements specified, the Manufacturer to modify or replace the blower equipment to meet the performance requirements specified.

.11 Perform the second test, if required, and any subsequent tests as may be necessary to prove compliance with Final Design.

END OF SECTION

SINGLE-STAGE CENTRIFUGAL INTEGRALLY GEARED BLOWER

1. GENERAL

1.1 Summary

.1 This Section describes the design, manufacture, supply, witnessed factory testing, functional testing, delivery, installation, testing and commissioning of the single-stage centrifugal integrally-geared blower equipment, as specified herein.

.2 With each blower include the drive motor, the lubrication system, the blower pressure/volume control system, the surge control system, the local control panel and the termination panel for all wiring to the automation system.

.3 Provide the control instrumentation in a separate cabinet, as required.

1.2 Standards

.1 CSA C22.2, No. 29 - Panelboards and Enclosed Panelboards

.2 ASME Power Testing Code PTC-l3.

.3 ANSI Cl 125 Flanges.

.4 API Std. 617 rotary association dynamic balancing.

.5 NEMA.

.6 IEEE:

.1 IEEE Std. 85

.2 IEEE Std. 112

.7 International Building Code (IBC).

.8 ABMA:

.1 ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.9 ASTM:

.1 A 48 - Standard Specification for Gray Iron Castings.

.2 A 108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.

.3 A 27G - Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes.

.4 A 283 - Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

.5 A 576 - Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality.

.6 A 743 - Standard Specification for Castings, Iron-Chromium, Iron-Nickel, Corrosion Resistant, for General Application.

.7 E 10 - Test Method for Brinnell Hardness of Metallic Materials.

1.3 Definitions

.1 Blower package: Blower package is defined by the limits of the scope of supply as specified in the overall project contractual agreement pertaining to the blower installation. This shall include all deliverable components to form an operational machine including but not limited to inlet, discharge, and all power devices that affect power consumption.

.2 Standard cubic metre per minute (SCMM, Sm^3/min): the volumetric flow rate in cubic meters per minute at standard conditions. Standard conditions defined as 20°C, one atmosphere (101.325 kPa), and 36 percent relative humidity.

.3 Actual Cubic Meters per Minute (ACMM or Am3/min): the volumetric flow rate in cubic meters per minute actually entering the blower under the specified environmental conditions.

.4 Discharge Pressure: the absolute total pressure that exists at the discharge measuring station. Unless specifically stated otherwise, this is the blower discharge pressure as used in PTC-13; in kPa at site conditions.

.5 Shaft Power (Brake Power): power required at the blower drive-shaft, equal to the sum of mechanical losses and the internal power, not including losses in external transmissions such as gear drives or belt drives unless part of the scope of supply, as defined by ASME PTC-13 -201X DRAFT, (June 2014) paragraph 2-3.1 (d), or most recent version of PTC-13.

.6 Isentropic Head: is the work required to isentropically compress (a reversible, adiabatic compression process where entropy remains constant) a unit mass of gas from the inlet total pressure and total temperature to the discharge total pressure. The total pressure and temperature are used to account for the compression of the gas and the change in the kinetic energy of the gas. The change in the gravitational potential energy of the gas is assumed negligible between inlet and outlet process connections.

.7 Overall Efficiency: total efficiency for blower motor, drive, transformers, oil pumps and all other equipment ancillary to or necessary for the operation of the blower from motor terminals to pumped air.

.8 Capacity: the net rate of flow compressed and delivered, expressed in terms of m^3 per minute at the prevailing inlet temperature and pressure. Airflow to be measured on the discharge side of the compressor at zero percent tolerance.

.9 Turn-down ratio: ratio expressed in percentage of the difference between maximum and minimum speed divided by the maximum speed of the main driver

.10 Blower package total wire power: The blower package total wire power (Pwire) is the electrical power measured at the power input to the blower package. This shall include all power consuming electrical components of the blower package as required for installation and normal operation. i.e., drive motor, motor cooling fan, bearing cooling fans, coolant pump and heat exchanger, enclosure and package cooling fan, sine wave filter or output reactor, variable frequency drive and cooling fan, input choke or line reactor, harmonic filter, local control panel, PLC or processor, HMI and miscellaneous electronics, voltage

transformer(s), DC power supplies, power conditioner, etc. If the blower package receives multiple power feeds, this is the sum of all wire powers measured individually.

.11 Dynamic Blower Surge Point: The blower surge point, for a given speed, is the inlet volumetric flow below which the blower operation becomes unstable. This occurs when flow is reduced and the blower back pressure exceeds the pressure developed by the blower and a breakdown in flow results. This immediately causes a reversal in the flow direction and reduces the blower back pressure. The moment this happens, regular compression is resumed and the cycle is repeated.

.12 Specified Operating Conditions: The specified operating conditions are those conditions for which the blower performance is to be determined.

.13 Test Operating Conditions: The test operating conditions are the operating conditions prevailing during the test.

.14 Acceptance Test: performance test carried out in accordance with ASME PTC l3, to determine if a new or modified piece of equipment satisfactorily meets its performance criteria, permitting the purchaser to “accept” it from the supplier

.15 Packaged blower power input: (electrically driven machines) sum of the electrical power inputs to the prime mover and any ancillaries and auxiliaries driven from the blower shaft or by a separate prime mover at rated supply conditions, including the effect of all equipment included in the package

.1 Auxiliaries include appurtenances such as oil pump, cooling fan and integral compressed air dryer.

.2 Rated supply conditions refer to phase, voltage, frequency and ampere capability.

1.4 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Guaranteed maximum power consumption information.

.2 General description of blower with all performance data including noise levels in dBa at operating conditions.

.3 Certify that the motor starting torque is compatible with the blower requirements.

.4 Provide a statement describing the rotating speed and lateral critical speeds of the blower system.

.5 Provide a detailed description that demonstrates the simultaneous, automatic, and continuous efficiency optimization using the change in speed to obtain the lowest power consumption, based on variables such as inlet temperature, inlet pressure, discharge pressure, relative humidity, and machine capacity.

.6 Results of vibration, critical speed and torsional analysis as indicated in this Section.

.7 Operating description for the local control panel covering all logic and sequences of operation. P&IDs of the complete blower system. Illustrate the approach implemented to coordinate controls through all operating scenarios with the existing blower installation.

.8 Blower Testing – Submit a detailed test plan with complete piping and instrumentation configuration diagram per ASME PTC-13 showing inlet and discharge air test pipe size.

.1 The location, type, and quantity of major instruments necessary for performance data with corresponding distances from reference points, shall be identified per ASME PTC-13 requirements.

.2 As a minimum, the detailed test plan shall include:

.1 Quality control procedures.

.2 ASME PTC-13 test procedure and method of calculating results.

.3 Functional testing of the entire package, including instrumentation, ancillary components, and temporary blower logic and integrated logic controllers.

.3 Insert the actual ASME PTC-13 test report into the O&M Information.

.9 Vibration and critical speed analysis in accordance with Section 11020.

1.5 Quality Assurance

.1 The blower supplier's machining and assembly shops shall be ISO 9001-certified and the blower supplier shall demonstrate proof of current ISO 9001 certificate status in order to assure conformance to the highest quality standards of the industry.

.2 Manufacturer of the blowers to be completely responsible for the proper design or selection of their system components, including but not limited to; blowers, VFDs, blow-off valves, and controls. All equipment is to perform as specified and the completed installation operate in accordance with the requirements of the Final Design.

.3 Additionally, the blower supplier shall furnish authorized and qualified installation engineers to supervise the adjustment, testing, and initial start-up of the indicated equipment and appurtenances.

.4 Coordination:

.1 Coordinate all work with those of other Divisions to ensure there are no conflicts in the work.

2. PRODUCTS

2.1 Description

.1 The single-stage integrally-geared centrifugal blowers supply process air to the aeration system.

.2 The blowers operate in cascade, at variable volume in response to process signals to maintain constant pressure in the discharge header.

.3 This specification is based on a design which employs a control philosophy using inlet guide vanes and variable diffuser vanes. This does not preclude acceptance of other control philosophies which do not use inlet guide vanes or variable diffuser vanes.

2.2 Acceptable Manufacturers

.1 Supply all products from a single manufacturer.

.1 Atlas Copco.

.2 Howden Roots.

.3 Howden Turblex.

.4 Or approved equivalent.

2. PLC and HMI products shall conform with Appendix 18E – Standardized Goods.

2.3 Performance Criteria

.1 The single-stage centrifugal integrally-geared blower supplies variable volumes of air to the aeration tanks as required for the Final Design. The air demand will vary in response to the influent flow and load conditions and the number of activated sludge basins in operation.

.2 The blower supply air shall be taken directly from a common plenum room.

.3 The air entering the suction header from the plenum will be unfiltered.

.4 The single-stage centrifugal integrally-geared blower will operate in cascade with other blowers, at variable volume in response to process signals to maintain constant pressure in the discharge header.

.5 Provide all material, labor and equipment required to produce a fully functioning system.

.6 Ensure that blowers can be turned down to a minimum flow that is 45 percent of the rated flow.

.7 Design the system such that operation of blowers in parallel is possible without special requirements.

.8 Process Information:

.1 The blower is to provide low pressure process air to the aeration tanks to maintain the desired dissolved oxygen concentrations.

.2 The service conditions for the following parameters shall conform to the Final Design:

.1 Site elevation.

.2 Relative humidity:

.1 Maximum temperature.

.2 Minimum temperature.

.3 Maximum and minimum dry bulb temperature.

.4 Barometric pressure.

.5 Blower inlet absolute pressure; allow for pressure losses in the inlet filters, ducting and other appurtenances upstream of the blower housing.

.3 The design capacity for the following parameters shall conform to the Final Design:

.1 Maximum (future conditions):

.1 Flow.

.2 Pressure.

.2 Maximum (existing conditions):

.1 Flow.

.2 Pressure.

.3 Average:

.1 Flow.

.2 Pressure.

.4 Minimum:

.1 Flow.

.2 Pressure.

.9 Provide single-stage centrifugal integrally-geared blower capable of operating for the full range of ambient conditions defined in Part 1 of this Section. The design criteria for the following parameters shall conform to the Final Design:

.1 Required minimum air flow.

.2 Required average air flow.

.3 Required maximum air flow.

.4 Discharge pressure at maximum air flow.

.10 Testing: Follow all requirements of the most recent revision of the proposed ASME PTC 13 for Factory Acceptance Testing and performance guarantees.

.1 Complete the following Factory Acceptance Testing:

.1 Submit a detailed Factory Testing Plan at least 30 days in advance of the Factory Testing. The plan must include, at a minimum:

.1 Pass/fail criteria for all factory tests.

.2 Detailed descriptions of testing procedures and methodologies.

.3 Quality control procedures to be employed.

.4 Detailed description of all testing equipment to be used.

.5 Assurance that the equipment tested is the same as the equipment to be shipped to site.

.6 Format for presenting testing results, clearly indicating outcome of all testing performed, and comparison of results to the pass/fail criteria.

.2 Perform tests on the actual assembled unit being supplied for this project. Prototype model tests and calculated values based on previous model testing are not acceptable.

.2 Blower Tests:

.1 Mechanical Test: Conduct a factory mechanical test to assure mechanical integrity. If the test indicates that adjustments are necessary to ensure conformance with specifications, make these adjustments prior to shipment. Unless otherwise specified, provide a certified report of a mechanical test of each blower furnished. For the mechanical test, operate the units at or near peak design conditions for a minimum of one (1) hour after blower temperatures are stabilized. Record test data including: duration of the test, bearing temperatures, speed, brake horsepower, pressure and temperature rise and vibration level.

.2 Performance Test: Performance tests will be witnessed by the designers and notification will be given to the City.

.3 Tests shall be in accordance with the ASME Power Test Code for Centrifugal Compressors and Exhausters, PTC-13, most current edition, prior to the testing date. The input wire horsepower to the motor shall be determined at the guarantee points. Conduct and submit a certified report of a performance test of the blowers furnished for review. Consider the overall power draw in the testing, including losses through transformers, drives, filters, and all ancillary equipment and equipment necessary to the operation of the blower, as well as parasitic loads.

.4 The test shall include the determination of the surge point at each point tested including minimum and maximum points, verification of the guarantee points, and verification of the minimum and maximum operating points.

.5 The blower test report shall present computations as defined by PTC 13 with performance curves showing capacity, pressure, and horsepower inputs.

.6 Test results not in verbatim agreement with test results presentation format per the Code shall be cause for rejection of the performance tests.

.7 Tolerances:

.1 The compressor net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance.

.2 There shall be no other tolerances or measuring uncertainties used in reporting the test results, i.e., the tests shall be reported with plus or minus zero percent tolerance.

.8 The test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date.

.9 Submit certifications showing the stability of calibration over a period of at least one (1) year per ISO 9001.

.10 Power Consumption:

.1 Power consumption shall be in accordance with the requirements of ASME PTC-13 testing as determined by the Professional of Record prior to the testing date.

.2 The Manufacturer's Representatives will assign an evaluated factor to each guaranteed point.

.3 Evaluated factors will estimate the amount of time that the defined condition would occur, and their sum will be equal to one.

.4 A total factored power draw will be obtained by multiplying each guaranteed point times the corresponding evaluated factor and summing the results.

.3 Motor Test:

.1 Perform tests in accordance with the ANSI/IEEE Standard 112 and ANSI C52.1 Parts 12 and 20 NEMA No. MG1.

.2 Routine Test: Conduct and submit a certified report of a routine test of each motor furnished for review. Test to include running light current, power input, and high potential.

.3 Certified data: Furnish certified data for motor efficiency and power factor at 100, 75 , and 50 percent of full load based on test data of a motor of identical design.

.4 In the event the blower equipment fails to meet the performance requirements specified, the manufacturer is to modify or replace the blower equipment to meet the performance requirements in the Technical Requirements.

.5 Perform the second test, if required, and any subsequent tests as may be necessary to ensure compliance with Final Design.

.4 Functional Testing:

.1 Perform the Functional Testing activities specified in Related Sections listed in Part 1 of this Section and the following additional testing activities.

.2 Upon completion of assembly, each blower, motor, and VFD, if applicable, assembly shall be functionally tested with the local termination panel connected to the local control panel, skidded instruments, electric valves, and appurtenances.

.3 Performance tests shall be witnessed by Design Builder. The City will be notified and may attend the testing.

.4 A temporary blower logic controller is to be connected to the blower termination panel in substitution of the automation system for the purpose of all factory testing. The functionality within the temporary blower logic controller shall be identical to that specified in the control descriptions provided for the configuration of the automation system.

.5 The proposed test procedure shall be submitted to Professional of Record for approval prior to scheduling the test.

.6 Functional operation and control testing shall be conducted.

.7 Components shall be individually inspected to confirm adherence with the Final Design.

.8 Design Builder shall sign the test procedure and results, certifying that the assembled blowers, auxiliaries, blow-off, discharge, air flow control valves, temporary blower logic and integrated logic controllers, were tested together, as a system, in the blower supplier's shop facility.

.5 Vibration Testing:

.1 Procedures: Section 11020.

.2 Vibration Limits: not to exceed the limits specified in Final Design.

.3 Perform vibration tests at all/each specified operating condition.

.11 Cooling system:

.1 Blower manufacturer to provide an integral cooling system for blower assembly. Cooling system must be fully integrated to allow automatic operation and blower protection together with the starting and stopping of the blower.

.12 Sound Pressure (Noise) Level:

.1 For each blower and motor package ensure that the sound pressure (noise) level does not exceed 80 dBA measured at a minimum of 1m distance from any point around the blower and motor skid. Noise level measured in accordance with ASME 36-1985 “Measurement of Industrial Sound”.

.13 Vibration Level:

.1 The vibration isolators to be designed for a transmissibility of less than 2 percent.

.2 Maximum vibration level in the shop is not to exceed 3 mm/s RMS when measured at every point on the blower bearing housing (vertical, horizontal and axial planes and measured at every operating blower speed).

.3 Maximum vibration level in the field must not exceed 4 mm/s RMS when measured in the vertical plane of blower bearing.

2.4 Configuration, Components and Features

.1 General:

.1 The blowers shall be used for supplying a variable volume of air to the aerobic zones of the activated sludge basins and channels as indicated.

.2 Detailed control descriptions and supporting complete sequential function charts (as defined in IEC 61131) for each blower and the integrated blower control system for optimized system operation.

.3 The items indicated in this Section shall be furnished by the blower supplier in order to provide a sole source responsibility for a properly functioning process air system with the objective to minimize power consumption while providing the proper volume of air to the activated sludge basin aerobic zones.

.4 The blowers shall be integrally-gear driven, single-stage centrifugal, complete with accessories as described herein. Each blower shall be provided with axial inlet, side discharge.

.5 Design each blower to operate at optimum specific speed in order to maximize adiabatic efficiency and reduce motor speed, (if VFDs are required).

.6 Provide blowers capable of operating continuously and satisfactorily at any point between the minimum and maximum air flow without any surge, vibration, hunting, or excessive heating of bearings or motor.

.7 Provide blowers capable of operation with a minimum turndown of 55 percent.

.8 Provide blowers that are CSA name plate certified. Failure to comply with this certification requirement results in rejection.

.9 Blower is not to surge or exceed the nameplate motor rating over the entire range of operation when operating singly, or in cascade with other blowers. The surge margin to maintain a minimum rise away from surge at any point in the blowers capacity range shall conform to the Final Design.

2.5 Materials

.1 Fabricate blower casing of cast iron, ASTM A278, Class 30B.

.2 Fabricate bearing housing of cast iron, ASTM A278, Class 30.

.3 Fabricate gearbox housing of cast iron, ASTM A278, Class 30B.

.4 Fabricate variable diffuser vanes of bronze or aluminum alloy.

.5 Fabricate impeller of forged aluminum alloy.

.6 Fabricate shaft of heat-treated forged steel.

.7 Fabricate base of structural steel, ASTM A36.

2.6 Blowers

.1 Provide integrally-geared single-stage centrifugal type blowers with end-suction, side-discharge, modulating inlet guide vanes, variable diffuser vanes, variable frequency drive (if required), integral speed-increasing gear, direct-coupled motor, lube oil system, vibration isolation system, seismic restraint system, discharge cone/silencer, inlet filter, inlet and blow-off silencers, inlet and discharge expansion joints, discharge check valve, automated discharge isolating valve, automated blow-off valve, instrumentation and control system.

.2 Design the blower so that air passes axially through an annular inlet in the blower casing.

.3 Blower casing shall not exceed 204°C (400°F) (continuous duty) or 50 psi.

.4 Provide the blower discharge flange drilled to ANSI B16.1 Class 125.

.5 The blower inlet shall be field connected directly to the inlet silencer by means of a flexible connection supplied by the blower supplier.

.6 Provide a threaded port, complete with stainless steel plugs at the lowest point of the casing for drainage.

.7 Provide the blower with lifting lugs capable of supporting the individual units such as the blower end, gear box and motor.

.8 Align the blower and motor on the base at the factory prior to shipment.

2.7 Impeller

.1 The impeller shall be of the open radial flow type, with backward leaning blades milled from forged aluminum alloy. Impellers constructed of any other method or material shall not be acceptable, except as described below.

.2 Aerodynamic design shall incorporate CFD with two (2) stages in one (1) (axial and centrifugal) and with first lateral critical speed at least 120 percent of the maximum allowable operating speed. Closed impeller designs or impellers constructed by other methods or of other materials, or the blower supplier not utilizing CFD analysis, will not be accepted.

.3 The impeller shall be statically and dynamically balanced.

.4 Provide shims to adjust the axial gap between the impeller and blower casing in order to assure the prescribed gap.

2.8 Shafts

.1 Any responsive lateral critical speed of the rotating assembly shall be at least 15 percent from the normal operating speed.

.2 Any torsional resonances of the package shall be at least 10 percent from the normal operating speed.

.3 The shafting shall conform to "Design and Selection of Components for Enclosed Gear Drives," AGMA 6001-D97.

2.9 Seals

.1 Provide air and oil shaft seals to contain the compressed air inside the blower casing, to prevent oil from leaking out of the gearbox, to prevent air from entering the gearbox casing and to avoid contamination of the lube oil with compressed air, dirt or moisture.

.2 Provide non-contact, multi-port labyrinth type shaft seals, to be operated dry. Provide a vented space between air and oil seals.

.3 The female part shall be made of aluminum or bronze in order to avoid damage to the shaft in the event of a seal rub.

.4 Provide sufficient slinger rings (diameter changes) on the shaft sealing area to ensure oil is centrifugally slung off the shaft.

.5 A uniform shaft diameter without multiple slinger rings in each sealing area will not be accepted.

.6 Design the shaft seals to be replaceable without having to disconnect any piping.

2.10 Bearings

.1 Provide cylindrical-journal bronze drive shaft radial bearings.

.2 Provide multiple-segment, bronze drive shaft thrust bearings, designed for thrust in both directions.

.3 Provide multiple-segment, babbitted-bronze pinion shaft radial bearings.

.4 Provide multiple-segment, tapered-land, bronze pinion shaft thrust bearings type, designed for thrust in both directions.

.5 Provide radial and thrust bearings pressure lubricated with sufficient oil film thickness under all operating conditions.

.6 Do not use ball bearings for any bearings in the gearbox.

.7 Size all bearings for an AFBMA B-10 bearing life of 100,000 hours.

.8 Mount bearings in outboard cast iron housings to effect a complete separation between the bearing and the casing to isolate the bearing from the heat generated by the machine.

.9 Provide bearings which are replaceable without disconnecting any piping or disassembling the machine.

2.11 Balance

.1 Accurately machine all rotating parts to ensure that they are as close to perfect rotational balance as practicable. Excessive vibrations to be sufficient cause for rejection of the equipment. The mass of the unit and its distribution to be such that resonance at normal operating speeds is avoided.

.2 Rotors shall be balanced at maximum speed to ISO 1940-1973, Quality Class 1.6.

.3 Statically and dynamically balance each impeller and dynamically balance the complete rotating assembly independently from the shaft. Design the rotating assembly to operate at least 20 percent removed from first critical speed.

.4 Electrically- or mechanically-induced vibration in the completed rotor assembly shall not exceed 3.0 MILS, peak-to-peak.

2.12 Inlet Guide Vanes and Variable Diffuser Vanes

.1 The purpose of the inlet guide vane and variable discharge diffuser system shall be to facilitate turndown of each blower from 100 to 45 percent of capacity, while maximizing efficiency over the turndown range.

.2 Inlet Guide Vanes:

.1 An adjustable inlet guide vane assembly shall be provided to pre-rotate incoming air and thus maximize efficiency.

.2 Inlet guide vanes shall be constructed in an aerodynamic, streamlined design in cross-section and located in a radial fashion around the annular inlet.

.3 Provide and position at least 13 asymmetrically profiled vanes in a velocity increasing air duct in order to minimize downstream wakes.

.4 The inlet guide vanes shall modulate simultaneously in coordination with the diffuser vanes via a continuous multi-point control algorithm to continuously optimize efficiency based on inlet temperature, differential pressure, and machine capacity.

.5 The blower supplier shall demonstrate, in submittals and testing, the simultaneous efficiency optimization based on these variables.

.6 Step-control or other control methods of vanes, which are less efficient, or control using less than these three variables, will not be accepted.

.3 Variable Discharge Diffuser Vanes:

.1 Provide variable discharge diffuser vanes for capacity control.

.2 The variable discharge diffuser vanes shall be designed to obtain the highest efficiency over the entire regulating range, and the vanes shall be aerodynamically shaped for maximizing efficiency.

.3 Provide at least seventeen (17) profiled diffuser vanes and arrange them in a radial fashion around the periphery of the impeller.

.4 Flat steel plates shall not be used for inlet guide vanes or the variable diffuser vanes.

.5 The inlet guide vane and the variable diffuser assemblies shall be mounted integrally with each blower, multi-leaf and pivoted, and located in cast iron housings.

.6 The vanes shall be mounted in permanently lubricated sleeve bearings.

.7 Operating linkages for inlet guide vanes and variable diffusers shall be housed within the blower.

.8 Blowers with variable vane assemblies located external to the blower housing, or having ball-in-socket linkages or other moving parts requiring periodic lubrication, will not be accepted.

.4 Actuator:

.1 Each variable vane assembly shall include a skid mounted electric actuator, limit switches, and open/closed indication on the LCP.

.2 Independent floor mounting of the actuator or its operating mechanisms will not be accepted.

.5 Position Indication:

.1 The position of each set of vanes, from fully open to fully closed, shall be transmitted to the LCP via an analog signal.

.2 The position of both sets of vanes shall be indicated by an adjustable manual lever arm and calibrated dial on the blower.

.3 The inlet guide vane and the diffuser vane position shall be indicated on the LCP.

2.13 Casing

.1 Blower casing is to have a maximum continuous duty design temperature of 200°C, and a design pressure of 300 kPag.

.2 Suction and discharge ports to be flanged. Flanges to be flat faced with diameter and drilling conforming to ANSI B16.1, Class 125.

2.14 Gear Drive Housing

.1 The gear drive housing shall be horizontally or vertically split, and shall be sufficiently rigid to maintain the shaft positions under maximum loads.

.2 Inspection Ports:

.1 Provide two (2) inspection ports, with bolt-on covers, in the upper portion of the gearbox housing.

.2 The ports shall allow access to the gearbox internals for inspection.

.3 Adjustment of the vibration proximity probes on the high-speed shaft shall be possible from the outside of the gearbox.

.4 Fast-Shaft Access:

.1 The need to disassemble the gearbox for fast-shaft proximity probe adjustment will not be accepted.

.2 Provide a circular, removable bolt-on plate located on the fast shaft centerline, opposite the impeller end.

.3 This removable plate shall facilitate inspection and replacement of the fast shaft opposite impeller end bearing without disassembly of the gearbox.

2.15 Speed Increasing Gearboxes

.1 Gearbox configuration shall incorporate a single helical gear set in an over/under configuration.

.2 The overhung impeller and fast-shaft shall operate between the first and second critical speeds.

.3 Provide gears manufactured of case-hardened alloy steel forging with gear teeth precision ground, all to a minimum AGMA quality number no less than 12, as specified in AGMA 2000.

.4 Size the gearbox for a service factor of 1.8 minimum.

2.16 Couplings and Guards

.1 Connect blower to drive unit with a flexible forged steel spacer coupling, double disk type.

.2 Size couplings to transmit power required to drive blower under all conditions of operation with a service factor of minimum 1.5.

.3 Provide an approved coupling guard of heavy-gauge steel, bolted solidly in place.

.4 Dynamically balance coupling and spacer independently to AGMA class 8, or better, suitable for maximum continuous speed.

.5 Provide coupling guard.

2.17 Oil Lubrication Systems

.1 Provide a complete lube oil system with each blower capable of supplying clean oil at suitable pressure and temperature to lubricate the speed increasing gears and bearings. Install all components of the lubrication system integral with the blower base and arranged to permit ease of access for operation, maintenance, inspection and cleaning.

.2 Include with lube oil system a three (3) minute minimum detention time oil reservoir, two (2) positive displacement pumps, an oil-to-water heat exchanger, duplex oil filter, and other miscellaneous appurtenances. Install pressure gauge, thermometer, adjustable high and low temperature switches and adjustable low oil pressure switches on each lube oil system.

.3 Provide one (1) shaft-driven and one (1) electrical motor driven oil pump, each of adequate capacity to supply lubrication for the air blower/gearbox when operating and during start/stop.

.1 Operate the electric motor driven pump as a stand-by unit activated at low oil pressure by the control system located in the local control panel. Supply gearbox with a high level reservoir (incorporated in the gearbox cover) or a bladder accumulator to supply a sufficient amount of oil during rundown of blower in case of power failure. Provide high efficiency motor.

.4 Provide full flow, replacement cartridge duplex oil filter, capable of removing particles over 10 microns with a clean oil filter pressure drop not exceeding 100 kPa at design temperature and flow. Filter cases suitable for operation at a pressure not less than the relief valve setting. Provide a visual gauge to indicate when a filter is dirty and requires changing.

.5 Provide water-to-oil oil cooler for each blower, mounted on each blower skid capable of maintaining required cooling rate at all ambient temperatures. Cooler rated to dissipate the total heat emitted from the blower gearbox.

.6 Furnish water-to-oil cooler with a cooling water flow control valve and an on/off water solenoid valve.

2.18 Blow-off/Bypass Valve

.1 Provide each blower with a flanged steel or cast iron body discharge butterfly valve for field installation and wiring to the LCP. The actuator shall be for open/close service with an open/close time no faster than 15 seconds.

.2 Control power for the valve shall be derived from the associated LCP.

.3 3-phase, 600 VAC power for the valves shall be derived from the associated LCP.

.4 The valves shall be fitted with electric motor actuators with controls.

.5 The valves shall be suitable for air service up to 121. °C (250°F).

.6 Provide bolting and gaskets as indicated and as appropriate for the service.

.7 Upon loss of signal, the valve shall hold position.

.8 Valves shall be model BAW by Dezurik or equal.

.9 Actuators shall be Rotork, or approved equivalent.

.10 Mount controls for the valve in each LCP with indicator lights to annunciate fully open or closed.

2.19 Blow-off Silencers

.1 Provide a carbon steel blow-off silencer for each blower and the main air header blow-off valve.

.2 Internal baffles, packed with a sound absorbent material, shall direct air flow around 3, 90 degree turns in an annular flow configuration.

.3 The blow-off silencer shall be an integral unit, fitted with one flange for direct bolting to the blow-off valve or piping.

2.20 Discharge Check Valve

.1 The check valve shall be suitable for use in the indicated service and capable of providing an airtight seal upon closure with minimum pressure loss when open. The check valve shall be of the dual disc type by Crane or Valmatic or approved equivalent.

.2 Design Builder shall mount the check valve in a horizontal run of piping.

.3 Check valves shall be provided for each blower discharge line and each individual blow-off line.

2.21 Main Air Header (Bypass) Valve

.1 Provide a lug style carbon steel body high performance butterfly valve, to be field-installed by Design Builder on the main air header, in order to allow excess air to be blown off to the atmosphere as necessary.

.2 Valve disks shall be nickel coated carbon steel.

.3 The valve shall be fitted with an electric motor actuator with controls.

.4 The blow-off valve shall be a “high performance” butterfly valve with offset seat and eccentric shaft.

.5 The modulating valves shall be sized by the blower supplier for control over the operating range, and each shall have a modulating positioner.

.6 Submittal information shall include a detailed analysis of sizing, including valve flow linearity versus flow.

.7 The valve shall be suitable for air service up to 121.11°C (250°F).

.8 The valve operator shall be for modulating service with an open/close time of fifteen (15) seconds or less.

.9 The valve shall have a Nitrile or TFE liner and bubble-tight shutoff, and shall be sized for not less than the blower’s rated capacity and open/close operation.

.10 Provide bolting and gaskets as indicated and as appropriate for the service.

.11 Upon loss of signal, the valve shall hold position.

.12 Valves shall be model BHP by Dezurik or approved equivalent.

.13 Actuators shall be Rotork or approved equivalent.

.14 Field Instruments:

.1 Two (2) main air header pressure transmitters shall be provided.

2.22 Expansion Joints

.1 Provide suction and discharge suitable wire reinforced rubber sleeve or single arch molded rubber expansion joints for each blower. The expansion joints to be installed between the blower and the suction and discharge piping to prevent the transmission of excessive vibrations, noise and to permit pipe expansion.

.2 The expansion joints to be provided with ANSI Class 125 pound drilled flanges for piping connection.

.3 The temperatures on the suction and discharge side of the blowers that the expansion joints are to be capable of withstanding shall conform to the Final Design.

2.23 Inlet Air Filter and Silencer

.1 Filter:

.1 Provide each blower with an inlet filter/silencer assembly designed for maximum air flow.

.2 The filter elements shall be rectangular, replaceable elements mounted on a flat, vertical track of aluminum construction, and removable through painted or galvanized steel doors located on each side of the painted or galvanized steel housing.

.1 The filter system shall be a two stage panel system.

.2 The coarse pre-filter shall have a removal efficiency of 93 percent on 10 micron.

.3 The final filter element shall have a removal efficiency of 99.5 percent on 2 micron.

.4 The filters shall be sized for a maximum face velocity of 175 m/minute at peak air flow.

.5 Pressure drop requirements shall be maximum of 64 mm water column across the clean filter system and 100 mm water column across the filter system when dirty.

.3 Install the inlet filter/silencer by connecting it to the blower inlet via a flexible connector.

.4 Include the inlet filter performance losses in all performance calculations.

.2 Silencer:

.1 Connect the silencer directly to the inlet of the blower via a flexible connector.

.2 The walls of the silencer shall consist of a sandwiched galvanized steel outer skin and an acoustical sound-deadening material comprised of a 25 mm sound insulation containing an inert barrier and located on the inside of the housing.

.3 The inert barrier shall have a thin aluminum foil on its exterior, affixed to the barrier with an industrial adhesive.

.4 Housing:

.1 The silencer housing structural frame shall be constructed of hot-dipped galvanized steel.

.2 The supporting legs shall be adjustable for vertical positioning and leveling.

.3 The silencer shall be provided with a bird screen and shall draw inlet air directly from within the plenum.

.5 Construction:

.1 The integral inlet silencer shall consist of a set of lamella, mounted internally in the filter/silencer between the filter elements and the blower inlet, and suitably wrapped with sound-deadening material.

.2 The lamella construction shall be such that there is no direct line of sight (i.e., direct flow) through the lamella, and the lamella shall be configured such that the line of air flow shall make at least four (4) turns for maximum sound attenuation.

.3 An air-tight seal shall be provided between the filter frame and silencer.

2.24 Discharge Cone/Silencer

.1 Provide a discharge cone/silencer for each single stage blower provided ("Evasé stack"), to be field-installed by Design Builder, to increase the blower outlet size to the larger diameter air discharge piping.

.2 Provide blow-off silencer with each blower sized to handle 120 percent of design air flow.

.3 The maximum sidewall angle increase shall be 7 degrees per side (14 degrees total).

.4 Use a minimum of 10-gauge carbon steel with a discharge flange and bypass flange size as indicated.

.5 Provide discharge cone/silencer with ANSI B16.1 Class 125 flanges.

.6 Provide instrument connections for components to be mounted on the cone/silencer.

.7 Control power for the instruments mounted on the cone/silencer shall be derived from the associated LCP.

.8 The inside of the discharge cone/silencer shall be lined with deep layers of sound absorbing material, resistant to high temperatures, and covered by high temperature fibreglass cloth and a perforated steel plate (minimum 10-gauge thickness), so as to form sandwiched layers of the external cone/silencer surface, acoustical material, and internal perforated steel plate.

.9 Provide silencers having the following minimum sound attenuation characteristics:

Frequency (Hz)	125	250	500	1000	2000	4000
Band	2	3	4	5	6	7
Attenuation (%)	10	20	25	30	30	25

2.25 Base and Vibration Isolators

.1 Provide a base for each blower of adequate size to support the blower, speed increasing gear, motor, lubricating system and accessories, and to contain the oil reservoir.

.2 Mount base plate on vibration isolators suitable to absorb weight and vibration of the blower assembly without undue stress or distortion.

.3 Design the base to withstand expected installation and operational forces without affecting alignment of the blower and driver.

.4 Provide the base with lifting lugs and of sufficient rigidity to permit lifting, using a four-point lift, with all equipment mounted, without distortion or other damage to the base or to component parts of the machinery.

.5 Use a safety factor of at least 2.0 for all dead and live loads.

.6 Provide sufficient stiffness to prevent undue vibration.

.7 Design vibration isolators to carry dead and live loads and to absorb 95 percent of vibration frequency from blowers.

.8 Provide anchor bolts for vibration isolators with sufficient length to permit installation of shims or additional vibration isolators to compensate for anticipated differential settlement of the supporting structure.

.9 Provide a balanced set of vibration isolators for each blower.

.10 Size the vibration isolators at the Manufacturer's optimum recommended.

.11 Number and color code each isolator to show location. Indicate number and color code on shop drawings, on each isolator and on each base to ensure proper placement.

2.26 Electric Motors

.1 Provide each blower with an electric motor designed in accordance with current NEMA, ANSI and IEEE Standards.

.2 Motors to be premium efficiency design. Efficiencies to be determined in accordance with NEMA Standard MGI-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies to be included on motor nameplates in compliance with NEMA Standard MGI-12.53b.

.3 Provide horizontally mounted, high-efficiency, low-noise electric motors with a 1.15 service factor to drive blowers.

.4 Provide motors in accordance with Division 16.

.5 Provide induction type, motors suitable for direct line starting.

.6 Motor voltage, phase, and frequency shall conform to the Final Design.

.7 Provide motors suitable for a non-exposed, non-hazardous location.

.8 Nameplate to be NEMA standard stainless steel. Include NEMA efficiency rating, bearing information, number of starts per hour.

.9 Design Builder to be responsible for coordinating the starting torque requirement of the blower and the motor.

.10 Certified tests to be submitted prior to shipment of the equipment.

.11 Motors to have two factory installed RTDs embedded in each phase of the windings (one operational and one spare). RTDs to be 100 Ohm platinum, three wire type with transmitters for interfacing with the LCP for monitoring and alarm.

.12 Motor bearings to have factory installed RTO temperature monitoring.

.13 Design motor to ensure sufficient power available for blower throughout temperature range for air flows varying from surge to 120 percent of the design air flow.

.14 Mount the motor to the blower base in the blower manufacturer's shop.

2.27 Blower Controls

.1 General Control Requirements:

.1 Electrical equipment to comply with Division 16.

.2 Control and sensing devices to comply with Division 17.

.3 Provide instrumentation and control documentation in accordance with Division 17.

.4 Provide a Local Blower Control Panel, PLCs panel-mounted operator interface, control and HMI software, sensing devices and other appurtenances necessary to meet the functional requirements of the proposed blower control strategy

.5 Structure the PLC control programs and HMI software in accordance with standard programming practice.

.6 Provide single-stage centrifugal direct-drive blower with the ability to be controlled by discharge pressure.

.7 Provide diagnostics and troubleshooting through the HMI.

.8 Provide built in automatic surge protection.

.9 Provide built-in flow measurement, vibration measurement, temperature and pressure sensors with associated data display and adjustment capability.

.10 Provide local controls accessible through a touch screen on the local control panel.

.11 Blower is controlled using a PLC mounted in a control cabinet to be used for multiple blowers.

.2 Control Description:

.1 Blowers are started or stopped remotely through plant control system or locally from the Operator Interface at the local blower control panel.

.2 Blower inlet guide vanes and variable diffuser vanes are operated automatically by the blower's PLC or manually from the local Operator Interface.

.3 Continuous control of the blowers is provided by a PLC-based pressure controller.

.4 An analog signal from the process air discharge header pressure transmitter, is used as the process control variable.

.5 The process air discharge header pressure setpoint of the PLC based controller is either a variable set by an operator or, when in the remote setpoint mode, a variable derived from plant control system.

.6 Each blower has inlet guide vanes and variable diffuser vanes which are modulated to vary the volume delivered by the blower.

.7 In the normal automatic operating mode, inlet guide vanes and variable diffuser vanes are modulated by an output signal from the PLC based pressure controller.

.8 In manual mode, variable diffuser vanes are positioned by the operator by adjusting the individual output signal at the local Operator Interface.

.9 Blower operating status (On/Off), failure/shutdown alarm, surge alarm, vibration alarms, and the filter differential pressure alarm are all wired to the plant control system and local blower control panel, and appear on plant control system and on the Operator Interface.

.3 PLC:

.1 Provide a PLC with the necessary input and output modules, communications modules, racks, power supply, cables, terminators and other accessories for the operation of the blower system. The PLC shall be in accordance with Appendix 18E – Standardized Goods with an Ethernet communication port. The PLC control system will be incorporated into a plant –wide control system.

.2 Provide separate processor, input and output modules for each blower.

.3 Provide a PLC control program for implementing the blower controls, alarms and sequencing.

.4 Comply with the requirements of Division 17.

.4 Panel-Mounted Work Station (Operator Interface):

.1 Provide a single EEMAC 12 rated panel mount PC-based Operator Interface for the control and monitoring of all three blowers.

.2 Provide Operator Interface programs to communicate with the PLCs, monitor and control the blowers, annunciate alarms, and interface to the plant control system.

.3 Comply with the requirements of Division 17.

.5 Instruments:

.1 Provide, as a minimum, the following instrumentation for each unit:

.1 Inlet air filter differential pressure switch.

.2 Inlet air temperature gauge.

.3 Inlet air temperature transmitter.

.4 Discharge air high temperature switch.

.5 Discharge air temperature gauge.

.6 Discharge air pressure gauge.

.7 Discharge air pressure switch (surge monitor).

.8 Differential pressure (inlet/discharge) transmitter.

.9 Oil high temperature switch.

.10 Oil low temperature switch.

.11 Oil temperature gauge.

.12 Oil low pressure switch.

.13 Oil pressure gauge.

.14 Oil filter differential pressure indicator.

.15 Self-acting thermostatic water valve for water-cooled oil cooler.

.16 Water inlet temperature gauge.

.17 Water outlet temperature gauge.

.18 Inlet guide vanes position transmitter.

.19 Variable diffuser vanes position transmitter.

.20 Motor windings temperature RTDs (one per phase).

.21 Motor bearing temperature RTDs.

.22 Blower/gearbox bearing temperature RTDs.

.23 Oil reservoir level switch.

.6 Provide a minimum of five (5) case-mounted vibration sensors for each blower and motor set. Provide displacement sensors for motors, monitoring both X and Y planes. Provide vibration sensor for gear increasers on the fast shaft bearing. Provide all vibration sensors for the blower units in accordance with the vibration sensor manufacturer's recommendations. Use piezo type for velocity sensors. Wire vibration sensors from each unit to PLC chassis-mounted vibration controller cards.

.7 Local Control Panel

.1 All starting, stopping speed control and monitoring of the blower unit to be via the blower panel PLC and Operator Interface.

.2 The following points to be monitored from the direct-drive blower and displayed on the HMI, as a minimum:

.1 Inlet Air Temperature.

.2 Filter Differential Pressure.

.3 Rotor Vibration.

.4 Bearing Temperature.

.5 Motor Temperature.

.6 Discharge Temperature.

.7 Discharge Pressure.

.8 Motor Amperage.

.9 Remote/Local Mode.

.10 Control Mode.

.11 Operation Status.

.12 Total Run Hours.

.13 Current Run Hours.

.3 The blower panel to accept the following inputs from the automation system.

.1 Start/Stop Blower.

.2 Blower Control Mode (Manual, DO).

.3 Command Reference.

.4 Command Signal.

.5 DO values for each aeration tank and selection of which DO values(s) to use (average, multiple DO values, etc.).

.4 The blower panel to make available the following outputs to the automation system.

.1 All Blower Parameters listed above.

.2 Alarm Conditions.

.5 In Manual mode the blower to be completely controlled from automation system or the local HMI. The user to be able to manually select the following for each blower:

.1 Start/Stop Command.

.6 Control Logic:

.1 The automation system shall provide manual and automatically variable air header pressure control over the indicated design range with any or every blower in service, utilizing hybrid sequencing control logic.

.2 The automation system shall receive the main air header pressure signal, and increase or decrease the on-line blower capacity to maintain the air header pressure at the set point.

.3 The discharge pressure set point shall be adjustable from the automation system.

.7 The automation system shall provide two modes of air header pressure control, as follows:

.1 A fixed mode in which the set point shall be manually adjusted via the automation system.

.2 A "most open" valve control mode in which the pressure set point shall be based on the air flow control valve position.

.3 In addition to the air header pressure 4-20 mA signal input, the automation system shall receive a 4-20 mA position signal input from each air flow control valve.

.4 The pressure set point versus valve position function shall be a linear function derived from field operated experiments, which shall be designed and conducted by Design Builder in conjunction with the blower supplier to determine the most efficient header pressure throughout the range of valve positions.

.8 The blower and aeration control system shall use inputs of DO, air flow, valve position, and main air header pressure to optimize system design, the objective being to operate at the lowest system pressure to modulate the required air flow to the aerobic zones of the activated sludge basins. The aerobic zones of each activated sludge basin shall be equipped with DO sensors one active and one backup (the common effluent channel aeration zone will be controlled by air flow only). The active sensor shall be operator selectable at the automation system operator interface.

.9 The automation system shall have process integrating control loops for each aeration cell DO, air flow meter, and air flow control valve. DO in an aeration cell shall be maintained at a pre-set level from the automation system via a manual set point, for each aeration cell. The air flow meter shall be used as the control function and air flow control valve as the controlled function. The DO probes shall input to the automation

system providing a secondary control loop to optimize the air flow rate with DO control. Maximum and minimum air flow set points and warning alarms shall be based on design parameters set during the submittal stages by the City.

.10 Maximum and minimum air flow set points and warning alarms shall be based on design parameters set by Final Design.

.11 The automation system shall bring blowers on and off-line and increase or decrease the on-line blower capacity as required to ensure the gradual increase or decrease of air throughout the entire range of on-line blowers.

.12 In the event of a blower failure, the next blower in the pre-selected start sequence shall come on-line.

.13 Surge Control:

.1 The automation system shall provide surge control of the entire on-line blower system by modulating the main air header blow-off valve as system pressure rises and approaches a surge condition.

.2 System surge shall be automatically controlled utilizing a dynamic algorithm based on the blower performance curves, ambient temperature, and the main air header discharge pressure, or manually utilizing a blow-off set point programmed through the automation system.

.14 Operator Interface Screens:

.1 Design Builder shall obtain details of the recommended Operator Interface graphical screens required for safe and satisfactory operation of the complete blower system from the blower manufacturer.

.15 Blower Start-up Sequence

.1 The blowers shall start under an automatic sequence initiated by the local start signal or by the remote start signal when in REMOTE/AUTO control.

.2 Upon receiving the signal to start, the automation system shall confirm that the inlet guide vanes and the variable diffuser vanes are at MINIMUM, the blow-off (bypass) valve is OPEN, and the discharge valve is CLOSED.

.3 The vanes and valves shall be equipped with limit switches on both the OPEN and CLOSED position to indicate their position.

.4 If components have not been properly positioned, they shall move to their respective start positions automatically via the automation system logic.

.5 The pre-start permissive functions shall have been confirmed before the blower motor is started.

.6 A feedback signal from the MCC shall confirm that the main drive motor starter has been energized.

.7 When the blower reaches its operating speed, as determined by the motor start sequence, the automation system shall open the inlet guide vanes and discharge valve, close the blow-off (bypass) valve, and transfer the control of the inlet guide vanes and variable diffuser vanes to LOCAL/REMOTE control.

.8 If the components have not been correctly positioned, interlocks shall prevent blower from operating after the programmed delay time.

.9 Provide a SEQUENCE FAIL alarm to trip if any portion of the START, RUN, or STOP sequence has not been properly executed.

.10 The automation system Operator Interface shall annunciate the function that caused the trip.

.16 Blower Shutdown

.1 There shall be the following three methods of shutting down the blower:

.2 Normal Stop:

.1 A normal stop shall be initiated by pushing the stop button or remote stop.

.2 The unit shall then stop normally, such that no surging occurs.

.3 Soft Stop:

.1 A soft stop shall be initiated by:

.1 High oil temperature.

.2 High inlet air temperature (recirculation/surge).

.3 High motor winding temperature.

.4 High bearing temperature.

.5 The discharge valve has not fully opened within two (2) minutes after receiving a feedback signal from the MCC.

.6 The blow-off valve has not closed within five (5) minutes after receiving a feedback signal from the MCC.

.7 High discharge pressure or temperature.

.8 High motor amperage.

.9 Surge.

.2 A soft stop shall de-energize the main drive motor eight (8) seconds after the initiation of an alarm in order to allow the blow-off valve sufficient time to partially open.

.3 Normal post-lube and other normal stop functions follow a soft stop.

.4 Emergency Stop.

.1 An emergency stop shall be initiated by:

.1 Pushing the emergency stop button.

.2 Low-low oil pressure.

.3 High vibration.

.4 No feedback signal from MCC during the start-up sequence.

.5 Loss of feedback signal from MCC during normal operation.

.6 Sequence failure during start-up.

.7 Automation system failure.

.2 An emergency stop shall de-energize the main drive motor immediately.

.3 Normal stop functions follow an emergency stop.

.8 Blower Control Panel:

.1 Fabricate the panel to house the controls for all blowers and space for a future blower.

.2 Provide miscellaneous materials such as wiring, wire ducting, relays, switches, terminals, tube fittings, regulators.

.3 Provide an EEMAC 12 rated enclosure, freestanding with double doors, with front access.

.4 Mount all accessories on or within the panel.

.5 Provide indication of blower operating parameters on the Operator Interface including:

.1 Blower operating status (On/Off).

.2 Blower failure/shutdown alarm.

.3 Inlet air filter high differential pressure alarm.

.4 Inlet air temperature alarm.

.5 Discharge air high temperature alarm.

.6 Pressure alarm.

.7 Surge alarm.

.8 Inlet/discharge high differential pressure alarm.

.9 Oil high temperature alarm.

.10 Oil low pressure alarm.

.11 Inlet guide vanes position.

.12 Variable diffuser vanes position.

.13 Motor windings high temperature alarm.

.14 Motor bearing high temperature alarm.

.15 Motor bearing high vibration alarm.

.16 Blower/gearbox bearings high temperature alarm.

.17 Oil reservoir low level alarm.

.18 Motor bearing high vibration alarm.

.19 Blower/gearbox bearings high vibration alarm.

.20 Discharge header pressure.

.21 Blower run time.

.22 Any other alarm as recommended by the blower Manufacturer to properly operate and monitor the blower.

.9 Aeration Control:

.1 Aeration control loop to consist of the following:

.1 DO values from DO probes.

.2 The aeration PLC to select the DO probe for control of each aeration zone.

2.28 Protective Coatings

.1 Shop prime and paint equipment in accordance with Division 9.

.2 Painted cast iron and carbon steel to be alkyd resin primer and final coat with a total dry film thickness of 400 microns dft. Surface preparation to be SSPC 10 or better.

.3 Aluminum, stainless steel, and brass are not to be painted.

2.29 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following for each blower:

.1 One (1) complete set of all bearings for the blower/gearbox.

.2 One (1) complete set of all bearings for the blower motor.

.3 One (1) complete set of O-rings, gaskets and seals for the blowers and motors.

.4 Five (5) sets of oil filter cartridges.

.5 One (1) main and one auxiliary oil pump.

.6 One (1) servomotor for the variable diffuser vanes.

.7 One (1) servomotor for the inlet guide vanes.

.8 One (1) set special tools required for maintenance, if any.

.2 Provide a list of recommended spare parts for the first year of operation and for the first five (5) years of operation.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Complete System Field Testing and Commissioning:

.1 The blower Manufacturer shall verify and be satisfied that the automation system has been configured in complete accordance with the requirement for safe and efficient individual blower control and for the optimized integrated control of the complete blower system. Implement, test and verify, in conjunction with the blower Manufacturer, the control logic for the first blower system before duplicating the logic for the additional blowers. Each additional individual blower system will then be tested as it becomes available. Begin undertaking testing of the fully integrated control logic once two or more blowers have been installed and tested. The integrated control logic testing and final verification can only take place once all individual blowers have been installed and tested.

.2 Design Builder shall perform a field test of the complete system under supervision of the manufacturers' representative, after acceptance of the start-up procedures.

.3 No fewer than 30 days before beginning field tests, Design Builder shall submit a detailed field testing plan. The Manufacturer shall provide input to Design Builder in preparation of the testing plan and shall review and approve the testing plan.

.4 Design Builder shall supply all materials, equipment, and labor necessary to perform field testing of the complete system.

.4 If the performance of any part of the system does not meet the requirements specified, corrective measures shall be taken, and equipment shall be removed and replaced with equipment that satisfies the conditions specified.

.5 Each blower provided shall require a separate start-up and commissioning.

END OF SECTION

DIGESTER GAS SEDIMENT AND CONDENSATE TRAPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of digester gas sediment and condensate traps for removal of moisture and sediment from saturated digester gas, complete with sight glass, removable screen and appurtenances.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

1.3 Quality Assurance

.1 All equipment as specified herein shall be furnished complete including appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use.

.2 Manufacturer shall be regularly engaged in the design and manufacture of condensate tanks and condensate accumulators for this project and who can demonstrate ten installations of this specified design, in actual service for a period of not less than five (5) years. North American installations are preferred.

.3 Provide workmanship, materials and methods of construction that conform to the best practice and highest standard of the industry.

.4 Provide materials and equipment that are new and of a quality equal to that specified. Equipment shall be the product of a manufacturer of established good reputation regularly engaged in the fabrication of such equipment. Any equipment or modification changes offered to have been in successful regular operation under comparable conditions for a period of at least three (3) years.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products from a single manufacturer.

.2 Acceptable Manufacturers for sediment and condensate trap:

.1 Varec.

.2 Or approved equivalent.

2.2 Performance Criteria

.1 The digester gas is expected to be comprised of 60 percent methane by volume, with the remainder comprised primarily of carbon dioxide.

.2 The digester gas is completely saturated with water vapour and is expected to contain substantial quantities of fine particulate matter, grease, oils, and small quantities of hydrogen sulphide, oxygen, hydrogen, and nitrogen.

.3 The expected specific gravity of the digester gas shall conform to the Final Design.

.4 The digester gas is expected to have a net heating value of approximately 22,400 kJ/m^3 of digester gas at a temperature of 15°C and pressure of 101.3 kPaA.

.5 Design sediment and condensate traps to remove liquid and solids from moisture-laden digester gas and to protect downstream equipment.

.6 Design sediment and condensate traps for a working pressure up to 172 kPa.

.7 Design sediment and condensate traps to produce not more than a 10 mm water column pressure drop for a design biogas flow rate of 1,700 m^3/h at temperature of 15°C and pressure of 101.3 kPaA.

.8 Design sediment and condensate traps suitable for continuous exposure to digester gas.

2.3 Capacities and Performance

.1 Identify sediment and condensate traps by the equipment number.

2.4 Materials

.1 Sediment and condensate trap: Type 316L stainless steel.

.2 Screen: Type 316L stainless steel.

.3 Gasket: neoprene, shore hardness 1250.

.4 Sight glass: armoured Pyrex glass tube, or approved equivalent.

2.5 Configuration, Components and Features

.1 Fabricate sediment and condensate traps from welded Type 316L stainless steel with Class 150 ANSI B16.5 flanged end connections at the size required for the digester gas piping. Fabricate and design tank in accordance with ASME B13.3.

.2 Supply sediment and condensate traps with:

.1 19 mm diameter stainless steel inspection pipe for level measurement.

.2 Removable top cover.

.3 Bottom plate with anchor bolt flange for securing tank to concrete pad.

.4 50 mm diameter blowdown connection.

.5 Two (2) 50 mm diameter drip tank or drain connection.

.6 Two (2) 12 mm diameter sight glass connections.

.7 Neoprene gasket.

.8 Baffle.

.9 Removable outlet pipe.

.10 Wire mesh mist extractor.

.11 Bolts with nuts and washers.

.3 Sight Glass:

.1 Provide each condensate tank/accumulator with 12 mm diameter armoured pyrex glass tube.

.2 Include two (2) stainless ball valves for isolating the glass tube from the condensate tank/accumulator, with drain cock on the lower valve for draining the glass tube.

.3 Provide 12 mm diameter purge isolation valves complete with threaded plug at all purge nozzles.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

DRIP TRAPS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and testing of manual drip traps and all specified appurtenances.

1.2 Quality Assurance

.1 Provide all equipment in this Section by a single manufacturer.

.2 All equipment as specified herein shall be furnished complete including appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Varec.

.2 Or approved equivalent.

2.2 Performance Criteria

.1 The performance criteria for the following parameters shall conform to the Final Design:

.1 Working pressure.

.2 Rated pressure.

.3 Capacity.

.4 Inlet size.

.5 Outlet size.

2.3 Materials

.1 Body: Type 316L stainless steel.

.2 Cover plate: Type 316L stainless steel.

.3 Disk and handle: Type 316L stainless steel.

.4 Ball valve: Type 316L stainless steel.

2.4 Configuration, Components and Features

.1 Low profile design.

.2 Provide a double-seal ball plug valve and locking lever to isolate the gas line connection.

.3 Provide a locking lever when the drip trap is in the “fill” position.

2.5 Spare Parts

.1 Provide spare parts in accordance with Schedule 18.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

ROTARY LOBE COMPRESSOR

1. GENERAL

1.1 Summary

.1 This section specifies the supply, installation, testing and commissioning of rotary lobe gas compressors for medium pressure sludge gas (MSG).

1.2 Definitions

.1 Terminology used in this Section conforms to the following definitions:

.2 Continuous operation: 24 hour-per-day operation for design life of not less than 20 years, or 175,200 hours.

.3 Intermittent operation: Operation including starts and stops, with extended periods of time when not in use.

.4 Standard cubic metre per minute (SCMM): the volumetric flow rate in cubic meters per minute at standard conditions. Standard conditions defined as 20°C, 101.3 kPa, and 36 percent relative humidity.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Compressor performance curves showing the head-discharge characteristics, efficiency and brake horsepower over the full operating range of the compressor. The curves shall be derived from a minimum of 10 points.

.3 Vibration and critical speed analysis in accordance with Section 11020.

.4 Sound power levels: Provide a list of predicted sound power levels for the compressor and for the compressor package when operating at design operating capacity. The predicted sound power levels shall be reported in a standard format conforming to the requirements of the Acoustical Engineering Institute.

1.4 Quality Assurance

.1 Qualifications: Provide compressor equipment produced by a manufacturer who regularly engages in the design, manufacture, assembly and production of rotary lobe compressor equipment of the size and type as specified for not less than five (5) years.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single manufacturer.

.2 Acceptable Manufacturers:

.1 M D Pneumatic/Tuthill.

.2 Roots.

.3 Spencer.

.4 Gardner Denver.

.5 Aerzen.

.6 Or approved equivalent.

2.2 Materials

.1 Fabricate impeller casings of heavy duty cast iron construction.

.2 Fabricate the base, motor pedestal, V-belt drive guard and gears of ASTM A36 steel.

2.3 Performance Criteria

.1 Design rotary lobe compressor for pressure and flow and compressor spacing for the application in accordance with Section 01450.

.2 The service conditions for the following parameters shall conform to the Final Design:

.1 Area exposure.

.2 Fluid type.

.3 Fluid temperature.

.4 Site elevation.

.5 Area classification.

.3 The operating conditions for the following parameters shall conform to the Final Design:

.1 Capacity.

.2 Inlet pressure.

.3 Atmospheric pressure.

.4 Relative humidity, maximum.

.5 Relative humidity, mean.

.6 Discharge pressure.

.7 Inlet air temperature maximum.

.8 Inlet air temperature mean.

.9 Inlet air temperature minimum.

.4 The compressor design requirements for the following parameters shall conform to the Final Design:

.1 Turndown from rated condition.

.2 Efficiency at full speed, percent, minimum.

.3 Inlet connection size, minimum.

.4 Discharge connection size, minimum.

.5 Operating speed.

.6 Casing pressure.

.7 Drive type.

.8 Vibration limit.

.9 Noise level at 1 m.

.5 The motor design requirements for the following parameters shall conform to the Final Design:

.1 Motor type.

.2 Power, maximum.

.3 Motor speed.

.4 Power supply 600/3/60.

.5 Service factor.

.6 Minimum motor efficiency at 3/4 load & above.

.7 NEMA design rating.

.8 Insulation.

.9 Lubrication.

2.4 Configuration, Components and Features

.1 Provide dual lobe type compressors with side mounted suction and discharge connections.

.2 Equip each compressor with an inlet filter, inlet and outlet silencers, discharge pressure gauge, check valve on the discharge piping, discharge butterfly valve, temperature indicators to measure suction and discharge temperature, and expansion joints for the inlet and outlet.

.3 All design information for suction and discharge conditions shall be at the flanged connections. Include pressure loss consideration for the intake filter, discharge check valve and intermediate piping.

.4 Design the compressors for continuous service. Mount on a common base plate with the electric motor drive.

.5 Impellers and impeller casing:

.1 Rib the impeller case to prevent distortion when operating at rated pressure.

.2 Fabricate the impellers of steel. Provide straight, two-lobe impellers designed to operate without rubbing or liquid seals or lubrication. Machine impellers on all exterior surfaces for operation at close clearances.

.6 Timing gears:

.1 Fabricate timing gears of hardened steel.

.2 Finish machine gears on all surfaces and attach to shafts in such a manner as to permit easy retiming of the unit.

.3 Enclose timing gears and gear end bearings in an oil-tight housing. Splash-oil lubricate the timing gears.

.7 Bearings:

.1 Provide grease or oil lubricated anti-friction type bearings, designed to withstand all stresses for the service specified.

.2 Provide bearings withe L-10 bearing life of 40,000 hours.

.3 Design so that inspection or replacement of bearings is possible without disconnecting piping or disassembling the compressor.

.4 Design bearing housings to effect a complete separation between the bearings and casing to isolate bearings from heat generated by the compressor.

.8 Belts:

.1 Connect the positive displacement compressor to the drive through V-belt and sheaves.

.2 Provide high-capacity type, oil and heat resistant, and static dissipating V-belts. Design the drive for a minimum 1.4 service factor.

.9 Drive guard:

.1 Fabricate the V-belt drive guard of steel a minimum 1.5 mm thick.

.10 Drive shaft:

.1 Fabricate shafts from hot-rolled steel bar, ground and polished, of sufficient diameter to prevent deflection or whip at design operating speed.

.2 Size the shafts so that the rotating assembly operates a minimum of 20 percent below the first critical speed.

.3 Where the compressor shafts pass through the impeller casing, provide suitable seals to minimize air leakage and maintain operating efficiency.

.4 Extend the shaft to permit connection to a V-belt drive.

.11 Mounting:

.1 Mount the compressor and motor unit on a single heavy, full-length steel frame, properly cross braced to form a rigid support for the entire unit. Design the frame to a safety factor of 2 for all dead and live loads.

.2 Provide vibration isolation between the base plate and the floor to prevent noise and vibration transmission.

.12 Accessories:

.1 Pressure relief valve: Supply one (1) adjustable spring-loaded pressure relief valve for each compressor, set to open at a pressure suitable to prevent overloading of the compressor and driver. The relief valve shall be capable of passing sufficient air volume to prevent overload on compressor and driver. Provide a relief valve suitable for connection to a discharge pipe to relieve exterior to the building.

.2 Expansion joints: The flexible section shall be of a single convolution able to withstand longitudinal and radial stresses developed during the compressor operation. Select the material of the flexible section of the expansion joint to withstand continuous duty operation at 70 kPa(g) pressure and 150°C temperature. Furnish retaining rings with each expansion joint to allow maximum concurrent longitudinal movements, hoop stress and flange sealing. Expansion joints shall have flat-faced flanged end connections to ANSI Class 125 standard.

.3 Inlet filter: Provide cleanable and replaceable dry type line size, inline air filters suitable for 120 percent of the design volume, and capable of retaining at least 98 percent of particles 10 microns or larger. The housing shall be of welded steel construction.

.4 Gauges: Provide gauges on the suction and discharge piping of each compressor. Provide glycerine filled type with 60 mm dial, 6.35 mm bottom connection, stainless steel movement Bourdon tube gauges. Discharge gauge shall have a range of 0 to 150 kPa. Suction gauge shall have a range 600 mm water column vacuum to 600 mm water column positive pressure. Indicate the units of measurement on the face of the gauge.

.5 Check valve: Supply one (1) check valve for each compressor, with inlet and outlet equivalent to the compressor discharge size.

.6 Provide Type 304 stainless steel, bimetallic element temperature indicators dampened with silicone for vibration reduction, external recalibrator, adjustable angle viewing face,

125 mm diameter, stainless steel thermowell (Acceptable Product: Tel-tru AA-575R). Provide minus 50°C to 50°C range on suction, 0°C to 150°C range on discharge.

2.5 Finishes

.1 Procedures: Section 09900.

.2 Prime coat: Shop applied, coating material per Section 09905.

.3 Finish coat: Field applied, coating material per Section 09905.

2.6 Spare Parts

.1 Provide spare parts in accordance with Schedule 18.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

.3 Test piping connections to prove the compressor nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with compressor nozzles.

.4 Complete Factory Acceptance Test.

END OF SECTION

EXTERNALLY FED ROTARY DRUM SCREEN

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of externally fed, self-cleaning rotary drum screens, complete with connections to inlet and outlet piping, and all other appurtenances.

1.2 Standards

.1 ANSI:

.1 ANSI B16.5, Pipe Flanges and Flanged Fittings.

.2 ANSI B36.19M, Stainless Steel Pipe.

.2 ASTM:

.1 ASTM A276, Stainless Steel and Heat Resisting Steel Bars and Shapes.

.2 ASTM A480, General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.3 ASTM A774, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

1.3 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Function

.1 The screen will separate solids and trash from primary scum skimmed off the top of the primary clarification tanks.

.2 Design the screen so that screening action is provided within a rotating, wedgewire screen, cylindrical drum with influent headbox and effluent discharge collection pan.

.3 The screen will operate in conjunction with primary scum pumps and for a duration (adjustable) after the scum pumps have stopped.

2.2 Acceptable Manufacturers

.1 Supply all products from a single manufacturer.

.2 Acceptable manufacturers are:

.1 Parkson.

.2 IPEC.

.3 Or approved equivalent.

2.3 Performance and Design Criteria

.1 Design rotary drums screen for operation in wastewater for the application selected.

.2 Drum screen shall be self-cleaning and shall remain fully functional during peak loading rates.

.3 Design in accordance with Section 01450.

.4 Provide the externally fed rotary drum screen system to meet the capacities and operating data.

.5 The design criteria for the following parameters shall conform to the Final Design:

.1 No. of screens.

.2 Screen capacity, each.

.3 Screen width.

.4 Screen depth.

.5 Screen height.

.6 Washwater flow rate.

.7 Washwater pressure.

.8 Motor power.

.9 Motor speed.

.6 Design screen to remove floating material such as paper, plastics, tissue, grease, and other debris.

2.4 MATERIALS

.1 Screen: Stainless steel, ASTM 276 Type 304.

.2 Doctor blade: Monel.

.3 Headbox: Stainless steel, ASTM 276 Type 304.

.4 Spray system: Stainless steel, ASTM 276 Type 304.

.5 Enclosure: Stainless steel, ASTM 276 Type 304L.

.6 Base Frame: Stainless steel, ASTM 276 Type 304L.

.7 Use stainless steel, ASTM 276, Type 304L for those stainless steel components which are to be welded.

2.5 Configuration, Components and Features

.1 Doctor Blade:

.1 Provide doctor blade outside the cylinder along its length to continually scrape solids from the screen and convey them to the discharge end of the screen as the screen rotates.

.2 Minimum height of doctor blade: 75 mm.

.3 Minimum thickness of doctor blade: 1 mm.

.4 Doctor blade assembly to include automatic tensioning assembly to ensure constant tension as the blade wears. Tensioner housing, lever and clevis to be cast bronze. Tensioner shaft and springs to be stainless steel, ASTM 276 Type 304.

.2 Headbox:

.1 Design cantilevered headbox to receive the pumped flow to the screen.

.2 Design headbox to dampen the influent velocity and to provide uniform flow distribution over weir(s) to at least two thirds of the length of the screen.

.3 Design headbox such that it does not retain liquid nor solids.

.4 Provide easily accessible drain and clean-out for the headbox.

.5 Inlet connection: flanged or grooved coupling, sized as per Final Design.

.6 Overflow connection: provide flanged emergency overflow connection to bypass rotary screen in the event that screen is blinded.

.3 Spray Wash System:

.1 Provide internal and external spray wash header system suitable for 65°C hot water, continuous or intermittent operation, to clean the screen. Normally, spray wash system will operate with hot water when the screen is operating. Following shutdown of primary scum feed, a hot water was cycle will continue for a preset timed. Duration of continuous of intermitted hot water spray wash during operation of the screen will be adjustable. Frequency that spray wash system operates will also be adjustable.

.2 Mount internal spray header parallel to the longitudinal screen axis with the spray nozzles positioned at approximately 30 degrees to the inside surface of the screen, on the upward rotating screen face.

.3 Spray nozzles to be easily removable from header to facilitate cleaning and replacement.

.4 Spray headers to be easily removable to facilitate cleaning and replacement.

.5 Minimum nozzle hydraulic capacity (each): 3.8 L/min.

.4 Drum Bearings:

.1 Provide spherical roller bearings mounted in cast iron housing. Use bearings with ABFMA rated L-10 life greater than 50,000 hours.

.2 Fit each bearing housing with a grease nipple with escape release provisions.

.5 Enclosures:

.1 Provide removable, hinged cover to enclose the screen to contain splash and odours. Provide 150 mm flanged connection on top of enclosure for foul air removal.

.2 Provide separate, removable screenings discharge enclosure. Provide integral screenings discharge chute on screenings discharge enclosure to direct screenings into a hopper. Coordinate discharge dimensions with conveyor supplier.

.3 Provide high level switch complete with mounting hardware for attachment to the head end enclosure. Mount the switch so that if the water level in the screen nears overflow levels, the vibration fork will become submerged. The switch shall be vibrating fork vertically mounted, suitable for Class 1 Zone 2 environment, four (4) wire instrument with 120 VAC power supply and 120 VAC rated DPDT contact. The high level switch shall be Endress + Hauser FTL50 Series with sufficient probe length, so that liquid level below overflow will activate switch which is vertically mounted.

.4 Provide flanged scum screenings discharge connection.

.6 Effluent Discharge Collection Pan:

.1 Design liquid discharge collection pan to collect the effluent as it discharges through the wedgewire screen.

.2 Discharge connection: flanged.

.3 Design pan to facilitate easy removal of screen for service.

.7 Base Frame:

.1 Design base frame to support the screen, headbox, discharge collection pan, enclosures, motor and drive.

.2 Base frame to be suitable for mounting to a platform, as shown on drawings.

.3 Design base frame for all operating and installation loads.

.8 Screen Motor and Drive Unit:

.1 Electric motors: 600/3/60 VAC, 1800 r/min, Type 3.

.2 Drive unit: Provide right angle drive.

2.6 Controls

.1 Provide a HAND-OFF-REMOTE switch, START-STOP pushbuttons and an emergency stop.

.2 All devices including local switches, control switch and buttons, motors and sensors to be factory wired to NEMA 7 junction boxes mounted exterior to the screens.

.3 Provide programming to incorporate screen operation, monitoring and control into the plant automation system.

.4 All settings to be operator adjustable.

.5 In the HAND position the screen is controlled by its START-STOP pushbuttons.

.6 In the OFF position, the screen to be inoperative.

.7 In the REMOTE position, the screens are operated by the automation system. Screens are to start when the scum pump starts and to stop an operator selectable time following the scum pumps stopping.

.8 Provide the following signals for remote monitoring of the screens:

.1 Screens on-off status.

.2 Screen failure.

.3 Running time.

.9 Provide NO unpowered auxiliary contacts.

2.7 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 Eight (8) spray nozzles.

.2 One (1) doctor blade.

.3 One (1) solenoid valve.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION

SAMPLING EQUIPMENT

1. GENERAL

1.1 Work Included

.1 Supply and supervision of installation, testing and commissioning of sampling equipment.

1.2 Submittals

.1 Provide submittals in accordance with Sections 11000 and 01300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Provide coordination drawing indicating all locations samples are being collected and confirmation the sample method is appropriate.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Sentry

.2 Or approved equivalent

2.2 Performance Criteria

.1 Provide an automatic sampler that provides representative samples of wastewater liquids and stores them in a dedicated refrigerator.

.2 Samplers to meet Area Exposure Designations in Section 01450.

.3 Sample volume and frequency of sample to be adjustable.

.4 Sampler to be easy to clean and repair with a minimum of moving parts.

.5 Provide a recirculation pump and pipe to draw the subject liquid near the sampler for sampling and then return it to the original location.

2.3 Configuration, Components and Features

.1 Sampler to operate when compressed instrument air is initiated to force a plunger into a process line to capture a fixed volume of material in the range of 25 ml per sample.

.2 Compressed air is then utilized to act on the plunger to draw the sample back, allowing it to drop into a sample container.

.3 The sample container is to be located in a dedicated refrigerator for sample preservation. Refrigerator cooling coils must be located at the back of the fridge.

.4 Sample to allow two removable, stainless steel drop-tubes that facilitate transfer of sample aliquots from the sampler to the refrigerated container.

.5 The volume and sample frequency shall be adjustable by the operator.

.6 If the liquid being sampled is not located near the sample, a pump shall be provided that allows a stream of the wastewater fluid (50 mm pipe) be conveyed by the sampler and then returned to the original location. In this instance the sampler is to be placed on the recirculation line.

.7 Use 120V or 208V 3 phase power supply for the compressor, sampler, recirculation pump and refrigerator.

.8 Provide instrument air for operation of the samplers from either the building instrument air line or a dedicated oil free compressor complete with moisture removal and air filtration.

2.4 Spare Parts

.1 Provide spare parts in accordance with Schedule 18 and the following:

.1 One (1) complete sampler of each configuration

.2 One (1) recirculation pump of each configuration

.3 One (1) piston replacement kit for sampler repair.

3. EXECUTION

3.1 General

.1 Install in accordance with Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Technical Requirements.

END OF SECTION