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 All standards referenced in the specifications are referring to the most recent version of the published standard.

.2 American National Standards Institute (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/ASME 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.

.3 American Society for Testing and Materials (ASTM):

- .1 ASTM A36 - Carbon Structural Steel.
- .2 ASTM A48 - Gray Iron Castings.
- .3 ASTM A240 - Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- .4 ASTM A276 - Stainless Bars and Shapes.
- .5 ASTM A278 - Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 650°F.
- .6 ASTM A312 - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- .7 ASTM A322 - Steel Bars, Alloy, Standard Grades.

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

.9 ASTM A576 - Steel Bars, Carbon, Hot Wrought, Special Quality.

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

.11 ASTM A743 - Corrosion-Resistant, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application.

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

.13 ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

.4 American Welding Society (AWS):

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

.5 American Society of Mechanical Engineers (ASME):

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

.6 The Society for Protective Coatings (SSPC).

1.3 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.

1.4 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 General

.1 Refer to the Schedule 18 Technical Requirements and Section 01450 for classified areas, exposure designations and environmental classifications.

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

2.2 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 a 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 a 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 an 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 the 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.

2.3 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.

.3 Welding: In accordance with the latest applicable American Welding Society Code or equivalent.

.4 Provide all components made of stainless steel passivated by full submergence in a pickling bath for perfect surface finishing. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.

.1 Fully submerge all stainless steel parts in a pickling bath for at least 8 hours to remove welding spots and to protect the stainless steel against corrosion. Sand or glass bead blasted or brushed or otherwise not equivalently treated stainless steel is not acceptable.

2.4 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 the control panel, indicating lights and instrumentation requirements.

2.5 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 the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 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 Sections 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 Schedule 18 Technical Requirements.

END OF SECTION

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 American National Standards Institute (ANSI):

- .1 ANSI/HI 1.4 - Centrifugal Pumps – Installation, Operation and Maintenance.
- .2 ANSI/HI 2.4 - Vertical Pumps – Installation, Operation and Maintenance.

.2 American Petroleum Institute (API):

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

.3 American Society for Testing and Materials (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 Canadian Standards Association (CSA):

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

.5 The Society for Protective Coatings (SSPC):

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

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

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 the 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 and 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 the 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 the top of grout and grout thickness; elevation of the 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 Chemical corrosive: Type 316 stainless steel, ASTM F593, Cond. CW.

.6 Materials selected according to Section 01450.

.7 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 weighing 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.

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

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

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

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

.9 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.

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

.11 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.

.12 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.

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

.14 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.

.15 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.

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

.17 Install fixators at mounting surfaces for drivers.

.18 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 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 has 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 is to be applied.

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

.5 Inspect preparation and application of epoxy grout formwork 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 the 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 01300 and 11000 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 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 the 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 the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

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 and functional testing in the field and in accordance with the Schedule 18 Technical Requirements.

1.2 Standards

.1 International Organization for Standardization (ISO):

.1 ISO 20816-1 - Mechanical Vibration - Measurement and Evaluation of Machine Vibration.

.2 ISO 21940-32 - Mechanical Vibration - Rotor Balancing - Part 32: Shaft and Fitment Key Convention.

.2 Hydraulic Institute (HI):

.1 9.6.4 - Rotodynamic Pumps for Vibration Measurements and Allowable Values.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 versus 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 the mounting location of vibration transducers, machine operating speed during the 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 Refer to HI 9.6.4. Maximum vibration limits shall be 50 percent of allowable limits in HI 9.6.4.

.3 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, the 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.

.4 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 in accordance with ANSI/HI 9.6.4.

.2 Unless specified otherwise in the equipment Specification, balance mechanical shafts per the requirements for Zone B classification as specified in ISO 20816-1. 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

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 The vibration analysis technician shall have a minimum of 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 machine’s 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 the 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 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 the 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

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 American Society for Testing and Materials (ASTM):

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

.2 ASTM B26 - Aluminum-Alloy Sand Castings.

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

.4 ASTM B584 - Copper Alloy Sand Castings for General Applications.

.5 ASTM D1056 - Flexible Cellular Materials—Sponge or Expanded Rubber.

.6 ASTM D2000 - Rubber Products in Automotive Applications.

.7 ASTM D6098 - Extruded and Compression Molded Shapes Made from Polycarbonate.

.8 ASTM A240 - Stainless Steel Bolts, Hex Cap Screws, and Studs.

.9 ASTM A240 - Stainless Steel Nuts.

.2 American Welding Society (AWS):

.1 AWS D1.6 - Welding Procedure and Performance Qualification.

.3 American Welding Society (AWS):

.4 American Water Works Association (AWWA):

.1 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 the weight of the plate, coefficient of friction, and seating and unseating head.

.3 Provide details of the 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 the 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 the formed plate.

.2 Provide a 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 is 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. Arrangements 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.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One set of all special tools required.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Equipment Checkout

.1 Complete the following testing during the Equipment Checkout phase:

  .1 Field Leakage Test:

    .1 The test forms part of Functional Testing.

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

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

    .4 Provide a 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 have 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 American Society for Testing and Materials (ASTM):

.1 ASTM A240 - Chromium And Chromium-Nickel Stainless Steel Plate, Sheet, And Strip For Pressure Vessels And For General Applications.

.2 ASTM A276 - Stainless Steel Bars And Shapes.

.3 ASTM A666 - Annealed Or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, And Flat Bar.

.4 ASTM B26 - Aluminium-Alloy Sand Castings.

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

.6 ASTM B584 - Copper Alloy Sand Castings for General Applications.

.7 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

.8 ASTM D2000 - Standard Classification system for Rubber Products in Automotive Applications.

.9 ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

.10 ASTM D6098 - Extruded and Compression Molded Shapes Made from Polycarbonate (PC).

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

.12 ASTM F594 - Stainless Steel Nuts.

.2 American Water Works Association (AWWA):

.1 AWWA C561-12 - Fabricated Stainless Steel Slide Gates.

.2 ANSI/AWWA C540 - Power Actuating Devices for Valves and Slide Gates.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 the weight of the gate, the 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 meet the requirements of Applicable Law and the requirements of the Design and Construction Specifications.

1.4 Quality Assurance

.1 The Manufacturer of gates shall have a minimum of five (5) operating installations with gates of the size specified and in the same service as specified operating for not less than five (5) years.

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 a 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	A276 Type 316L stainless steel
Thrust nuts	Bronze
Stem couplings	ASTM A276, Type 316 stainless steel
Seats	ASTM D4020, UHMW polyethylene
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 the 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 the 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, the 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 the 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 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 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 a 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 a width to height ratios of 2.0:1 or less. Provide dual rising stems for gates having a 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, 16, and 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 the horizontal shaft of right angle gear drive.

.3 Every valve/gate shall have a dedicated operator.

.4 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.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One set of all special tools is required.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Equipment Checkout

.1 Complete the following testing during the 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 the 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 Valve to be free of excessive torque at the most stringent conditions for a minimum of five (5) maneuvers.

.2 Field Leakage Test:

.1 The test forms part of Functional Testing.

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

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

.4 Provide a 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 have been completed.

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 American Society for Testing and Materials (ASTM):

.1 ASTM A167 - Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM A276 - 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- Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

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

.7 ASTM F594 - Stainless Steel Nuts.

.8 AWS B2.1 - Welding Procedure and Performance Qualification.

.1 American Welding Society (AWS):

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

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

.2 American Water Works Association (AWWA):

.1 AWWA C561 – Fabricated Stainless Steel Slide Gates.

1.3 Submittals

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

.1 Manufacturer's descriptive literature for materials.

.2 Maximum bending stress and deflection of the stop logs under the 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.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Equipment Checkout

.1 Complete the following testing during the 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 the 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 Valve to be free of excessive torque at the most stringent conditions for a minimum of five (5) maneuvers.

.2 Field Leakage Test:

.1 The test forms part of Functional Testing.

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

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

.4 Provide a 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 have been completed.

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 American Society for Testing and Materials (ASTM):

- .1 ASTM A112C - 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 American Water Works Association (AWWA):

- .1 AWWA C501 - AWWA Standard for Cast-Iron Sluice Gates.

1.3 Submittals

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

  .7 Provide upper pivots adjustable for gate sensitivity, cover pivots that 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.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

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

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Equipment Checkout

.1 Complete the following testing during the Equipment Checkout phase:

.1 Field Leakage Test:

.1 The test forms part of Functional Testing.

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

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

.4 Provide a 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

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 American Society for Testing and Materials (ASTM):

  .1 ASTM A167 - Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip.

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

  .3 ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

  .4 ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

  .5 ASTM A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

  .6 ASTM A582 - Standard Specification for Free-Machining Stainless Steel Bars.

  .7 ASTM A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

.2 Canadian Standards Association (CSA).

1.3 Submittals

.1 Provide submittals in accordance with Section 01300 and 11000 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 Schedule 18 Technical Requirements.

.2 Operation and normal cleaning of the 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 the 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 Max moisture content of washed/compacted screenings at 45%.

.5 Screw speed.

.6 Inlet hopper dimensions.

.7 Conveyor outlet diameter.

.8 Screen discharge height (above floor).

.9 Washwater flow rate.

.10 Washwater pressure.

.11 Motor power.

.12 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 the outlet of the 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 full 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 As a minimum, provide a HAND-OFF-REMOTE switch, start and stop buttons and an emergency stop to the equipment.

.2 All devices are 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 As a minimum, 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

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

.4 Auger Bearing Temperature Testing:

.1 The test forms part of Functional Testing.

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

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

3.2 Factory Testing

.1 Fully factory assembly a minimum of 1 washer compactor and operate for a minimum of 30 minutes and record results.

.2 Conduct testing using debris representative of a combined sewer collection system.

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 American Society for Testing and Materials (ASTM):

- .1 ASTM A36 - Carbon Structural Steel.
- .2 ASTM A48 - Gray Iron Castings.
- .3 ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .4 ASTM A240 - Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- .5 ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.
- .6 ASTM F593 - Stainless Steel Bolts, Hex Cap Screws, and Studs.
- .7 ASTM F594 - Stainless Steel Nuts.

.2 American National Standards Institute (ANSI):

- .1 ANSI B20.1 - Safety Standards for Conveyors and Related Equipment.
- .2 ANSI S1.11 - Octave, Half-Octave, and Third-Octave Band Filter Sets.

.3 Conveyor Equipment Manufacturers Association (CEMA).

.4 American Gear Manufacturers Association (AGMA).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 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 the 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 Schedule 18 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 a 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 Locate gearbox at a serviceable location.

.3 Provide conveyors designed specifically for the transport of screenings and grit. Conveyor designs developed for free-flowing bulk material are not permitted.

.4 Provide screw conveyors able to operate continuously at the specified operating conditions and also able to start and operate with a full trough.

.5 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 by the Manufacturer.

.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 by the Manufacturer.

.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 the length of the 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 the trough of each screw conveyor.

.14 Coordinate conveyor support with adjacent equipment and grating to avoid interferences with the installation or maintenance of other equipment.

.15 Support leg spacing across the trough shall not exceed 760 mm from centre of the support leg to centre of the 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 for wear indication.

.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. The 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 Electric operation to be the standard, however pneumatic operation is acceptable if high speed operation is required.

.2 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.

.3 Gate blade shall be constructed of Type 316 stainless steel.

.4 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.

.5 Gate blade leading edge shall be beveled to facilitate its travel through material being handled.

.6 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.

.7 Each frame shall be designed for a gasketed, bolted connection to each screw conveyor trough or chute or flexible connection as applicable.

.2 Provide 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 SCADA system.

.2 Conveyor to operate based on operation of the equipment feeding the conveyor. Operation sequence is based on process stream.

.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 pull cord emergency stop shutdown of conveyors on actuation of any conveying system safety device, sound alarm horn and light the safety stop alarm light. System shall restart only after the safety devices are reset and 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 process 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.

.3 FORWARD-OFF-REVERSE selector switch (spring to OFF from REVERSE).

.4 Provide an over torque alarm for the conveyor.

.5 General alarm

.6 Speed sensor motion alarm

.7 Indicating lights:

.1 RUN.

.2 OFF.

.3 General alarm

.4 Torque alarm

.8 Provide an audible alarm to sound as follows:

.1 Emergency stop.

.9 Provide dry contacts for the following:

.1 Equipment run status.

.2 Remote status

.3 Ready status

.4 Each alarm condition as specified.

.5 Shutdown feed equipment to the conveyors on the conveyor stop.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) speed switch.

.2 One (1) E-stop switch.

.3 Ten metres (10) of each size of gaskets.

.4 Shaft seal packing materials for re-packing stuffing boxes of each size.

.5 One (1) grease lubricator.

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Observe solids conveyance in the trough and identify bridging or buildup of solids in the conveyor. If a 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 of 30 minutes before taking temperature readings of the bearing and motors.
- .3 Bearing temperatures 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 of the shafted screw conveyors, gear reducers, motors, controls and appurtenance.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

  .1 ASTM A36 - Carbon Structural Steel.

  .2 ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

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

  .4 ASTM D4020 - Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

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

  .6 ASTM F594 - Stainless Steel Nuts.

  .7 ASTM A48 - Specification for Gray Iron Castings.

.2 American National Standards Institute (ANSI):

  .1 ANSI B20.1 - Safety Standards for Conveyors and Related Equipment.

  .2 ANSI S1.11 - Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

.3 National Electrical Manufacturer Association (NEMA).

.4 Conveyor Equipment Manufacturers Association (CEMA).

.5 American Gear Manufacturers Association (AGMA).

1.3 Submittals

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

  .1 Manufacturer's descriptive literature for materials.

  .2 Control Panel Submittals:

    .1 Front elevations, with and without door.

.2 Elementary wiring connection diagram.

.3 Catalog sheets for devices in the control panel.

.4 Use NEMA device designations and symbols for electric circuit diagrams. Make contents of elementary connection diagrams in accordance with NEMA ICS 1.

.5 Manufacturer's standardized elementary diagrams will not be accepted unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.

1.4 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 The 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 the 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 the 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 SCADA system.

.2 Conveyor to operate based on the operation of the equipment feeding the conveyor. Operation sequence is based on process stream.

.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 pull cord emergency stop shutdown of conveyors on actuation of any conveying system safety device, sound alarm horn and light the safety stop alarm light. System shall restart only after the safety devices are reset and 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.

  .3 FORWARD-OFF-REVERSE selector switch (spring to OFF from REVERSE).

  .4 Provide over torque alarm.

  .5 General Alarm.

  .6 Speed sensor motion alarm.

  .7 Indicating lights:

    .1 RUN.

    .2 OFF.

    .3 General alarm.

    .4 Torque alarm.

  .8 Provide an audible alarm to sound as follows:

    .1 Emergency stop.

  .9 Provide dry contacts for the following:

    .1 Equipment run status.

    .2 Remote status.

    .3 Ready status.

    .4 Each alarm condition as specified.

    .5 Shutdown feed equipment to the conveyors on conveyor stop.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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.

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

3. EXECUTION

3.1 General

.1 Install in accordance with the 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 the trough and identify bridging or buildup of solids in the conveyor. If a 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

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 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A36 - Carbon Structural Steel.

.2 ASTM A48 - Gray Iron Castings.

.3 ASTM A276 - Stainless Steel Bars and Shapes.

.2 American Bearing Manufacturers Association (ABMA), L10.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 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 propeller mixers rotate at 200 RPM to 1200 RPM.

.2 Submersible, horizontally mounted, and includes a motor and propeller in a close-coupled configuration.

.3 As required per design, propellers with adjustable orientation for optimization.

.4 Provide mixers shall be able to be raised and lowered and easily removable for inspection without the need for personnel to enter the mixing tank.

.5 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.

.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 balanced 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 Divisions 11 and 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 by 100 mm and 4.0 mm thick material, or

.4 Configure double mast guide bar arrangement of two (2) cylindrical sections; 114.3 mm diameter and 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 an electric winch 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Mechanical seal: one (1) spare lip seal of each type, and one (1) set of bearings of each type and size.

.2 One (1) propeller and propeller shaft and end fitting of each type and size.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 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

1. GENERAL

1.1 Summary

.1 This Section specifies the requirements for the supply, installation, and commissioning of all process pumps.

1.2 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 Electrical and Electrical Equipment Manufacturers Association of Canada (EEMAC) and the Canadian Standards Association (CSA).

.3 The pump motor assembly shall have CSA approval as one unit, for the environment in which it is installed. 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 Based on area classification, the pump/motor shall be approved by CSA for service in hazardous location.

.5 American Society for Testing and Materials (ASTM):

- .1 ASTM A36 - Carbon Structural Steel.
- .2 ASTM A48 - Gray Iron Castings.
- .3 ASTM A108 - Steel Bar, Carbon and Alloy, Cold-Finished.
- .4 ASTM B584 - Copper Alloy Sand Castings for General Applications.

.6 Hydraulic Institute (HI):

- .1 HI/ANSI Pump Standards.
- .2 HI/ANSI Joint Standards.

1.3 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 flows 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.

1.4 Submittals

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

.1 Manufacturer's descriptive literature for materials.

.2 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 Results of shop performance tests as specified.

.4 The 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 the flow. Where required in the specific pump sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.

.5 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.

.6 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 the head, capacity, horsepower, efficiency, and NPSH3.

.1 For units of the 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.

1.5 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 of experience in designing and manufacturing pumps of similar size for this project.

2. PRODUCTS

2.1 Performance Criteria

.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. Refer to Specification Section 16223.

.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 Provide diaphragm seal for pressure sensing.

.3 For centrifugal pumps provide the transmitter with an indicator for the inlet and outlet of each pump.

.4 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.

.5 For positive displacement pumps provide full pipe diameter annular ring pressure sensor for both the suction and discharge complete with gauges, pressure switches and connections for instrumentation devices.

2.3 Pump Seals

.1 Provide double 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 a seal vent in accordance with API Plan 13.

.2 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.

2.11 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

.2 For each pump provide:

.1 One (1) complete set of gaskets and O-rings.

.2 One (1) mechanical seal repair kit and restriction brushing

.3 Spare mechanical seal for each pump provided with mechanical seals.

.3 For each set of pumps of the same size and performance:

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 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 done 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, the 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 after conducting tests.

.6 Test each 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 the 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 the cause for noncompliance, undertake remedial Work as required to bring the 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 the 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

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and testing of process valves.

.2 Provide the valve type as indicated in the Drawings by the valve symbol shown. See the valve tables attached to this Section for specific valve types suitable for a given commodity and line size.

.3 For valves not identified here refer to Section 15105.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

  .1 ASTM D1784 - Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

  .2 ASTM A351 - Castings, Austenitic, for Pressure-Containing Parts.

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

  .4 ASTM A536 - Ductile Iron Castings.

  .5 ASTM D429 - Rubber Property - Adhesion to Rigid Substrates.

  .6 ASTM D2000 - Rubber Products in Automotive Applications.

  .7 ASTM A164 - Electrodeposited Coatings of Zinc on Steel.

.2 American Water Works Association (AWWA):

  .1 AWWA C509 - Resilient Seated Gate Valves - Piping & Pipeline.

  .2 AWWA C508 - Swing Check Valves.

.3 Manufacturers Standardization Society (MSS):

  .1 MSS SP-078 - Gray Iron Plug Valves, Flanged and Threaded Ends.

  .2 MSS-SP72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.

.4 American Petroleum Institute (API):

  .1 API 593 - Ductile Iron Plug Valves, Flanged Ends.

1.3 Definitions

.1 Abbreviations:

.1 ARV - Air Relief or Vacuum Safety Valve.

.2 BV - Ball Valve.

.3 CV - Check Valve.

.4 FCV - Flow Control Valve.

.5 PV - Plug Valve.

.6 KV – Knife Gate Valve.

.7 SOL - Solenoid Valve.

.8 GV - Gate Valve.

1.4 Submittals

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

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 General

.1 Provide all valves of the same type, size range and service from a single Manufacturer (i.e., all plug valves from a single Manufacturer).

.2 Provide new, unused valves for the work.

.3 Provide valve materials free from defects or flaws, with true alignment and bores.

.4 Provide valves that open counterclockwise unless otherwise specified in the valve Specifications Sheets.

.5 Provide a lockout/tagout feature on all valves.

.6 If any process commodities included in the Final Design are not listed in the following detailed valve Specification Sheets, refer to Section 15105 and select a valve Specification that most closely matches the process commodity and service conditions and refine the Specification to suit the Final Design and include in the blacklined Specification submitted for review. The quality of products and scope of execution for any such process commodities not to be lower than the minimum standards set out in this Section.

.7 Detailed valve Specification Sheets follow.

2.2 Configuration, Components, and Features

.1 Manual Operators:

.1 Provide valves with manual operators in accordance with detailed valve Specification Sheets attached to this Section, unless otherwise indicated on the Drawings, and in accordance with Section 15105.

.2 For hand wheels, clearly show the direction of opening in raised lettering and symbols.

.3 The maximum rim pull on a hand wheel is not to exceed 300N when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater force to operate, provide a gear operator. Unless different operators are scheduled or indicated on the Drawings, conform to the following minimum requirements.

.4 Provide a dedicated operating wrench for use on all the valves with no hand wheel or other operator.

.5 Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.

.6 Lever operators on ball valves are to be two positions. Provide butterfly valves with ten position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.

.7 The maximum pull at the end of the lever arm is not to exceed 300N when one side of the valve is at test pressure and other side is at atmospheric pressure. Where greater force would be required to operate the valve with a lever, provide a gear operator. Unless different operators are scheduled or indicated on the Drawings, conform to the following minimum requirements.

.8 Provide grease lubricated, worm gear type operators, equipped with a hand wheel and a visual indicator of the valve position. Provide gear operators with adjustable mechanical stop-limiting devices to prevent over travel of the disc/ball in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant.

.9 For manual valves on lines 75 mm diameter and greater, mounted over 2.5 m above the operating floor, provide chain wheel gear operators with secondary safety restraint. Design the operator so that a force of 150N is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide chain pulley that meshes positively with the chain. The chain will extend from the valve operator to an operating height of 1.2 m above the floor or as directed by the Engineer. The exact dimensions will be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.

.10 Where manual operators are installed over 2.5 m above the operating floor and as indicated on the Drawings, specify a vertical shaft for the chain wheel, revise the gear operator and/or chain wheel position to provide a horizontal chain wheel shaft. Retain the valve orientation as indicated on the Drawings.

.11 Provide ductile iron chain wheels. Provide galvanized steel operating chains.

.2 Valve Stem Extensions:

.1 Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult, and in chambers to reduce requirement for entry.

.2 Where angle valve stem extensions are employed, they will be angle geared. Universal joint types are not permitted.

2.3 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) spare valve including the appropriate operator for each valve type and size.

.2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five (5) years. At the City’s request, provide a price for these parts.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Preparation

.1 Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Works.

.2 Prior to the installation of the valves, field measure and check all equipment locations, pipe alignments, and structural installation. Ensure that the valve location and orientation provide suitable access to manual operators and that sufficient space and accessibility is available for electric actuators.

.3 Where conflicts are identified, inform the City and initiate the necessary piping modifications at no cost to the City.

3.3 Valve Installation

.1 In horizontal pipe runs other than in locations where space does not permit, mount all valves except for butterfly valves and trunnion ball valves with a vertical operating shaft with the actuator at the top. Avoid installing a valve with the operator shaft pointing down.

.2 Mount butterfly valves and ball valves with the shaft in a horizontal orientation unless impractical.

.3 Mount valves in a position for easy access to the operators and maintenance personnel.

.4 When joining valves to pipe or fittings, do not overtorque bolts to correct for misalignment.

.5 Support valves in position using temporary supports until valves are fixed in place.

.6 Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

.7 Where valves are installed in PVC pipework larger than 100 mm diameter, support valves independently and brace against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

.8 Generally, pipe supports and hangers are not shown unless for indication purposes only.

.9 Install valves which are bubble-tight in one direction to seal in a direction opposite to normal flow unless otherwise noted or directed by the City.

.10 Unless otherwise specified, install single seated ball valves with the seat downstream. Install at tank connections with seat away from tank. Install on pump discharge and suction lines with seat adjacent to the pump.

.11 Install all valves in accordance with the Manufacturer's recommendations.

.12 Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tapewrap.

.13 Insert wafer and lug wafer butterfly valves between the flanges in the closed position, align and bolt finger-tight. Then open the valve fully before working the bolts. Test that the disk does not catch the edge of the flange on closing and opening.

3.4 Valve Testing

.1 Ensure that the position indicated by the lever or actuator matches the actual position of the valve.

.2 Operate valves under simulated and/or actual process conditions to ensure they operate as intended.

.3 Pressure test the valves in conjunction with the pipes in which the valves are installed as specified.

FCV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Flow Control Valve – Plug Valve	FCV	Liquid	0-750	5-30	1200	35

TYPICAL SERVICE
Automatically modulating flow control valve for liquid service.

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Reference Document	A126 Class B
Body	Cast Iron A126 Class B (Ballcentric plug valve body)	Size Range	50-200 mm
Plug	Rubber Coated Ductile Iron ASTM A536	Rating	Class 125
Disc Trim	Not Mandatory	Body/Valve Ends	Lug Wafer (Note 1)
Seats	Buna-N or EPDM	Actuator	Electrical

NOTES
1. Full lug, wafer style body for placement between two Class 125 flanges.

ACCEPTABLE PRODUCTS			
Flomatic	Cla-Val	Singer	Watt
Mueller-Pratt	DeZurik	Keystone-Emerson	Approved equivalent

BV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	BV	Liquid/Air	0-850	5-120	1275	140

TYPICAL SERVICE
For process air, process liquid and utility lines.

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Reference Document	Body Material: ASTM A351 (Note 2)
Body	316 SS CF8M body	Size Range	10 mm to 65 mm
Ball	Stainless Steel - floating	Rating	CWP 1000 kPag
Packing	Reinforced PTFE	Body/Valve Ends	Female Threaded or Flanged (Note 3)
Seats	Reinforced PTFE	Pattern	Two-Piece, Full Port
Shaft	Stainless Steel (Note 1)	Operator	Lockable Lever; Gear if ≥ 150 mm
Stem	316 SS Blow out proof	Actuator	Manual or Electrical

NOTES

1. Blowout-proof stem.
2. When this valve is installed into a gas service it must comply with the applicable Gas Safety Branch requirements: also refer to Division 40.
3. For SA service flanged connections only, threaded valves for this service are unacceptable.

ACCEPTABLE PRODUCTS		
M. A. Stewart Model G2	Apollo 76F-100-A Series (full port)	Approved equivalent

DETAILED PROCESS VALVE SPECIFICATION SHEETS

BV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Ball Valve	BV	Liquid	100-750	5 to 40	1000	60

TYPICAL SERVICE
For chemical lines and sample lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	Material: ASTM D1784 (Grade A)
Body	PVC	Size Range	10 mm to 75 mm
Ball	PVC – floating ball	Rating	CWP 1000 kPag
Packing	O-Ring, EPDM or Viton (Note 1)	Body/Valve Ends	Schedule 80, Female Threaded, True Union
Seats	PTFE	Pattern	Full Port
Shaft	PVC (Note 2)	Operator	Lockable Lever
		Stem	Blow out proof

NOTES

1. Material to be compatible with commodity.
2. Blowout-proof stem.

ACCEPTABLE PRODUCTS			
Chemline 21 Series	Hayward Safe-Block	Nibco Tru-Block PVC	Fabco Superbloc
IPEX VX-True Union	Approved equivalent		

CV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	CV	Liquid	0-750	5-30	1200	35

TYPICAL SERVICE
For non-potable water and wastewater (Note 1).

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Reference Document	AWWA C508 ASTM A126
Body	Cast Iron	Size Range	50 mm to 300 mm
Disc	Ductile iron or steel	Rating	Class 125
Seats	316 SS	Valve Ends	Flanged
Seat ring	Suitable material	Type of Disc	Swing Check
Coating	Fusion bonded epoxy coating, interior and exterior		

NOTES
1. For all check valves greater than 75 mm on pump discharges, provide weighted lever arm.

ACCEPTABLE PRODUCTS			
Crane 383 / 34612	DeZurik	Newman Hattersley T651	Milliken 801BBW
Jenkins 587J / 477LJ	Approved equivalent		

DETAILED PROCESS VALVE SPECIFICATION SHEETS

CV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Check Valve	CV	Liquid	0-550	5-100	850	115

TYPICAL SERVICE
For chemical lines, sample lines, utility lines.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Size Range	25 mm to 50 mm
Body	PVC	Rating	Sch. 80
Disc	PVC ball	Valve Ends	Flanged / Threaded / True Union
		Type of Disc	Ball Check (Note 1)

NOTES
1. Viton seat and seal.

ACCEPTABLE MANUFACTURERS			
Chemline	Fabco	Nibco	Hayward True Check
Approved equivalent			

KV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Knife Gate Valve	KV	Liquid	0-100	5-30	1200	35

TYPICAL SERVICE
For wastewater services.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	
Body	316 SS	Size Range	75 mm to 900 mm
Disc	316 SS	Rating	Class 150
Seats	Buna N, NBR	Valve Ends	Lugged
Seals	Buna N, NBR	Type of Disc	
Shaft	Stainless Steel	Operator	RS, Handwheel, epoxy coated
Wiper Ring	Reinforced PTFE	Actuator	Manual or Electrical (Note 1)
Pillars	Stainless Steel		
Stem	316 SS		

NOTES
1. Bi-directional pressure rating 100 kPa, drip tight shut off with downstream flange removed.

ACCEPTABLE PRODUCTS			
Trueline F8112	DeZurik KGC-BD	Pratt LVC77	MAS FCC84B
Fabro Valve C37C	Approved equivalent		

ARV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Air Relief Valve	ARV	Liquid	420	0-40	1000	40

TYPICAL SERVICE
For wastewater and non-potable water.

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Size Range	25-50 mm
Body, Cover	Ductile Iron ANSI B16.42	Rating	Class 150
Cover	Ductile Iron	Valve Ends	Flanged
Disc retainer and diaphragm washer	Cast Steel	Stem	Stainless Steel
Trim	Stainless Steel	Pilot Control	Bronze or Steel
Disc	Buna-N		
Diaphragm	Nylon Reinforced Buna-N		

NOTES:

1. Air valves shall be designed for automatically exhausting air from a pipeline when it is being filled with water at a high rate. They should be designed to automatically ventilate a pipeline where it is being emptied of water. The air flow rate shall be sufficiently high to prevent the development of high vacuum pressure in the line.
2. The valves shall be suitable for wastewater application.
3. Complete with isolation ball valve as recommended by the Manufacturer.
4. Complete with throttle device.

ACCEPTABLE PRODUCTS		
APCO	Valmatic	Cla-Val
Approved equivalent		

DETAILED PROCESS VALVE SPECIFICATION SHEETS

PV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Plug Valve	PV	Liquid	750	5-30	1200	35

TYPICAL SERVICE
For raw wastewater isolation, On/Off valve for wastewater and sludge.

VALVE MATERIALS		**VALVE DESCRIPTION**	
ITEM	MATERIAL	Reference Document	API 593, MSS SP-078
Body	Cast Iron	Size Range	50 mm to 450 mm
Plug	Cast Iron (see plug coating)	Rating	Class 150
Seats	Nickel	Valve Ends	FF Flanges
Seals	O-Rings, Buna-N, Acyionitrile-butadene	Type of Plug	Eccentric (Ballcentric), port area not less than 100% of pipe area
Shaft	Stainless Steel	Operator	gear operator (Note 1 &2)
Bearings	Stainless Steel	Actuator	Manual or Electrical
		Lining	Abrasion Resistant
		Plug Coating	Buna-N, Al-Clad, or Hycar, or chloro-sulfonyl polyetheylene

NOTES
5. Gear operator for 100 mm and over. 6. Square nut and lever under 100 mm.

ACCEPTABLE PRODUCTS			
DeZurik Series PEC Eccentric	Val-Matic Series 5800R Cam-Centric	Pratt Ballcentric Plug	Approved equivalent

SOL

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Solenoid Valve	SOL	Liquid	0-600	0-30	1400	50
TYPICAL SERVICE						
For non-potable water.						

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Reference Document	
Body	Stainless Steel	Size Range	10 mm to 50 mm
Plug	316 SS	Rating	CWP 1400 kPag
Seats	Buna-N or FKM	Body/Valve Ends	Female Threaded
Shaft	316 SS	Actuator	Solenoid
		Power	Coordinate with the vendor

ACCEPTABLE PRODUCTS		
ITT General Control sS21	ASCO Model Redhat	Approved equivalent

GV

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	OPERATING LIMITS		DESIGN LIMITS	
			PRESSURE (kPag)	TEMP. (°C)	PRESSURE (kPag)	TEMP. (°C)
Gate Valve	GV	Liquid	0-1050	5-20	1575	30

TYPICAL SERVICE

For non-potable water.

VALVE MATERIALS		VALVE DESCRIPTION	
ITEM	MATERIAL	Reference Document	AWWA C509
Body & Bonnet	Cast Iron (Note 1)	Valve End/Connections	FLG
Disk	Cast Iron or Ductile Iron (Note 2)	Type of Disk	Solid Wedge (Note 6)
Disk Coating	Urethane Rubber (Note 3)	Operator	Hand Wheel, Closed Bonnet (Note 7)
Seals/Packing	O-Rings, Manufacturer Standard	Special	Ground level position indicator (Note 8)
Shaft	Bronze or Stainless Steel	Gland Bolts	Zinc-Coated Steel (Note 1)
Bonnet Gasket	Rubber (Note 4)	Size Range	50-300 mm
Stem Nut	Bronze		
Operating Nut	Cast Iron (Note 1)		
Wiper Ring	Rubber (Note 4)		
Bonnet Bolt & Nut	Zinc-Coated Steel Sealed with Hot Melt (Note 5)		

NOTES

1. ASTM A126, Class B.
2. ASTM A536.
3. ASTM D429.
4. ASTM D2000.
5. ASTM A164.
6. Resilient seat.
7. Non-rising stem.
8. Below grade service to have valve box with stem extension.

ACCEPTABLE PRODUCTS

CLOW	American	Approved equivalent	

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the general requirements for selection and supply of process pipe materials, fittings, appurtenances. The piping Specification Sheets on the following pages detail the requirements for each type of process pipe included in the Work.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.2 ASTM A105 - Carbon Steel Forgings for Piping Applications.

.3 ASTM A193 - Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

.4 ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.5 ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

.6 ASTM A312 - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

.7 ASTM A403 - Wrought Austenitic Stainless Steel Piping Fittings.

.8 ASTM A563 - Standard Specification for Carbon and Alloy Steel Nut.

.9 ASTM A774 - As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

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

.11 ASTM A967 - Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts.

.12 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

.13 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

.14 ASTM D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

.15 ASTM D2665 - PVC Plastic Drain, Waste, and Vent Pipe and Fittings.

.16 ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.

.17 ASTM F37 - Sealability of Gasket Materials.

.18 ASTM F104 - Non-metallic Gasket Materials.

.19 ASTM F152 - Tension Testing of Non-metallic Gasket Materials.

.20 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

.2 American National Standards Institute (ANSI):

.1 ANSI B1.20.1 - Pipe Threads, General Purpose.

.2 ANSI B16.5 - Pipe Flanges and Flanged Fittings.

.3 ANSI B16.9 - Pipe Fittings.

.4 ANSI B16.11 - Forged Fittings, Socket-Welding and Threaded.

.5 ANSI B16.21 - Non-metallic Flat Gaskets for Pipe Flanges.

.3 American Water Works Association (AWWA):

.1 AWWA C110 - Ductile-Iron and Gray-Iron Fittings.

.2 ANSI/AWWA C151/A21.5 - Ductile-Iron Pipe, Centrifugally Cast.

.3 ANSI/AWWA C207 - Steel Pipe Flanges for Waterworks Service.

.4 AWWA C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.

.5 AWWA C606 - Grooved and Shouldered Joints.

.4 Canadian Standards Association (CSA):

.1 CSA/ANSI B149.6 - Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization.

.2 CSA B137.3 - Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications.

.3 CSA B182.1 - Plastic Drain and Sewer Pipe and Pipe Fittings.

.5 American Society of Mechanical Engineers (ASME):

.1 ASME B31.3 - Process Piping.

.6 Workplace Hazardous Materials Information System WHMIS.

.7 NACE RP0178 - Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to Be Lined for Immersion Service.

1.3 Definition

.1 Pressure terms used in this, and other related Sections are defined as follows:

.1 Operating Limits: The minimum and maximum pressure at which the piping system operates for sustained periods of time.

.2 Test pressure: The hydrostatic pressure used to determine system compliance.

.2 Unless otherwise specified or shown, the interface between piped commodities common to process/mechanical and yard piping is below grade and 0.5 m from the exterior face of a building or tunnel wall unless otherwise shown.

.3 Pipe and appurtenance location terms used in this, and other related sections are defined as:

.1 Inside (Tunnels, Pumphouse and Buildings): Within an environmentally controlled enclosure where temperature is maintained above 5°C.

.2 Outside (Exposed or Aboveground): Outside or within an enclosure which is not environmentally controlled so that the temperature is maintained above 5°C. For the purpose of defining exterior protection systems, this definition is extended to vertical piping to a point of 0.5 m below finished ground level.

.3 Buried: Placed in soil and not tied to structures.

.4 Submerged: Regularly or occasionally immersed in liquid; inside tanks and/or channels, and within 3.0 m above maximum water level of open tankage. Includes pipe and appurtenances within manholes, vaults and chambers.

.4 Abbreviations used in the detailed piping Specification Sheets defined as below:

Abbreviation	Commodity	Pipe Material
FSW (W3)	Flushing Water	316 or 304L Stainless Steel – Interior and Exterior
DRA	Drain	PVC-DWV – Interior
VNT	Vent	PVC-DWV – Interior
CE	Centrate	316 Stainless Steel Schedule 10 – Interior HDPE DR17 - Exterior
PRE	Phosphoros Recovery Effluent	316 Stainless Steel Schedule 10 – Interior HDPE DR17 - Exterior
BSL, SLS, SLI, BSL	Sludge and Biosolids Lines	Ductile Iron ceramic-epoxy lined or 316 Stainless Steel Schedule 10 - Interior HDPE DR17 or PVC Schedule 80- Exterior
PD	Process Drain	316 Stainless Steel Schedule 10 -Interior HDPE DR17 - Exterior
RS	Raw Sewage (forcemain)	HDPE DR17 or PVC Schedule 80- Exterior
DP	Polymer Makeup Skid	316 Stainless Steel Schedule 10
LCP	Liquid Polymer	PVC Schedule 80– Interior
MP	Mixed Polymer	PVC Schedule 80 and PE Tubing – Interior
-	Chemicals	316 Stainless Steel or PVC or CPVC (According to Corrosion Study)
CHL	Sodium Hypochlorite	CPVC or PVC Schedule 80- Interior
FC	Ferric Chloride	Double-wall 316 Stainless Steel or PVC or CPVC (According to Corrosion Study)

Abbreviation	Commodity	Pipe Material
FOA	Foul Air Ducting	FRP (interior and exterior above ground) HDPE DR17 (underground) 316 Stainless Steel Schedule 10
DG	Digester Gas	316 Stainless Steel Schedule 10 – Interior and Exterior
PA	Air Process	316 Stainless Steel Schedule 10

1.4 Submittals

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

.1 Manufacturer's descriptive literature for materials.

.2 Documentation listing pipe, fittings, flexible connectors, expansion joints, linings, coatings, and valving to be used for each pipe size and category.

.3 Radiographic Weld Testing: Submit the name and qualifications of at least two independent firms for the radiographic weld testing to be undertaken by the Construction Contractor if and as required by the applicable Code. The selected firm will be subject to the review and acceptance of the City.

.4 Provide hanger, guide, anchor, support system design details including locations, load information, design calculations and illustrative drawings, stamped and signed by a Professional Engineer registered in the Province of Manitoba.

.2 Welding:

.1 Prior to commencing any welding of stainless steel pipe, prepare and submit to the Contract Administrator a written description of welding techniques including but not limited to materials, methods, and quality control. Identify differences in shop and field techniques. Written procedures will be stamped and sealed by a Professional Engineer and qualified for welding design. For stainless steel welds exposed to process fluids, the weld procedure shall provide for maximizing the corrosion resistance of the final weld as well as providing the mechanical strength required.

.2 Provide radiographic weld test results.

.3 Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.

.4 Provide passivation procedures that will be followed.

2. PRODUCTS

2.1 Performance Criteria

.1 All pipe materials to be new, free from defects and conforming to the requirements and standards identified and as described below.

.2 For mechanical piping, select materials from those listed on the mechanical piping system Specification Sheets (Section 15055), including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings.

.3 Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same Manufacturer.

2.2 Pipe and Valve Compatibility

.1 Coordinate the selection of pipe materials, linings and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves. Support wafer style valves or spectacle flanges between flanges of equal inside diameter.

2.3 Bonding Jumpers

.1 Provide plated, flexible copper braid jumpers with unplated copper ferrules for attachment to pipe flanges, rated for a 100-amp minimum. Provide sufficient conductive, antioxidant compound to protect ferrules.

.1 Acceptable Products:

.1 Burndy Electrical, Type B series.

.2 Or approved equivalent.

2.4 Joints

.1 Use Victaulic grooved couplings for all process pipe joints except:

.1 Flanged joints for disassembly within 1 m of any connection to equipment, on both sides of structural penetrations, and within 0.6 m of all threaded end valves: Unless otherwise specified, adapt all equipment connections to a flanged connection compatible with the connected piping system.

.2 Flexible Joints at Structural Joint Crossings: As specified, provide a flexible joint on all piping crossing structural joints.

2.5 Flanges and Other Couplings

.1 General requirements for flanges are as follows:

.1 Reface raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.

.2 Provide flat-faced flanges on each side of butterfly valves.

.3 For steel piping, provide weld neck flanges on both sides of lug body valves.

.4 Slip-on flanges that are attached to a pipe by means of set screws and gaskets are not permitted.

2.6 Fittings

.1 General:

.1 Comply with Manufacturer’s up and down stream requirements.

.2 Provide eccentric reducers in horizontal lines with the flat side on top, unless shown otherwise.

.3 Provide concentric reducers in vertical lines unless indicated otherwise.

.4 Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow measurement device dimension.

.5 Provide long radius (greater than or equal to 1.5 times nominal diameter) elbows on all sludge and biosolids lines. Provide smooth flow stainless steel elbows 350 mm and less, to ANSI B16.9. Provide mitered elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use 3-0 piece construction unless otherwise shown or specified.

.2 Stainless Steel Pipelines:

.1 Less than 75 mm diameter: Provide fittings of the same class as the pipe, conforming to ASTM A403 and ANSI B16.11.

.2 Equal to or greater than 75 mm diameter: Fabricate fittings using similar materials and classes as the pipe and conform to ASTM A774 (scale removed).

.3 PVC Pipe and Fittings:

.1 Schedule 80.

.2 All PVC Schedule 80 pipe shall conform to ASTM D1785, and/or CSA B137.0/B137.3.

.3 PVC Schedule 80 socket fittings shall conform to ASTM D2467 and Schedule 80 threaded fittings shall conform to ASTM D2464.

.4 All potable water pipeline and fittings shall be third party certified to NSF 14.

.5 Provide PVC to CSA B137.3, of the same material and class as the pipe.

.6 Joining to be solvent cementing process. Provide flanges at valves, pumps and equipment only or as indicated and specified.

.7 Provide Type 316 stainless steel flange bolting and hardware for all piping system except sodium hypochlorite use titanium.

2.7 Gasket Materials

.1 For flat faced flanges, use full-face gaskets. For raised-face flanges, use flat ring gaskets. Conform to ANSI B16.21.

.2 Material designations used in the detailed process pipe Specification Sheets are as follows:

.1 Bl. Neoprene: neoprene (black) 70 durometer.

.2 SBR: Styrene-butadiene (red).

.3 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37).

.4 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37).

.5 CPE - Chlorinated Polyethylene.

.3 Use gasket materials for flanged connections suitable for the temperature, pressure, and corrosivity of the fluid conveyed in the pipeline durometer.

.4 Unless otherwise specified, minimum gasket material thickness for full face gaskets:

.1 Up to 250 mm pipe diameter; 1.6 mm thick.

.2 Greater than 250 mm pipe diameter; 3.2 mm thick.

.5 Unless otherwise specified, minimum gasket material thickness for raised face ring gaskets:

.1 Up to 100 mm pipe diameter; 1.6 mm thick.

.2 Greater than 100 mm pipe diameter; 3.2 mm thick.

.6 Grooved type gaskets:

.1 Select material as recommended by the Manufacturer for the service conditions indicated.

.2 Unless otherwise specified, provide flush seal type gaskets for all other grooved joint systems.

2.8 Bolts and Nuts

.1 Provide hex head bolts and nuts. Threads to be ANSI B1.20.1, standard coarse thread series.

.2 For general indoor service, use bolts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Gr.A.

.3 Provide stainless steel bolts, nuts and washers for exposed, submerged, buried and concrete encased service; bolts conforming to ASTM A193, Gr.B8, C1.1; nuts conforming to ASTM A194, Gr.8. Provide these also for connections above normal water level but which may be subjected to direct contact with splashed water.

.4 Provide hot dip galvanized bolts, nuts and washers for use with hot dip galvanized Van Stone flange back-up rings and lap-joint flange back-up rings.

.5 Provide hex nuts equal to or less than 25 mm. Greater than 25 mm, provide heavy hex.

2.9 Dissimilar Metal Connections

.1 Where dissimilar metals are in direct contact, furnish and install dielectric fittings or isolating flanges, including bolt sleeves and washers.

2.10 Cathodic Protection

.1 Provide cathodic protection of piping, pipe fittings and appurtenances.

2.11 Structural Element Penetrations

.1 Penetrations through structural elements to be in accordance with the Standard Details and as required for the Final Design based on the type of structure, exposure and type of pipe.

.2 Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

2.12 Schedule

.1 Detailed process pipe Specification Sheets follow.

.2 Connections to all equipment and valves shall be flanged. Grooved, butt welded, or solvent welded connections are not permitted without prior approval from the City.

.3 Transitions between pipe materials are not shown on Contract Drawings and are incidental to Contract Work.

Chemical Feeds

GENERAL					
PROCESS FLUID	SYMBOL	MAXIMUM CONDITIONS		TEST CONDITIONS	
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Mixed Polymer, Liquid Polymer	MP, LCP	750	0-30	1125	120
PIPE					
LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**SPECIFICATIONS**	**REMARKS**
All	10 – 300	PVC	Schedule 80	ASTM D1785, CSA 137.3	

JOINTS					
LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARKS**
All	10 – 65 10 – 65 ≥75 ≥75 ≥75	Solvent Welded Unions Solvent Welded Flanges Grooved Mechanical	N/A 12 m N/A 12 m 12 m	ASTM D2467, D2564 ASTM D2467 ASTM D2467, D2564 ASTM D2467	 Note 1 Note 1
FITTINGS AND APPURTENANCES					
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Flanges	10 – 300	PVC	Schedule 80		
ELL - Short Radius ELL - Long Radius, Couplings, Tees, Reducers, Reducing Outlets and Laterals, grooved	10 – 300	PVC	Schedule 80	ASTM D2467, Grooved or flanged	
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Plug	10 – 300	PVC	Schedule 80	ASTM D2467, Flanged	
Cap	≥75	PVC	Blind Flange Schedule 80		
Flange Hardware		Stainless Steel 316			
Flange Gaskets		Neoprene, Viton		ASTM F477	Note 2
PVC Solvent				ASTM D2564	Note 3 & 4

NOTES

1. Per maximum spacing allowed by the Manufacturer, provide as a minimum, unions, flanges, and flange adapters to allow for pipe and equipment disassembly and reassembly.
2. Gasket material to be compatible with designated chemical solution.
3. Provide pipe support. Piping supports are generally not shown on the Drawings, see Section 15096 Process Pipe Hangers and Supports.
4. Male and female adapters not to be used with PVC piping.

Drains and Vent to Outside

GENERAL					
PROCESS FLUID	SYMBOL	MAXIMUM CONDITIONS		TEST CONDITIONS	
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Drain, Vent	DRA, VNT	750	0-30	1125	120

PIPE					
LOCATION	SIZE (mm)	MATERIAL	RATING	STANDARD	REMARKS
All	10 – 300	PVC	DWV	CAN/CSA B182.1	

JOINTS					
LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	STANDARD	REMARKS
All	10 – 65	Solvent Welded	N/A	ASTM D2665	
	10 – 65	Unions	12 m	ASTM D2665	Note 1
	≥75	Solvent Welded	N/A	ASTM D2665	
	≥75	Flanges	12 m	ASTM D2665	Note 1
	≥75	Grooved Mechanical	12 m	ASTM D2665	

FITTINGS AND APPURTENANCES					
ITEM	SIZE (mm)	MATERIAL	RATING	STANDARD	REMARKS
Flanges	10 – 300	PVC	DWV		
ELL - Short Radius ELL - Long Radius, Couplings, Tees, Reducers, Reducing Outlets and Laterals, grooved	10 – 300	PVC	DWV	ASTM D2665	
ITEM	SIZE (mm)	MATERIAL	RATING	STANDARD	REMARKS
Plug	10 – 300	PVC	DWV	ASTM D2665	
Cap	≥75	PVC	DWV		
Flange Hardware		Stainless Steel 316			
Flange Gaskets		Neoprene, Viton		ASTM F477	
PVC Solvent				ASTM D2564	Note 2 & 3

NOTES

1. Per maximum spacing allowed by the Manufacturer, provide as a minimum, unions, flanges, and flange adapters to allow for pipe and equipment disassembly and reassembly.
2. Provide pipe support. Piping supports are generally not shown on the Drawings, see Section 15096 Process Pipe Hangers and Supports.
3. Male and female adapters not to be used with PVC piping.

DETAILED PROCESS PIPING SPECIFICATION

Flushing Water, Sludge and Process Piping

GENERAL					
PROCESS FLUID	**SYMBOL**	**MAXIMUM CONDITIONS**		**TEST CONDITIONS**	
		PRESSURE (kPa)	**TEMP. (°C)**	**PRESSURE (kPa)**	**DURATION (Min.)**
Phosphoros Recovery Effluent Centrate, Flushing Water, Process Drain, Sludge and Biosolids Lines.	PRE, CE, FSW (W3), PD, BSL, SLS, SLI, BSL.	750	0-30	1125	120
PIPE					
LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Inside Outside Buried Submerged	38 - 600	Stainless Steel 316	Schedule 10	ASTM A312	

JOINTS					
LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARK**
Inside	38- 600	Victaulic/Flanged/ butt weld	N/A		
Outside/Buried	38- 600	Flanged or Butt Weld	N/A		
Submerged	38- 600	Butt Weld Or Flanged	20 m	AWWA C606	
FITTINGS AND APPURTENANCES					
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARK**
Flanges, FF or RF	≥38	Stainless Steel 316	Class 150	Material: Same as Pipe Dimensions: ANSI B16.5 ANSI B16.9	
ELL – Short Radius ELL – Long Radius, Tees, Reducers, Reducing Outlets, Laterals and Caps	≥38	Stainless Steel 316	Same as Pipe	Material: Same as Pipe Dimensions: ANSI B16.9	
Plug	≥38	Stainless Steel 316	Class 150 Blind Flange	Material: Same as Pipe Dimensions: ANSI B16.5	
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARK**
Flanged Adaptors	≥38	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	
Flanged Gaskets	≥38	Neoprene		ASTM F477	
Grooved Joint Gaskets	≥38	Neoprene		AWWA C606	
Grooved Joint and Fittings	>38	Stainless Steel 316			
NOTES					

Sludge and Biosolids Piping (Ductile Iron)

GENERAL					
PROCESS FLUID	**SYMBOL**	**OPERATING LIMITS**		**TEST CONDITIONS**	
		PRESSURE (kPa)	**TEMP. (°C)**	**PRESSURE (kPa)**	**DURATION (Min.)**
Sludge and Biosolids Lines.	BSL, SLS, SLI, BSL.	750	5-30	1200	120
PIPE					
LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Inside	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
Submerged	≥75	Ductile Iron, Seamless	Std. Wt.	ANSI A21.51 Class 53, AWWA C151	
COATINGS					
LOCATION	**SIZE (mm)**	**MATERIAL**		**STANDARD**	**REMARKS**
Interior	≥75	Epoxy		AWWA C210	
Submerged	≥75	Epoxy		AWWA C210	
LININGS					
LOCATION	**SIZE (mm)**	**MATERIAL**		**STANDARD**	**REMARKS**
Interior	≥75	Ceramic Epoxy			
Submerged	≥75	Ceramic Epoxy			
JOINTS					
LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARKS**
Interior	≥75	Grooved or Flanged Joint	N/A	AWWA C110 Dimensions: AWWA C606	
Submerged	≥75	Grooved or Flanged Joint	N/A	AWWA C110 Dimensions: AWWA C606	
FITTINGS AND APPURTENANCES					
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Flanges, FF	≥75	Ductile Iron	Class 125	Material: ANSI A21.51 Class 53 Dimensions: ANSI B16.1 AWWA C110	
ELL - Short Radius ELL - Long Radius, Tees, Reducers, Reducing Outlets, Laterals	≥75	Ductile Iron, Seamless	Same as Pipe	Material: ANSI A21.51 Class 53 ASTM A536 Dimensions: AWWA C606 AWWA C110	
3 Piece ELL	>350	Ductile Iron	Same as Pipe	Material: Same as Pipe Dimensions: AWWA C110	

DETAILED PROCESS PIPING SPECIFICATION

ITEM	SIZE (mm)	MATERIAL	RATING	STANDARD	REMARKS
Plug	≥75	Ductile Iron	Class 125 Blind Flange	Material: Same as Pipe Dimensions: ANSI B16.1	
Cap, Grooved	≥75	Ductile Iron	Class 125	Material: Same as Pipe Dimensions: AWWA C606	
Sockolet					
Threadolet					
Flange Adaptors	≥75	Same as Pipe	Same as Pipe	Flange: ANSI B16.1 Grooved End: AWWA C606	
Flanged Gaskets		Bl. Neoprene			
Grooved Joint Gaskets	≥75			AWWA C606	Note 1
1. Comply with the Manufacturer's recommendations for grooved joint gaskets.					

Raw Sewage, Sludge and Biosolids Piping (PVC)

GENERAL					
PROCESS FLUID	**SYMBOL**	**MAXIMUM CONDITIONS**		**TEST CONDITIONS**	
		PRESSURE (kPa)	**TEMP. (°C)**	**PRESSURE (kPa)**	**DURATION (Min.)**
Raw Sewage, Sludge and Biosolids Lines.	RS, BSL, SLS, SLI, BSL.	750	0-30	1125	120
PIPE					
LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**SPECIFICATIONS**	**REMARKS**
All	10 – 500	PVC	Schedule 80	ASTM D1785, CSA 137.3	

JOINTS					
LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARKS**
All	10 – 65 10 – 65 ≥75 ≥75 ≥75	Solvent Welded Unions Solvent Welded Flanges Grooved Mechanical	N/A 12 m N/A 12 m 12 m	ASTM D2467, D2564 ASTM D2467 ASTM D2467, D2564 ASTM D2467	 Note 1 Note 1
FITTINGS AND APPURTENANCES					
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Flanges	10 – 500	PVC	Schedule 80		
ELL - Short Radius ELL - Long Radius, Couplings, Tees, Reducers, Reducing Outlets and Laterals, grooved	10 – 500	PVC	Schedule 80	ASTM D2467, Grooved or flanged	
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Plug	10 – 500	PVC	Schedule 80	ASTM D2467, Flanged	
Cap	≥75	PVC	Blind Flange Schedule 80		
Flange Hardware		316SS			
Flange Gaskets		Neoprene, Viton		ASTM F477	Note 2
PVC Solvent				ASTM D2564	Note 3 & 4

NOTES

1. Per maximum spacing allowed by the Manufacturer, provide as a minimum, unions, flanges, and flange adapters to allow for pipe and equipment disassembly and reassembly.
2. Gasket material to be compatible with designated chemical solution.
3. Provide pipe support. Piping supports are generally not shown on the Drawings, see Section 15096 Process Pipe Hangers and Supports.
4. Male and female adapters not to be used with PVC piping.

DETAILED PROCESS PIPING SPECIFICATION

GENERAL					
PROCESS FLUID	**SYMBOL**	**MAXIMUM CONDITIONS**		**TEST CONDITIONS**	
		PRESSURE (kPa)	**TEMP. (°C)**	**PRESSURE (kPa)**	**DURATION (Min.)**
Digester Gas, Air Process	DG, PA	750	0-30	1125	120
PIPE					
LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Inside Outside Buried	38 - 600	Stainless Steel 316	Schedule 10	ASTM A312	

JOINTS					
LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARKS**
All	≥38	Butt Weld	N/A		
FITTINGS AND APPURTENANCES					
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Flanges, FF or RF	≥38	Stainless Steel 316	Class 150	Material: Same as Pipe Dimensions: ANSI B16.5 ANSI B16.9	
ELL – Short Radius ELL – Long Radius, Tees, Reducers, Reducing Outlets, Laterals and Caps	≥38	Stainless Steel 316	Same as Pipe	Material: Same as Pipe Dimensions: ANSI B16.9	
Plug	≥38	Stainless Steel 316	Class 150 Blind Flange	Material: Same as Pipe Dimensions: ANSI B16.5	
ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Flanged Adaptors	≥38	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	
Flanged Gaskets	≥38	Neoprene		ASTM F477	
Grooved Joint Gaskets	≥38	Neoprene		AWWA C606	
Grooved Joint and Fittings	>38	Stainless Steel 316			
NOTES					

HDPE Piping

GENERAL

PROCESS FLUID	**SYMBOL**	**MAXIMUM CONDITIONS**		**TEST CONDITIONS**	
		PRESSURE (kPa)	**TEMP. (°C)**	**PRESSURE (kPa)**	**DURATION (Min.)**
Raw Sewage, Phosphoros Recovery Effluent, Centrate, Process Drain, Sludge and Biosolids Lines, Foul Air.	RS, PRE, CE, PD, BSL, SLS, SLI, BSL, FOA	750	0-30	0-1125	120

PIPE

LOCATION	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
Buried	10-900	HDPE	DR17	ASTM D3350	

JOINTS

LOCATION	**SIZE (mm)**	**TYPE**	**MAXIMUM SPACING**	**STANDARD**	**REMARKS**
Buried	10-900	Thermal butt fusion	N/A	ANSI/AWWA C207	

FITTINGS AND APPURTENANCES

ITEM	**SIZE (mm)**	**MATERIAL**	**RATING**	**STANDARD**	**REMARKS**
PP Compression Fittings	10-32	PP		Design Standard Cepex Performance Series	
ELL - Short Radius ELL - Long Radius, Couplings, Tees, Reducers, Reducing Outlets and Laterals	40-900	HDPE	1100 kPa	ASTM A105	

NOTES

3. EXECUTION

3.1 Preparation

.1 Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

.2 Make all minor modifications to suit installed equipment and structural element locations and elevations.

.3 Advise the City of all modifications. Do not commence work on the related piping until all modifications have been reviewed by the City.

.4 Include any piping modifications in the Shop Drawings submitted prior to fabrication or installation.

3.2 Pipe Handling

.1 Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings. Do not use sections of large diameter, thin-walled stainless steel piping that may have been deformed out of roundness or dimpled. Such damaged sections shall be discarded.

.2 Remove all foreign matter from inside of pipe prior to installation.

.3 Repair pipe with damaged protective coatings with material similar to the original in accordance with the Manufacturer's directions and to the satisfaction of the City.

.4 Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe or coatings.

.5 When lifting sections of large diameter, thin wall piping onto the supports use methods that will prevent damage or deformation. Lift evenly at several places to limit piping deflection between lifting points to a maximum of 6.3 mm.

3.3 Sleeves

.1 Unless otherwise noted or approved by the City, provide sleeves where piping passes through a wall, floor or ceiling.

.2 Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.4 Installation of Pipe Underground/Buried and Below Structures

.1 Trenching and backfill for buried pipe: conform to Division 2.

.2 Pipe laying and bedding: conform to Division 2.

.3 Unless otherwise shown, protect pipe laid below structures with a concrete surround having a minimum coverage of 100 mm all around the pipe; extend concrete surround to undisturbed ground.

.4 For concrete surround, comply with the following:

  .1 Install pipe in straight alignment. Do not exceed 10 mm variance from the true alignment in any direction.

  .2 Ensure the pipe alignment stays true during and after placement of concrete surround.

  .3 Ensure that the method used to prevent pipe uplift during placement of concrete surround results in a level invert and crown.

  .4 Maintain pipe circular cross section.

  .5 Provide lean concrete to within 150 mm of the underside of the slab or footing for backfill over pipe laid below structures, except as detailed otherwise.

  .6 Place concrete in accordance with Section 03300.

.5 Provide Yellow Jacket or tapewrap on all fittings and flanged, grooved, plain end and welded joints underground and below structures.

.6 Unless otherwise specified or shown, for underground piping, provide groove joints or flex coupled joints at 6 m on centre.

.7 Use anti-seize compound with all stainless steel nuts and bolts.

.8 Prior to installation provide a Manufacturer's Representative from the HDPE pipe Manufacturer for a minimum of one (1) day to instruct personnel on installation procedures of HDPE pipe.

3.5 Installation

.1 Fabricate and install pressure piping in interior building spaces in accordance with the ASME pressure vessel code. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with Authorities Having Jurisdiction.

.2 Install as per ASME B31.3, latest edition.

.3 Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage. Supports, bracing, and expansion joints shown in the Drawings are schematic only. The Construction Contractor is responsible for the design, supply, and installation of the piping system in general accordance with the indicated requirements.

.4 Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

.5 Install expansion joints where shown and at other locations as necessary to allow for piping expansion and contraction.

.6 Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

.7 Accurately cut all piping for fabrication to field measurements. Process air piping sections shall be measured and cut at 15 to 20°C. If the installation in the field takes place at lower outdoor temperatures, provide circulation of hot air inside the piping to expand the material such that flanges can be bolted. Expansion joints for process air piping shall be blocked at their natural length at 15 to 20°C and such that they will not deflect excessively during handling and installation. These blocks shall be removed prior to pressure testing.

.8 Install pipes in straight alignment. For large diameter (500 ND and greater), thin walled (6.4 mm and thinner) stainless steel piping, laser alignment of all pipe supports. Lateral and vertical misalignment between any three (3) consecutive supports shall not exceed the pipe wall thickness.

.9 For piping other than large-diameter, thin-walled stainless steel, do not exceed 10 mm in 10 m variance from the true alignment, in any direction.

.10 Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. The "springing" of pipework to ensure alignment is not permitted. Undo and subsequently remake all pipework connections to ensure that springing does not occur. Take care not to damage equipment, valves or flanges.

.11 Do not cut or weaken the building structure to facilitate installation.

.12 In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 200 mm.

.13 In vertical pipe runs of diameter greater than 250 mm, provide 200 mm long spool piece on lower side of each valve.

.14 Provide aluminum watertight drip trays under pipe carrying corrosive commodities (sodium hypochlorite, ferric chloride) crossing over cable trays. The drip trays will be 300 mm wider and 600 mm longer than the piping area over the cable tray. Fit with 12 mm drains that extend to within 150 mm of the floor, near a floor drain.

3.6 Stainless Steel Welding

.1 Conform to reviewed stainless steel pipe welding procedures, which have been stamped and signed by a Professional Engineer registered in the Province of Manitoba.

.2 Remove all scale, rust and any other surface deposits from the entire pipe and fittings before welding. Be particularly thorough with the internal surface preparation.

.3 For all stainless steel pipe intended to convey liquids, use inert gas backing (GMAW or GTAW) for field and shop welds. For these services, solar flux will not be allowed.

.4 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.5 Grind or buff all welds to a minimum radius of 6 mm on all edges and corners to achieve a smooth surface, eliminate any pockets and eliminate any protruding root passes. Adhere to latest edition of NACE RP0178. If material thickness will not allow 6 mm radius, make radius one half of material thickness.

.6 Ensure the OD weld (weld cap) is free of excessive weld cap and free of discoloration due to welding. Ensure all ID welds (root pass) or OD welds exposed to corrosive fluids/environments are ground flush and have no discoloration.

.7 Passivation:

.1 Passivate the inside of all stainless steel piping after completion of all piping and supports welding. Any welding after passivation will require passivation of the entire piping section again. A piping section is the length between flanges.

.2 Comply with ASTM A380 and ASTM A967.

.3 Use fine-grit carbide sandpaper to remove any discoloration, such as bluish tint due to overheating at welds.

.4 Thoroughly clean the interior of the pipe and ensure there are no oil or grease deposits or particulate (such as from the sandpaper) using trisodium phosphate (TSP) solution per Manufacturer's recommendation. Thoroughly rinse with tap water.

.5 Acid pickle using a solution of 20% nitric acid and 2% hydrofluoric acid in chloride-free water. Treat for no less than two (2) hours at 20°C to 40°C. Do not work at less than 20°C. An equivalent pickling paste shall be used for air piping not designed to be filled with water. Follow the Manufacturer's instructions. Rinse thoroughly with chloride-free water (distilled or de-ionized) until the rinse water shows less than 0.1 mg/L of fluoride. Rinse thoroughly with chloride-free water (distilled or de-ionized) brought to pH 10 using ammonia (preferred). Alternatively caustic soda or soda ash may be used to increase the final rinse water pH, but the maximum concentration of chloride allowed in this solution is 1 mg/L. Note that chloride concentration in commercially available caustic soda and soda ash may be too high for this use. Completely drain and leave drying in warm air (not less than 20°C at the outlet end) overnight.

.6 Collect all acids, caustics and rinses and take all necessary precautions to prevent spills on the ground. Neutralize as needed, for example blending acid and caustic wastes and using pebble or ground limestone, lime or other suitable material. Dispose of the neutralized waste as indicated by the City at the closest primary effluent channel. Note that the City may limit the volume that may be discharged over time.

.7 Process air piping may not be filled with water unless laid flat on the ground or otherwise supported every 5 m and on each side of sliding supports.

.8 Provide adequate ventilation that will blow any fumes away from the worker. This individual shall wear adequate protection per MSDS and clean, thick cloth socks over footwear and follow WHMIS safety procedures.

3.7 Grooved Piping System - Installation

.1 All grooved products shall be installed according to Manufacturer's installation instructions.

.2 Schedule 10 and 80 stainless steel pipe shall be roll grooved using "RX" rolls in accordance with Manufacturer's installation instructions.

.3 Copper piping shall be Roll Grooved in accordance with Manufacturer's installation instructions.

3.8 Testing

.1 Give the City twenty-four (24) hours notice prior to testing.

.2 Do not insulate or conceal work until piping systems are tested and accepted.

.3 Complete any required weld tests.

.4 Interior of stainless steel piping shall be bright metal with no discoloration. Any discoloration, such as bluish tint at welds, will require spot pickling and passivation using paste containing nitric acid and hydrofluoric acid, followed by rinsing and drying as indicated previously.

.5 Spot check the interior of the stainless steel piping and weld areas. Use 5% copper sulphate solution. After ten (10) minutes at not less than 15°C there shall be no observable deposit of metallic copper. Otherwise, pickling and passivation shall be repeated for the entire piping section. Carefully wipe off copper sulphate solution with several damp pieces of cloth.

.6 Supply all water, air and inert gases required for pressure testing.

.7 Supply all pumps, compressors, gauges, etc. required for testing.

.8 Install air threadolets, air relief valves and line fitting valves as necessary to complete testing. Remove after testing and plug the threadolets.

.9 Cap or plug all lines which are normally open ended. Remove on completion of testing.

.10 Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

.11 Test all underground lines prior to backfilling. Do not place concrete surround until lines are tested.

.12 Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the City of such failure.

.13 Isolate all low-pressure equipment and appurtenances during testing so as not to place any excess pressure on the operating equipment.

.14 Where defective material or equipment is identified, repair or replace using new material.

.15 Release pressure safely, flush and drain liquid pipes after pressure tests. Release pressure safely and purge if needed all gas pipes after pressure tests.

.16 Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests.

.17 Dispose of flushing water in manner approved by the City, which causes no damage to buildings or siteworks.

3.9 Pressure Testing of Liquid Lines

.1 Hydrostatically test all lines normally used for the conveyance of liquid using water as the test medium.

.2 Test pressures and durations shall be as specified in the detailed Specification Sheets.

.3 Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

.4 Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

.5 Show evidence of leakage rates below 0.01 L/hr/mm pipe diameter per 100 m of pipe length for buried piping, unless otherwise specified.

3.10 Pressure Testing of Gas, Air and Vapour Lines

.1 Hydrostatically or pneumatically pressure test, as shown in the table below, all lines normally used for the conveyance of gas, air, and/or vapour in accordance with Process Piping Code B31.3 procedures for testing pressure piping.

.2 For air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the City. At the City's request, provide calculations indicating design of temporary support system.

.3 Other than for sodium hypochlorite and ferric chloride piping systems, use the following test medium:

Pipe Size Specified	**Testing Medium**	**Test Pressure**
50 mm and smaller	500 kPa or less	Air or Water
50 mm and smaller	Greater than 500 kPa	Water
Greater than 50 mm	500 kPa or less	Air or Water
Greater than 50 mm	Greater than 500 kPa	Water

.4 Test pressures are identified in the detailed piping Specification Sheets.

.5 Zero leakage rate for insulated systems, and systems tested with water is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

.6 Do not exceed 5% of the specified test pressure as the allowable leakage are over the test period for other systems tested with air. Provide feed air pressure regulator with gauge and pressure safety valve with ring pressure set at not more than 20 kPag above the test pressure and adequately sized for both the compressor capacity and any condition that could result in pressure increases.

.7 Wet all joints using a mixture of soap and water in systems tested with air. Remake all joints which display leakage and retest. For stainless steel piping, repeat cleaning and passivation procedure indicated above for the entire piping section, then test for adequate passivation in the re-worked area.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation and testing of motorized strainers.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A36 - Carbon Structural Steel.

.2 ASTM A48 - Gray Iron Castings.

.2 American National Standards Institute (ANSI):

.1 ANSI S1.11 - Octave, Half-Octave, and Third-Octave Band Filter Sets.

.2 ANSI B16.5 - Pipe Flanges and Flanged Fitting.

.3 National Electrical Manufacturer Association (NEMA):

.1 MG1 - Motors and Generators.

.4 The City of Winnipeg Automation Design Guide.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 based on differential pressure.

.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.

.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 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 and in accordance with the City of Winnipeg 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.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) grease lubricator.

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

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 a pump, intermediate shafting, couplings, electric motor, ring base and variable speed drive.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A48 - Gray Iron Castings.
- .2 ASTM A743 - Corrosion-Resistant, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application.
- .3 ASTM A332 - Nickel-Chromium-Molybdenum Steel Bars for Springs Active Only.
- .4 ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.

.2 American Bearing Manufacturers Association (ABMA):

- .1 ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.3 American National Standards Institute (ANSI):

- .1 ANSI/HI 9.1-9.5 - Pumps, General Guidelines for Types, Definitions, Application, Sound Measurement and Decontamination.
- .2 ANSI/HI 9.6.1 - Rotodynamic (Centrifugal and Vertical) Pumps for NPSH Margin.
- .3 ANSI/HI 9.6.2 - Centrifugal and Vertical Pumps for Allowable Nozzle Loads.
- .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 9.6.6 - Rotodynamic Pumps for Pump Piping.
- .7 ANSI/HI 9.8 - Pump Intake Design.
- .8 ANSI/HI 14.6 - Hydraulic Performance Acceptance Tests.

.9 ASA/ANSI S1.11 - Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

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

.11 ANSI B16.5 - Steel Pipe Flanges - Pressure and Temperature Ratings.

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

.13 ANSI B18.2.2 - Square and Hex Nuts.

.4 American Society of Mechanical Engineers (ASME):

.1 ASME B18.2.1- Square, Hex, Heavy Hex, And Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, And Lag Screws (Inch Series).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Vibration and critical speed analysis in accordance with Section 11020.

.2 Provide predicted variable speed pump performance curves showing total dynamic head, power, efficiency, and NPSH3 required plotted against the capacity for the following, at a minimum:

.1 Annual average day flow at the max static head.

.2 Annual average day flow at min static head.

.3 Peak wet weather flow at the max static head.

.4 Peak wet weather flow at min static head.

.5 Minimum flow at min static head.

.6 Minimum flow at the 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 a 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.

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 shall 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 the minimum anticipated system head, assuming a hypothetical head-capacity curve.

.3 Condition C indicates operating conditions when the pump is operating against the 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 the 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 The 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 that 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 Pumphead capacity curves shall have no points of reverse slope inflection within the specified operating range.

.9 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.

.10 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.

.11 Provide non-overloading pumps and motors at any point on the pump's full-speed operating curve.

.12 Pump General Performance:

.1 The pumps shall be designed to function over the entire variable speed, and 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.

.13 Motor General Performance:

.1 The 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 an average of four (4) or more readings at evenly spaced points, 1 m from the 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.

.14 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 a 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.

.15 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 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 hydraulic components of the pump can be removed from the dry well without disturbing the motor, shaft and suction and discharge piping.

.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 a 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 the seal to function when the 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 shafts after removal of the motor.

.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 the 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 the principal section of the 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 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 the 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Factory tests shall be conducted on pump assembly in accordance with Section 11330.

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 the 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

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, design, fabrication, delivery, and installation of a mechanical mixing system complete with pumps; motors; mixing and foam control nozzle assemblies; complete with all required piping within the respective tanks and connections to pumps; valves as required complete with all accessories and appurtenances; instrumentation and controls; and ancillaries required for the complete installed system.

.2 Provide mechanical mixing systems for the following processes:

.1 Anaerobic Digesters.

.2 Liquid Biosolids Holding Tanks.

.3 Wet Weather Sludge Storage Tanks.

1.2 Standards

.1 American Bearing Manufacturers Association (ABMA):

.1 ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.2 American Society for Testing and Materials (ASTM):

.1 ASTM A48 - Gray Iron Castings.

.2 ASTM A148 - Steel Castings, High Strength, For Structural Purposes.

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

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

.5 ASTM A322 - Steel Bars, Alloy, Standard Grades.

.6 ASTM A536 - Ductile Iron Castings.

.7 ASTM A576 - Steel Bars, Carbon, Hot Wrought, Special Quality.

.8 ASTM A743 - Corrosion-Resistant, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application.

.3 Hydraulic Institute Standards (Hydraulic Institute Pump Standards, Joint Standards of Hydraulic Institute and ANSI).

.4 National Electrical Manufacturer Association (NEMA).

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 ,11000 and 11300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Layout of mixing nozzles, scum control nozzles, and mixing piping within the tanks, including pipe sizes, from the floor of the tank up to each nozzle.

.3 Pump performance curves showing the pumphead-discharge characteristics, NPSH required, efficiency and brake horsepower over the full operating range of the pump. The pumphead-discharge characteristics shall be derived from a minimum of ten points including one at the shut-off head.

.4 Details of impeller size, pump rpm and solid sphere passing capacity.

.5 Dimensional drawings of motors and drives and details including full output power in kilowatts, rpm and slip.

.6 Details of mechanical seals.

.7 Standard factory test results for motors.

.8 Information on the proposed factory-applied coating system. Include the Manufacturer's descriptive technical catalog literature and specifications, and a written Manufacturer's Certificate of Compliance that the factory-applied coating system is identical to the requirements specified.

.9 Where the system proposed is different from that specified, or where, in the Manufacturer's opinion, the coating system proposed exceeds the requirements specified, submit complete technical literature for the proposed system for review.

.10 Vibration and critical speed analysis in accordance with Section 11020.

.11 CFD analysis and dye-tracer studies

.1 This work is applicable to Anaerobic Digesters only.

.2 The CFD analysis shall be undertaken for the proposed works that will model the specified mixing flows specific to the digester tanks proposed by Design Builder. The CFD analysis shall indicate Volume Averaged Velocities equal to or greater than 0.15 m/sec and active volume mixing greater than or equal to 90 percent based on a simulated tracer washout test for the proposed mixing system based on 6 percent solids digested sludge. The report along with the underlying CFD computer files shall be submitted to the City. Proof of a current license for the software used shall also be submitted.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single Manufacturer.

.2 Acceptable Manufacturers:

  .1 Vaughan Co., Inc (Rotamix).

  .2 Or approved equivalent.

2.2 Performance Criteria

.1 Anaerobic Digesters:

  .1 The feed sludge to each digester is pre-screened, thermally hydrolyzed mixed fermented primary sludge and thickened waste activated sludge, having a solids concentration range of 9.5 to 10.5 percent dry solids by weight.

  .2 Provide one (1) complete mechanical mixing system for each digester tank consisting of wall-mounted and floor-mounted mixing and foam control nozzle assemblies connected to mixing pumps.

  .3 The number, size, and locations of nozzles shall be designed to optimize organic substrate conversion to biogas. The Manufacturer shall be responsible for determining the size and capacity of the mixing pump and motor, mixing nozzle assembly quantity, location, and appropriate nozzle angles in order to optimize organic substrate conversion to biogas.

  .4 The mixing equipment shall provide adequate mixing intensity to suspend anaerobic biomass and organic substrate, but specifically not inorganic material such as grit. Provide at least one (1) top-mounted foam suppression nozzle for each digester to prevent scum buildup and control foam accumulation on the surface of the digester contents. The mixing pumps are to provide the motive flow for this nozzle as well.

  .5 The digester mixing system must positively and continuously mix the contents of a digester.

  .6 The mixing pump and nozzle system shall provide complete mixing of the digester contents. Provide a duty/standby arrangement for the mixing pumps for each digester. Size pumps so that one (1) mixing pump has full capacity for mixing one (1) digester. The Manufacturer shall be responsible for confirming that the specified pump capacity is adequate to provide the specified performance and provide the necessary duty/standby pump equipment.

  .7 When the mixing pump for each digester is in operation, the variation in total solids concentration throughout the associated digester must not vary more than plus or minus 5 percent from the mean total solids concentration.

.8 When the mixing pump for each digester is in operation, the variation in temperature throughout the associated digester must not vary more than plus or minus 0.5°C from the mean temperature.

.9 When the mixing pump for each digester is in operation, the tank will have a minimum active volume of 90 percent.

.10 Achieve the specified active volume within 30 minutes of start-up of each mixing system.

.2 Liquid Biosolids Holding Tanks:

.1 Size the mixing system for percent solids in the liquid biosolids holding tank.

.2 Provide a complete mechanical mixing system for each liquid biosolids holding tank consisting of floor mounted mixing assemblies connected to mixing pumps.

.3 The number, size, and locations of nozzles shall be designed to optimize optimal tank mixing. The Manufacturer shall be responsible for determining the size and capacity of mixing pump and motor, mixing nozzle assembly quantity, location, and appropriate nozzle angles in order to optimize the mixing of the tank contents.

.4 The mixing pump and nozzle system shall provide complete mixing of the tank contents.

.5 The mixing equipment shall provide adequate mixing intensity to suspend the stored sludge from a settled stage. The mixing pumps are to provide the motive flow for this nozzle as well.

.6 The mixing system must be capable to operate either intermittently or continuously based on an operator selected mode.

.7 Provide a duty/standby arrangement for the mixing pumps.

.8 Size pumps so that one mixing pump has full capacity for mixing one (1) tank. The Manufacturer shall be responsible for confirming that the specified pump capacity is adequate to provide the specified performance and provide the necessary duty/standby pump equipment.

.9 When the mixing pump is in operation, the variation in total solids concentration throughout the associated tank must not vary more than plus or minus 1 percent from the mean total solids concentration.

.10 When the mixing pump for each tank is in operation, the tank will have a minimum active volume of 90 percent.

.11 Achieve the specified active volume within 30 minutes of start-up of each mixing system.

.3 Wet Weather Sludge Storage Tanks:

.1 The feed sludge to each Wet Weather Sludge Storage tanks is sludge pumped from the ballasted flocculation system located in the Headworks building.

.2 The mixed sludge may include minor amounts of sand, grit, plastics, rags, stringy and fibrous material and other settleable solids typically found in municipal wastewater.

.3 Provide a complete mechanical mixing system for each wet weather storage tank consisting of floor mounted mixing assemblies connected to mixing pumps.

.4 The number, size, and locations of nozzles shall be designed to optimize optimal tank mixing. The Manufacturer shall be responsible for determining the size and capacity of mixing pump and motor, mixing nozzle assembly quantity, location, and appropriate nozzle angles in order to optimize the mixing of the tank contents.

.5 The mixing pump and nozzle system shall provide complete mixing of the tank contents.

.6 The mixing equipment shall provide adequate mixing intensity to suspend the stored sludge from a settled stage. The mixing pumps are to provide the motive flow for this nozzle as well.

.7 The mixing system must be capable to operate either intermittently or continuously based on an operator selected mode.

.8 Provide a duty/duty/standby arrangement for the mixing pumps.

.9 Size pumps so that one mixing pump has full capacity for mixing one (1) tank. The Manufacturer shall be responsible for confirming that the specified pump capacity is adequate to provide the specified performance and provide the necessary duty/standby pump equipment.

.10 When the mixing pump is in operation, the variation in total solids concentration throughout the associated tank must not vary more than plus or minus 1 percent from the mean total solids concentration.

.11 When the mixing pump for each tank is in operation, the tank will have a minimum active volume of 90 percent.

.12 Achieve the specified active volume within thirty (30) minutes of start-up of each mixing system.

2.3 Materials

.1 Nozzles, pipe and assembly fittings: ASTM A536 cast ductile iron glass-lined.

.2 Nozzle assembly floor bases and wall mounting brackets: Type 304 stainless steel; anchor bolts and washers Type 316 stainless steel.

.3 Pump casing: ASTM A536 cast ductile iron.

.4 Impellor: ASTM A148 cast alloy steel; case hardened to minimum Rockwell C 60.

.5 Cutter Bar: ASTM A536 cast ductile iron; hardened to minimum Rockwell C 60.

.6 Shear bars and upper cutter bar: AISI 8620 alloy steel; case hardened to minimum Rockwell C 60.

.7 Pump shaft: AISI 4140 heated treated alloy steel.

.8 Mechanical seals: flushless; AISI Type 316 stainless steel; Viton O-rings; tungsten or carbide faces.

2.4 Configuration, Components and Features

.1 Nozzles:

.1 Design the mixing nozzles, including location, the direction of discharge, and outlet velocity, tailored for the specified design in order to optimize mixing effectiveness and efficiency.

.2 Supply all nozzle assemblies with grooved joint fittings and couplings to permit easy disassembly for cleaning. Select couplings that prevent nozzles from rotating out of position.

.3 Supply single or dual directional nozzles as required by the Manufacturer.

.4 Glass lining shall be a minimum thickness of 0.25 mm; hardness exceeding 5 (Mohs Scale) and a minimum density of 2.5 g/cm^3.

.2 Mixing Pumps:

.1 Pumps shall be horizontal, centrifugal, end suction chopper type impellor with all appurtenances.

.2 The pumps shall be specifically designed to pump digesting sludge solids and mixed sludge solids at consistencies ranging from 6 to 11 percent.

.3 For the Anaerobic Digesters: Digesting sludge solids and the feed of mixed sludge solids into a digester shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump shall be able to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hairballs, wood, paper products and stringy materials without plugging.

.4 Rated capacity and head shall be determined by the mixing system Manufacturer.

.5 Minimum NPSH available: flooded suction.

.6 Maximum pump speed of 1000 RPM.

.7 Motor size shall be determined by the Manufacturer; maximum motor speed 1800 RPM. V-belt connected drive.

.3 Casing:

.1 The pump casing shall be a semi-concentric back pullout design, with the first half of the circumference being cylindrical and starting after the pump outlet; and the remaining circumference spiraling outward to the 150 lb flanged centreline discharge.

.2 Water passages for the pump casing shall be smooth, and free of blowholes and imperfections for good flow characteristics.

.3 Provide a 6 mm diameter NPT pressure tap in the discharge flange.

.4 Impeller:

.1 Semi-open type impeller with pump-out vanes to reduce seal area pressure.

.2 Chopping 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 maximum set clearance between the impeller and cutter bar of 0.50 mm to 0.75 mm.

.3 Impeller shall be cast from ASTM A148 alloy steel, case hardened to minimum Rockwell C 60 and dynamically balanced.

.4 Impeller shall be threaded to the shaft and have no axial adjustments and no set screws.

.5 Cutter bar:

.1 Cutter bar shall be recessed into the pump bowl, with a funnel-shaped inlet opening, and extend diametrically across the entire pump suction opening.

.2 Cutter bar shall be cast from ASTM A536 ductile iron, hardened to a minimum Rockwell C 50. Replaceable shear bars shall be AISI 8620, case-hardened to minimum Rockwell C 60.

.3 Upper cutter shall be threaded into the back pull-out adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. The upper cutter shall be AISI 8620 alloy steel case-hardened to a minimum Rockwell C 60.

.6 Pump shaft:

.1 The pump shaft and impeller shall be supported by a ball or roller bearings. All shafting shall be heat-treated AISI 4140.

.7 Bearings:

.1 Shaft thrust in both directions shall be taken up by two (2) back-to-back mounted single-row angular contact ball bearings. Radial loads at the inboard bearing shall be taken up by a properly sized spherical roller bearing.

.2 L 10 bearing life shall be minimum of 100,000 hours.

.8 Bearing housing:

.1 Bearing housing shall be A536 ductile cast iron, and machined with piloted bearing fits for concentricity of all components.

.2 Bearing housing shall be oil bath lubricated with ISO Gr. 100 turbine oil and a side-mounted site glass to provide a permanently lubricated assembly.

.3 Viton double lip seals riding on stainless steel shaft sleeves to provide sealing at each end of the bearing housing.

.9 Mechanical seal:

.1 Flushless mechanical seal system specifically designed to require no seal flush. The seal shall be made of AISI Type 316 stainless steel and shall be cartridge-type with Viton 0-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 must 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.

.10 Inlet manifold:

.1 The pump assembly shall be mounted horizontally with 150 lb standard inlet flange, cleanout, 6 mm diameter NPT suction pressure tap, drain connection, and mounting feet.

.11 Motors and drives:

.1 Motor nameplate horsepower shall not be exceeded at any head capacity point on the pump curve.

.2 Size motors for full speed run-out condition of the pump performance curve.

.3 Motors shall be equipped with thermostats in motor windings.

.4 Align the motor and pump on the base at the factory prior to shipment.

.12 Lifting lugs:

.1 Provide lifting lugs suitably attached for equipment assemblies and components weighing over 25 kg.

.13 Anchor bolts:

.1 Type 316 stainless steel anchor bolts, sized by equipment manufacturer minimum 15 mm diameter, and as specified in Section 05501.

2.5 Equipment and System Controls

.1 Provide temperature and vibration sensors to protect the pump and shaft bearings.

2.6 Finishes

.1 Procedures in accordance with Section 09900.

.2 Prime Coat: shop applied, coating material per Section 09905.

.3 Finish Coat: field applied, coating material per Section 09905.

.4 Provide at least 1 L of finish coat per pump for field touch-up painting.

2.7 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

.1 Provide the following spare parts for each two (2) identical pumps:

.1 One (1) set of thrust bearing tool, upper cutter tool, cartridge cap and any other special tools necessary for the maintenance and operation of the pump. Special tools are defined as those tools not normally found in a tool supplier's catalogue, or which are normally used only on pumps of this type.

.2 One (1) pump impeller for each type and size (trimmed to specified conditions).

.3 One (1) set of all gaskets, O-rings and grease seals.

.4 One (1) set of pump bearings.

.5 One (1) mechanical seal identical to that is installed.

.6 One (1) cutter bar.

.7 Five (5) tubes of bearing grease as recommended by the bearing Manufacturer.

.8 Five (5) tubes of coupling lubricant as recommended by the coupling Manufacturer.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Factory Testing

.1 Perform factory testing in accordance with Section 11330.

- .1 Factory: Shop tests shall be conducted on the pump and motor assembly as specified. Provide copies of all factory test data and interpreted results.

.2 Conduct mixing test as follows.

- .1 Fill the tanks with sludge.
- .2 Start mixers.
- .3 After a minimum two (2) hours of continuous mixing, withdraw samples from at least two (2) different discharge points.
- .4 Analyze each sample to determine the suspended solids content and temperature.
- .5 Confirm the mixing system is able to achieve the mixing and temperature requirements as set out in clause 2.2.2.

.3 For the Anaerobic Digesters, complete the tracer study as follows and as set out in Appendix 18K:

- .1 This test can only be completed once the digester is in full operation.
- .2 Operate the digester until the following conditions are met:
  - .1 The digester is operating at design conditions, temperature and solids concentration.
  - .2 The digester has been operating for a minimum time equal to two (2) times the design hydraulic retention time.
- .3 Prior to injection of the tracer collect grab samples of the sludge from the digester and analyze the samples for the presence of lithium to establish the background lithium concentration, if any.
- .4 Discontinue sludge feed to the digester and stop the sludge recirculation and cooling system prior to injection of the tracer.

.5 Inject a solution of lithium chloride into the digester through the sludge inlet piping in sufficient quantity to produce a theoretical uniform concentration of 5 ppm lithium in each tank. Provide all necessary mixing vessels, pumps, piping, and appurtenances to prepare and inject the tracer into the sludge inlet piping.

.6 After a minimum of eight (8) hours of continuous operation of the digester mixing system to disperse the tracer, resume raw sludge feed to the digester and restart the sludge recirculation and cooling system.

.7 Collect a grab sample from the transfer pump suction piping of each tank every half hour for the first 12 hours.

.8 Analyze the samples for lithium in accordance with methods as defined in the current edition of Standard Methods for the Examination of Water and Wastewater. Sample analysis reporting will be carried out by an independent certified laboratory experienced in this type of work. Electrode analysis is not acceptable.

.9 Use the arithmetic average of the lithium concentrations for each set of three (3) samples as the lithium concentration for those samples.

.10 Monitor the quantity of sludge fed to and removed from the digester and record flows. Maintain a log of the sludge volume fed to and removed from the digester during each day of the test.

.11 Calculate the active liquid volume of the digester using the data collected during the sampling period. Consider the digester a CSTR.

.12 Verify complete-mix conditions are met and confirm no short-circuiting. Provide results in a report confirming actual conditions match CFD modeling requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the testing requirements for centrifugal wastewater pumps greater than 30 kW.

1.2 Standards

.1 American National Standards Institute (ANSI):

.1 ANSI/HI 14.6 - American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

.2 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE. Standard No. 112.

.3 ISO Standards.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 and the following:

.1 Manufacturer's descriptive literature for materials.

.2 Submit a factory testing configuration with 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 the 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 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 modeling 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 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.

3.3 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 and other relevant parameters 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 the 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 the speed required to discharge the minimum Final Design rating point specified with one point of the 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:

$$\text{Average Weighted Efficiency} = 1/n\ \Sigma(a_i\ E_i)$$

where n = number of contractually specified design points.

a = weighting factor based on the 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 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 a 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.

.6 Connection Testing:

.1 Test piping connections to prove the pump nozzle shall be installed with the pipe in a free-supported state and without the 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.

3.4 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, 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 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.

3.5 System Operational Testing

.1 Perform the System Operational Testing activities specified in the Schedule 18 Technical Requirements and the following additional testing activities:

.1 Run pump through the 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

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of horizontally mounted, screw impeller, centrifugal pumps.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A36 - Carbon Structural Steel.
- .2 ASTM A48 - Gray Iron Castings.
- .3 ASTM A276 - Stainless Bars and Shapes.
- .4 ASTM A322 - Steel Bars, Alloy, Standard Grades.
- .5 ASTM A532 - Abrasion-Resistant Cast Irons.
- .6 ASTM B16.5 - Steel Pipe Flanges - Pressure and Temperature Ratings.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 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 the requirement of Section 01450.

.4 Pumps shall be designed for ease of operation and replacement of worn 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 the 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 an 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 a 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 a reduced diameter section for sleeves.

.5 Each shaft shall be of a sufficient section to limit deflection at the outer seal face to not more than 0.10 mm when the pump is operating at a 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following for each pump size:

.1 One (1) bearing set.

.2 One (1) suction cone.

.3 Five (5) tubes of bearing grease as per the bearing Manufacturer's recommendation.

.4 Five (5) tubes of coupling lubricant as per the coupling Manufacturer's recommendation.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Factory Acceptance Testing:

.1 Factory testing shall comply with the requirements of Section 11330.

.2 Pressure test casings at 1.5 times the pressure developed by the pump at the shut-off head.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of solids handling horizontal centrifugal pumps.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A48 - Gray Iron Castings.

.2 ASTM A108 - Steel Bar, Carbon and Alloy, Cold-Finished.

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

.4 ASTM A743 - Corrosion-Resistant, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300,11000, 11300, 16223 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 Morse.

.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 the requirements of Section 01450.

.4 Pumps shall be designed for ease of operation and replacement of worn 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 the 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 A743, CA6MN stainless steel.

.5 Shaft: ASTM A108, Grade 4140, steel.

.6 Shaft sleeve: ASTM A276, 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, mounting plate and all specified appurtenances.

.3 Provide pumps, electric motors, and 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 in 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 the inlet nozzle, provide a hand hole and cover matching the contour of the waterway.

.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 the 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 suitably thickened to withstand bending loads at all speeds of operation and at all conditions of flow and head.

.5 Each shaft shall be of a sufficient section to limit deflection at the outer seal face to not more than 0.10 mm when the pump is operating at any continuous duty point defined by the operating conditions specified above.

.6 Calculate shaft deflection using the following relationship:

$$Y_{max}=\frac{W_r}{3E}\left(\frac{b^3}{I_b}+\frac{a^3-b^3}{I_a}+\frac{a^2c}{I_c}\right)$$

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
I_a	=	area moment of inertia of the shaft just outboard of the radial bearing, mm4
I_b	=	area moment of inertia of the shaft under the shaft sleeve, mm4
I_c	=	area moment of inertia of the shaft between the radial and thrust bearings, mm4
W_r	=	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)
Q_n	=	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 the pump and motor bearings.

.2 Bearing isolators fitted for the specific size and type of bearing.

.3 Labyrinth, a 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 a 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 unit:

.1 Direct-coupled to pump.

.2 Provide inverter duty rated motors for use with VFDs Premium efficient motors.

.3 Service Factor: 1.15.

.4 Enclosure: as required for the Final Design.

.5 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.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following for each pump size:

.1 Two (2) bearings and bearing isolators of all types.

.2 Two (2) complete seals.

.3 Two (2) repair kits for seals.

.4 Two (2) complete wear rings for the impeller.

.5 Five (5) tubes of bearing grease as per the bearing Manufacturer's recommendation.

.6 Five (5) tubes of coupling lubricant as per the coupling Manufacturer's recommendation.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

  .1 Factory tests on the 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 the shut-off head.

END OF SECTION

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 centrifugal solids-handling type pumps complete with an electric motor, guide brackets, lifting chain, access cover and all specified appurtenances.

.3 Provide submersible pumps and electric motors for fixed-speed operation.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A48 - Gray Iron Castings.
- .2 ASTM A276 - Stainless Bars and Shapes.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 and inspection reports of the equipment.

1.4 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 the minimum anticipated system head, assuming a hypothetical head-capacity curve.

.3 Condition C indicates operating conditions when the pump is operating against the 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 the rated head.

.3 NPSHA.

.4 Pump speed.

.5 Maximum motor power.

.6 Inlet/outlet size.

.5 The 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; the 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 as required by the Manufacturer.

.4 Provide submersible pump that automatically connects to the discharge elbow when lowered into place on the discharge connections.

.5 The 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 the rotary motion of the submersible pump shall not be required for sealing.

.7 Sealing at the discharge connection by means of a diaphragm or a 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 of each pump.

.5 Access covers for process sumps:

.1 Provide each sump with unsealed hatches 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 forklift truck wheel load.

.4 Provide hatched 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Factory 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 the shut-off head.

END OF SECTION

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 a 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 Standards

.1 American National Standards Institute (ANSI):

.1 ANSI/HI 9.6.4 - Centrifugal and Vertical Pumps, Vibration Measurements and Allowable Values.

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

.2 American Society for Testing and Materials (ASTM):

.1 ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.

.2 ASTM A536 - Ductile Iron Castings.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300,11000 and 11300 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 a 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 the 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 of 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Factory tests shall be conducted on the pump and motor assembly in accordance with Section 11330. Provide 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 self-priming solids-handling centrifugal pumps.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

  .1 ASTM A48 - Gray Iron Castings.

  .2 ASTM A322 - Steel Bars, Alloy, Standard Grades.

  .3 ASTM A532 - Abrasion-Resistant Cast Irons.

  .4 ASTM A536 - Ductile Iron Castings.

  .5 ASTM A897- Austempered Ductile Iron Castings.

.2 American National Standards Institute (ANSI):

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

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 shown 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 the pump specially adapted for the service specified and capable of pumping unscreened raw wastewater, grit, plastics, grease and hairballs, 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 the high point of the casing with an air vent and the 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 the casing with machine-faced joints.

.3 The 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 the interior surface of covers to maintain the contour of the interior of the 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 a removable and replaceable sleeve.

.7 Sleeves:

.1 Extend sleeves through stuffing box.

.2 ASTM A743 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 a 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 the 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 the 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 a 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 For each pump:

.1 One (1) complete set of gaskets and O-rings.

.2 One (1) mechanical seal repair kit or complete mechanical seal.

.3 One (1) shaft sleeve.

.2 For each set of pumps of the same size and performance.

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

.2 One (1) wear plate.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory test: Factory tests to be conducted on the 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

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 American Society for Testing and Materials (ASTM):

  .1 ASTM A276 –Stainless Steel Bars and Shapes.

  .2 ASTM A48 – Gray Iron Castings.

.2 American National Standards Institute (ANSI):

  .1 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 01300 and 11000 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 Design pumps to meet area classification in Section 01450.

.2 Design pumps for corrosion resistance for the product being pumped.

.3 Area exposure per Section 01450.

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

  .1 Fluid type.

  .2 Fluid temperature.

.5 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.

.6 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 the baseplate.

.2 Baseplate:

.1 Design each baseplate to span one-half of the sump opening; one pair of baseplates shall cover the sump opening.

.3 Impeller:

.1 Balance the impeller statically and dynamically to ensure accurate and permanent alignment.

.2 Fit the 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 the 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory test: Factory tests to be conducted on the 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 and installation of chemical transfer pumps.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

 .1 ASTM A48 - Gray Iron Castings.

 .2 ASTM A216 - Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

 .3 ASTM A276 - Stainless Steel Bars and Shapes.

 .4 ASTM A278 - Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F.

.2 American Society of Mechanical Engineers (ASME):

 .1 ASME B16.5 - Pipe Flanges and Flanged Fittings.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 an 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 the 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory tests to be conducted on the 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 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 American Society for Testing and Materials (ASTM):

  .1 ASTM A532 - Abrasion Resistant Cast Iron.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 Manufacturers and Products

.1 Supply all products from a single Manufacturer.

.2 Acceptable Manufacturers:

  .1 Moyno.

  .2 Seepex.

  .3 Netzsch.

  .4 Or approved equivalent.

2.2 Performance Criteria

.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 Design pumps to meet area classification Section 01450.

.3 Design pumps for corrosion resistance to the fluid being conveyed.

.4 Design pumps for ease of maintenance and repair.

.5 The pumps have the following operating conditions:

.6 Condition A is the rated, continuous-duty operating condition.

.7 Condition B indicates operating conditions when the pump is operating against minimum anticipated pressure.

.8 Condition C indicates operating conditions when the pump is operating against maximum anticipated pressure.

.9 Condition D indicates operating conditions when the pump is operating at the maximum anticipated discharge flow rate.

.10 The operating characteristics for the following parameters shall conform to the Final Design for each operating condition:

- .1 Rated pressure.
- .2 Capacity at the rated head.
- .3 Maximum motor power.
- .4 Inlet/outlet size.

.11 The pump speed at duty points shall not exceed 80 rpm.

.12 Rated pressure in the above list is the algebraic difference between the total discharge pressure and total suction pressure.

.13 Supply PC pumps under this specification suitable for continuous operation.

.14 Provide all PC pumps from a single manufacturer.

2.3 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.

2.4 Configuration, Components and Features

.1 Rotor and Stator:

.1 A 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 pump's inlet to the 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 The 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 Stator:

.1 Provide pump stator of two-piece construction to allow vertical pull out of the rotor. Provide with a cleanout opening on each side of the inlet fitting.

.2 Provide a 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.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 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 ANSI horizontal end-suction frame-mounted centrifugal pumps for pumping aqueous corrosive solutions.

1.2 Standards

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):

.1 ANSI/ASME B73.1 - Horizontal End Suction Centrifugal Pumps for Chemical Process.

.2 ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

.2 American Society for Testing and Materials (ASTM):

.1 ASTM A48 - Gray Iron Castings.

.2 ASTM A276 - Stainless Steel Bars and Shapes.

.3 ASTM A395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

1.3 Definitions

.1 FRP: Fibreglass-reinforced plastic.

.2 BPO-DMA: Benzoyl peroxide-dimethylaniline.

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 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 the 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 be 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 the 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 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer's recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

3.2 Factory Acceptance Tests

.1 Factory tests shall be conducted on the 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 covers the work necessary for the design, manufacture, supply, delivery, installation assistance, training, commissioning, and equipment testings of a Thermal Hydrolysis Process System (THPS). All equipment, excluding the process gas unit, will be installed indoors, within a new THP building. The process gas unit will be installed outside within a separate enclosure.

.2 The systems that supply feedstock to the THPS, and the ancillary systems are critical parts to the operation of the THPS and must be fully integrated into the design of the THP. The pre-dewatering system, sludge storage, THPS feed pumps, and digester feed pumps will be provided by the Design Builder.

.3 Responsibility and Scope of Supply:

- .1 Provide a complete THPS, including all accessories and appurtenances.
- .2 The System shall include but not be limited to:
  - .1 THPS reactors and vessels.
  - .2 Interconnecting sludge, water, gas and steam piping, including all necessary fittings and valves within the THP skid or module. Piping will extend to the boundary of the skid, terminating in flanges for the interconnection of piping installed by the Design Builder.
  - .3 THP reactor recirculation pumps and fittings (if required).
  - .4 Process gas system skids including condensing/cooling systems, all safety and regulating valves, instruments and controls, and flanged connections to piping provided by the Design Builder. The process gas system skids will be installed outdoors, in a separate enclosure provided by the Design Builder.
  - .5 Control systems complete with all accessories and appurtenances, including main control panels, instruments and devices directly connected to equipment within the scope of supply or on equipment skids, pneumatic tubing, airsets, instrument air piping within the boundary of the skids, and connections at the skid boundary for interconnection by the Design Builder.
  - .6 Electrical wiring within the boundary of the skids, with terminations at junction boxes, for connection to the City’s electrical power supply by the Design Builder.
  - .7 Safety systems including pressure/vacuum relief valves, pressure safety valves, emergency stops/pullcords for each piece of equipment, etc.
  - .8 Steam feed lances and control valves.
  - .9 Insulation and recovery jackets.

.10 Testings as specified herein.

.11 Structural components including supporting framework, anchoring systems, service platforms, handrails, staircases etc. that fit within the boundaries of the equipment skids.

.3 Provide all components and accessories of the system to enhance ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features and functions.

.4 The THPS Supplier is responsible for the THP vessel design including all layouts, 3D models, structural calculations for support platforms and structures, and vessel material and sizing.

.5 The THPS Supplier is responsible for the design of interconnecting piping and valves supplied and pre-assembled as part of the THPS package (on skid piping or piping that is part of a module), including supporting structure and pipe supports, and stress analysis and expansion/contraction design for all piping 100 mm in diameter or greater.

.6 The THPS Supplier will also review the design and installation of the upstream dewatering system, polymer system, steam generation system, feed and discharge pumps, and ancillary systems to be designed and provided by others to ensure that they are acceptable to the THPS Supplier.

.7 Instrumentation and Controls must meet the requirements of the City of Winnipeg Water and Waste Department Automation Design Guide.

.8 Electrical equipment and wiring must meet the requirements of Division 16.

1.2 Standards

.1 Reference Codes and Standards: The design, manufacture, and installation of the THPS must meet or exceed the applicable provisions and recommendations of the following codes and standards authorities:

.1 The Steam and Pressure Plants Act (SPPA): C.C.S.M. c. S210.

.2 American Bearing Manufacturers Association (ABMA):

.1 ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.2 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.3 American Gear Manufacturers Association (AGMA).

.4 American Institute of Steel Construction (AISC):

.1 Manual of Steel Construction.

.2 Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

.5 American National Standards Institute (ANSI).

.6 American Petroleum Institute (API):

.1 API STD 520 - Sizing, Selection, and Installation of Pressure-relieving Devices.

.2 API STD 521 - Pressure-relieving and Depressuring Systems.

.3 API STD 620 - Design and Construction of Large, Welded, Low-pressure Storage Tanks.

.7 American Society of Mechanical Engineers (ASME):

.1 ASME B16.5. - Pipe Flanges and Flanged Fittings.

.2 ASME/BPVC Section V - Non-destructive Examination.

.3 ASME/BPVC Section VII - Recommended Guidelines for the Care of Power Boilers.

.4 ASME/BPVC Section VIII-1 - Division 1 Rules for Construction of Pressure Vessels.

.5 ASME/BPVC Section VIII-2 - Division 2 Alternative Rules - Rules for Construction of Pressure Vessels.

.6 ASME/BPVC Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding, Brazing and Fusing Qualifications.

.7 ASME B31.1 - Power Piping.

.8 ASME B31.3 - Process Piping.

.9 ASME B40.100 - Pressure Gauges and Gauge Attachments.

.10 ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

.8 American Society for Testing and Materials (ASTM):

.1 ASTM A193 - Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

.9 American Welding Society (AWS):

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

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

.3 AWS QC1 - Standard for AWS Certification of Welding Inspectors.

.10 Canadian Standards Association (CSA):

.1 CSA B149.1 Natural Gas and Propane Installation Code.

.2 ANSI/CSA B149.6 - Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization.

.3 CSA B51 - Boiler, Pressure Vessel, and Pressure Piping Code.

.4 CSA C22.1 - Canadian Electrical Code, Part I Safety Standard for Electrical Installations.

.5 CSA CAN/CSA-C22.2 No. 0 - General Requirements - Canadian Electrical Code Part II.

.6 CSA CAN3-C235 - Preferred Voltage Levels for AC Systems, 0 to 50 000 V - Second Edition; General Instruction No 1.

.7 CSA W47.1 - Certification of Companies for the Fusion Welding of Steel.

.8 CSA W59 - Welded Steel Construction (metal arc welding).

.9 CSA W178.1 - Certification of Welding Inspection Organizations.

.10 CSA W8.2 - Certification of Welding Inspectors.

.11 FM: Factory Mutual Research.

.12 International Electrotechnical Commission (IEC):

.1 IEC60079 Series: Explosive Atmospheres.

.13 Institute of Electrical and Electronics Engineers (IEEE).

.14 Instrument Society of America (ISA).

.1 ISA Tr 12.24.01 - Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2.

.2 ISA 12.01.01 - Definitions and Information Pertaining to Electrical Equipment in Hazardous (Classified) Locations.

.15 International Organization for Standardization (ISO).

.16 National Fire Code of Canada.

.17 National Research Council Canada (NRC):

.1 National Building Code of Canada (2010).

.2 National Plumbing Code of Canada (2010).

.18 National Association of Corrosion Engineers (NACE):

.1 NACE SP0178, Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.

.19 National Electrical Manufacturer Association (NEMA).

.20 National Fire Protection Association (NFPA).

.21 National Lubricating Grease Institute (NLGI).

.22 Occupational Safety and Health Act (OSHA).

.23 UL Standards.

.24 ULC.

.25 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.26 Regulations of Manitoba:

.1 124/2015, Manitoba Electrical Code.

.2 31/2011, Manitoba Building Code.

.3 32/2011, Manitoba Building Code.

.27 City of Winnipeg Water & Waste Department

.1 Electrical Design Guide.

.28 All local laws and ordinances.

1.3 Abbreviations

.1 The following is a list of abbreviations which may be used in this Section:

.1 DS: Dry Solids.

.2 HMI: Human-Machine Interface.

.3 HS: Hydrolyzed Sludge.

.4 H_2S: Hydrogen Sulphide.

.5 LCP: Local Control Panel.

.6 MCP: Main Control Panel.

.7 PCS: Process Control System.

.8 PDPFS: Pre-dewatered primary fermented sludge.

.9 PCN: Process Control Narratives.

.10 PDS: Pre-dewatered Sludge (undigested).

.11 PDWAS: Pre-dewatered waste activated sludge.

.12 P&ID: Piping and Instrumentation Diagram.

.13 PLC: Programmable Logic Controller.

.14 PS: Primary Sludge.

.15 SIS: Safety Instrumented System.

.16 TEW: Treated Effluent Water.

.17 TFS: Thickened Fermented Primary Sludge.

.18 THPS: Thermal Hydrolysis Process System.

.19 TPS: Thickened Primary Sludge.

.20 TSS: Total Suspended Solids.

.21 TWAS: Thickened Waste Activated Sludge.

.22 WAS: Waste Activated Sludge.

1.4 Materials, Workmanship and Quality Assurance

.1 The THPS Supplier will fabricate, pre-assemble, and test the equipment provided under this Section in their fabrication shop to the extent possible and as required for shop testing. The THPS Supplier will then disassemble and make the equipment ready for shipment for installation and reassembly by Design Builder on site.

.2 This Section directs attention to certain features but does not purport to cover all details entering into the design of the equipment. Design all parts to have adequate strength and durability to ensure that the equipment performs in accordance with the requirements of the Contract.

.3 Confirm material and equipment complies with the latest edition of the applicable standards in force at the time of tendering. In the case of a conflict between this Section and any standards, the more stringent of the two shall apply.

.4 Provide materials and equipment as follows:

.1 New and of the highest quality. Reconditioned equipment is not acceptable.

.2 Suitable for the service intended.

.3 Selected and fabricated with an equipment design life exceeding 20 years.

.5 Design machinery such that all working parts are readily accessible for inspection and repair, and each part is suitable for the service required.

.6 Design equipment to have adequate strength, power and capacity for both continuous and intermittent service.

.7 Equipment Tag Numbers: As specified in the City of Winnipeg Tag Naming Standard (Appendix 18D), all items of equipment, piping, and piping accessories will be identified by a tag number. These tag numbers will be assigned by the Design Builder and should be used throughout the project as a unique identifier for the equipment and information associated with that equipment.

1.5 Submittals

.1 With the Submittals, provide a copy of the Technical Specifications marked up to reflect any revisions, additions, or deletions. Summarize any revisions, additions, or deletions in an attached document, clearly identifying the revision, addition, or deletion, and including an explanation. Include a detailed explanation on the function of the process, performance of the process, interfacing equipment or Systems, and utility requirements.

.2 For the Initial Submittal, provide the following Shop Drawings:

.1 General arrangement drawings showing the layout of the THPS, including dimensions. Include a plan view of the THPS and elevation/section views from the side and from the front of the THPS. As a minimum, also provide Drawings for the following:

.1 All primary units of mechanical and electrical equipment showing outside dimensions.

.2 All maintenance and access platforms.

.3 Process piping and ductwork with diameter or maximum cross-section dimension of greater than or equal to 100 mm in double-line format and piping and tubing less than 100 mm in single-line format.

.4 Locations for all interfaces with the process, structural, mechanical, and electrical and controls equipment supplied under other packages, including clearly identified tie-in points.

.5 Isometrics and 3D models, AutoCAD DWFx format (2014) of the THPS, including spool sheets for the piping.

.2 A detailed schematic process flow diagram (PFD) of the System to fully illustrate interconnection of equipment, location of critical monitoring and control instrumentation and to describe the functionality of the process. The process flow streams in the diagram must be cross referenced to the heat and mass balance summary to completely describe the process.

.3 A complete list of equipment, including primary equipment, design criteria proposed Manufacturer's name, model number, and shipping and operating weights (when full).

Append and cross reference equipment catalogue descriptions to the equipment list, where applicable.

.4 A summary of utility requirements for total System operation, including steam requirements (during start-up, normal, and peak conditions), wash water/flushing water, and instrument air. This summary must be based on the same conditions as the heat and mass balances described in this Section. Itemise utility requirements for each equipment component and list peak volumetric flow rate (L/s), maximum month, and annual average demands (m^3/h), design and operating pressures (kPa), and design and operating temperatures (°C).

.5 Materials of construction for major components.

.6 Outline Drawings and Specifications of all major items of equipment to be supplied showing all dimensions, parts, weight, and construction details and materials.

.7 Detailed drawings showing safety systems to be employed.

.8 Complete piping and instrumentation diagrams (P&IDs) using AutoDesk Smart P&IDs (2014). The P&IDs must graphically describe the process, the flow streams, the major equipment, and the control method. Show and label each pump, instrument, valve, line, and other similar items.

  .1 The P&ID must accurately represent the relative position of equipment and control sensors within the process network so that the purpose and the operating ranges can be determined. Optionally, identify flow quantities and temperatures at appropriate points on the P&ID to clarify the process.

  .2 Electrical interlocks and control functions must be represented by standard symbols on the P&ID.

  .3 All equipment, valves, lines, and instruments and programming must use the City of Winnipeg's tagging system.

.9 PCN to complement the P&IDs.

  .1 Overview: Describe the goals and intent of each unit process within the THPS.

    .1 The overview must provide a functional description of the process, including key operating parameters, control schemes, and interfaces to the PCS. The description must include the purpose of, and process reactions expected from each control device for all modes of operation, including reactions to fault conditions.

    .2 The description must also include all manual actions required of the Plant operator. Automatic operations must be clarified as to discrete (ON/OFF or step) type actions and analog (proportional or gradual) type actions.

  .2 Detailed Description: Describe in detail the monitoring and control functions of each unit process within the THPS.

.1 The detailed descriptions must provide definition of all interlocks, alarms and permissives.

.2 Define all dependent steps required for start-up, shutdown, and the consequences of out-of-sequence operator action. Describe start-up and shutdown steps for both the entire System and for select components of the System (e.g. one reactor vessel).

.3 Describe adverse operating conditions and define operator action for each adverse operating condition.

.4 Address all possible process fault conditions.

.5 Indicate the extent of automatic and manual control action required for fail-safe reactions to fault conditions.

.6 Define all the requirements for process interlocks with the rest of the process.

.3 PCNs to be updated and provided after Commissioning with all commissioning settings and modifications, as part of the final submittals.

.3 As part of the Second Submittal provide the following additional Shop Drawings:

.1 Locations and details of any sampling stations directly mounted to equipment in this Contract.

.2 Locations and details of all drain and vent connections.

.3 Piping less than 12 mm diameter may be shown in a schematic form for initial submission purposes. Actual routing drawings for piping less than 12 mm diameter are required for final Shop Drawings.

.4 A finish schedule and colour schedule for equipment, piping, and structural steel members.

.5 A schedule, or graphic, that delineates all piping and ductwork materials to be used in the System, by service. This submittal must include, as a minimum, size, material with grade designations, operating pressure and temperature, test pressure and test type (pneumatic or hydrostatic), insulation thickness and type, and recovering/jacketing to be used.

.6 A valve schedule that indicates for each valve: the valve number, service, the valve type, size, manufacturer and model/series number, and temperature/pressure ratings. In addition, catalogue information fully describing the materials of construction and Manufacturer's service requirements must be submitted.

.1 For all actuated valves, include torque requirements, actuator type, fail position, stroke time, and limit switch details (where appropriate).

.2 For all actuated valves, include actuator catalogue information, tubing diagrams and wiring diagrams.

.3 For self-contained automatic valves (pressure/vacuum relief, pressure reducing, backpressure sustaining, etc.), include catalogue information describing materials of construction and Manufacturer's service requirements. Include information describing pilot devices, tubing, and other attachments, as necessary.

.4 For self-contained automatic valves, include in the valve schedule the adjustable range and initial factory set point of the valve.

.7 For the welding of pressure vessels and steel and stainless steel piping and ductwork, the following welding submittal information must be provided:

.1 Submit all documentation necessary to validate that piping and pressure vessels, including the completed Systems, comply with ASME, SPPA, and Manitoba Labour requirements for fabrication shop inspection, shop testing, quality control, and certification; for the services required for the piping, pressure vessels and complete Systems.

.2 Where the THPS Supplier has obtained certification from ASME and has the National Board of Boiler and Pressure Vessel Inspectors Registration provide proof of ASME and National Board of Boiler and Pressure Vessel Inspectors documentation.

.4 Provide the following Submittals for Information Only:

.1 Detailed heat and mass balance summary and basis of design for the complete THPS based on the requirements of this Section. Provide drawings stamped by a Professional Engineer licensed in the Province of Manitoba. Base the heat and mass balance on conditions specified below in this Section under Design Conditions. Include, at a minimum, the following:

.1 Dry solids mass rates, total wet mass (dry solids and moisture) rates, percent dry solids concentrations, temperatures, and pressures for each process, recycle, discharge and exhaust stream.

.2 Heating and fuel requirements (natural gas and steam flows), including maximum design and operating temperatures and pressures.

.3 Cooling water requirements, itemized for each point of usage within the System, including flow rates, temperature, pressure, and quality of cooling water supply and cooling water discharge streams.

.4 All System exhaust gas flow rates, temperatures, pressures, density and quality, including H_2S, methane and oxygen concentrations.

.2 The heat and mass balances to be submitted and displayed graphically, using a flow schematic of the THPS to display the figures. In addition, utility system requirements must be displayed. The following units must be used:

.1 For solid material flows:

Mass flow rate	kilograms per day of dry material (kgDS/d)
Solids concentration	percent dry solids (%DS)
Volumetric flow rate	cubic metres per hour (m^3/h)
Temperature	degrees Celsius (°C)
Pressure (gauge)	kiloPascals (gauge) (kPa(g))
Enthalpy	mega joules per tonne (MJ/t)
Heat flow/power	mega joules per day (MJ/d) and kilowatts (kW)

.2 For liquid flows:

Mass flow rate	kilograms per day (kg/d)
Volumetric flow rate	litres per second (L/s) or cubic metres per hour (m^3/h)
Temperature	degrees Celsius (°C)
Pressure (gauge)	kiloPascals (gauge) (kPa(g))
Enthalpy	mega joules per tonne (MJ/t)
Heat flow/power	mega joules per day (MJ/d) and kilowatts (kW)

.3 For gaseous flows (biogas, process gas, air):

Mass flow rate	kilograms per hour (kg/h)
Volumetric flow rate	normal and actual cubic metres per hour (Nm^3/h, m^3/h). Normal (standard) conditions are defined as 1 atmosphere pressure and 15°C. Relative humidity is 0 percent.
Temperature	degrees Celsius (°C)
Pressure (gauge)	kiloPascals (gauge) (kPa(g))
Enthalpy	mega joules per tonne (MJ/t)
Heat flow/power	mega joules per day (MJ/d) and kilowatts (kW)

.4 For air flows:

Mass flow rate	kilograms per hour (kg/h)
Volumetric flow rate	normal and actual cubic metres per hour (Nm^3/h, m^3/h). Normal (standard) conditions are defined as 1 atmosphere pressure and 15°C.
Temperature	degrees Celsius (°C)
Pressure (gauge)	kiloPascals (gauge) (kPa(g))
Enthalpy	mega joules per tonne (MJ/t)
Heat flow/power	mega joules per day (MJ/d) and kilowatts (kW)

.5 For steam flows:

Mass flow rate Volumetric flow rate	kilograms per hour (kg/h) cubic metres per hour m^3/h expressed as cold water equivalent (CWE)
Temperature	degrees Celsius (°C)
Pressure (gauge)	kiloPascals (gauge) (kPa(g))
Enthalpy	mega joules per tonne (MJ/t)
Heat flow/power	mega joules per day (MJ/d) and kilowatts (kW)

.3 Pressure Vessels: In addition to Product Data and Shop Drawings, submit vessel calculations stamped and sealed by a Professional Engineer licensed in the Province of Manitoba and provide certifications and test reports as required by the applicable codes.

.4 Stress analysis results and expansion/contraction design for skid mounted piping 100 mm in diameter or greater stamped and sealed by a Professional Engineer licensed in the Province of Manitoba.

.5 A preliminary safety assessment of the System (for use in the HAZOP), summarising hazard potential and mitigation measures included in the design.

.6 A list of all certification requirements for the operation and maintenance of the THPS in the Province of Manitoba. Certification requirements shall be specific to Manitoba as determined by the Office of the Fire Commissioner, Water and the Wastewater Facility Operators Regulation 77/2003, and any other applicable Provincial requirements.

.7 Safety Plan, prepared by the THPS Supplier, addressing equipment and features incorporated into the design, control attributes, and procedures to be followed for start-up, shutdown, normal operation, and emergency shutdown conditions including power failure, to assure a safe working environment for the THPS.

.8 Structural calculations for support structures for all equipment, piping and appurtenances, and for all access platforms, elevated walkways, stairs, and landings stamped by an Engineer licensed in the Province of Manitoba.

.9 Anchor bolt design calculations stamped by a Professional Engineer licensed in the Province of Manitoba.

.10 A description, including narrative and drawings (where necessary), of equipment hoisting and maintenance access required. This description must include a summary plan for the maintenance and removal/replacement of all major equipment items. Hoisting and maintenance access to be provided by Design Builder. Coordinate with Design Builder.

.5 Electrical Shop Drawings:

.1 Motor starters and VFDs will be provided by the Design Builder.

.2 Provide sufficient electrical loading information to allow for sizing electrical distribution equipment, motor starting equipment and power cabling to power the proposed Systems and equipment.

.3 Provide Shop Drawings showing floor plan with area classifications identified by hatching and legends and use Zones as defined in CSA C22.1 Section 18.

.4 .2 Provide Shop Drawings showing floor plan with area categories identified by hatching and legends and use Categories as defined in CSA C22.1 Section 22.

.5 Electrical load list.

.6 Plan drawings showing the locations of all equipment, devices and control panels.

.7 Interior layout drawings for electrical and instrumentation panels.

.8 Layout drawings for all electrical, instrumentation and controls cables.

.9 Recommended list of equipment that requires emergency or standby power.

.6 Instrumentation and Control Shop Drawings:

.1 Control system architecture drawings depicting the layout and location of hardware and communication interfaces.

.2 Technical information and descriptive data for all instruments and control devices provided under this Supply Contract.

.3 For the digital based control system provide I/O and memory mapping and detailed operating description consisting of flow charts that describe the functionality of the programmed logic.

.4 Provide digital control system hardware information depicting component layout drawings including terminal wiring schematics, I/O addressing, I/O rack/card assignments, and complete BOMs.

.5 Provide digital control systems software information in the form of program files and HMI development files. In addition, provide a spreadsheet with a database listing tag name, data type, units, ranges or states, text description and memory location of all system data elements.

1.6 Operations and Maintenance Manuals

.1 Provide Operations and Maintenance Information for the Systems specified herein as required by Appendix 18F. Also include:

.1 All information necessary for Design Builder to compile an overall Operations Manual for the NEWPCC Upgrade.

.2 Provide detailed installation check-out, process operating instructions, start-up and shutdown procedures, process control and troubleshooting procedures, all emergency procedures, and safety procedures.

.3 Descriptions and schedules for Manufacturer's recommended routine preventative maintenance procedures and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing, and calibrations. Indicate service intervals: daily, weekly, monthly, quarterly, semi-annually, annually, or after "X" hours of operation.

.4 Table showing recommended lubricants for specific temperature ranges and applications. Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities. If the equipment or instrument is not lubricated, indicate with the words "Not Applicable".

.5 Recommended settings for all automatic control functions.

.6 A set of complete as-approved information, and as-built electrical, instrumentation, and control wiring diagrams.

.7 Descriptive data and operating characteristics of all electrical and control equipment including equipment ratings, testing and adjustment information, troubleshooting procedures, final devices settings or programmed features, programming manuals, Shop Drawing information updated to site record information and any other information required for operating and maintaining the devices or systems.

.8 A listing of all I/O points, with definitions, electrical characteristics, state conditions and ranges as appropriate.

.9 A map of internal tag and registers to be made available for integrators to read from and/or write to, as appropriate, via the PCS.

.10 A copy of final programs and program listings in native device format on hard media that can be used to reload the programs on the device(s).

.11 An index of all equipment suppliers, listing current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.

.12 The approved safety plan in a separate tabbed section of the manual.

.13 Test certificates and warranty certificates from all manufacturers.

.14 Local authorities' inspection, approval and acceptance certificates.

.15 As-fabricated Drawings.

.16 Commissioning data sheets and reports.

.17 Air balancing reports.

.18 Spare parts lists and prices, and special tools requirements and prices.

.2 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.

.3 Three (3) advance copies of the manuals shall be submitted prior to commissioning of the THPS. A maximum of eight weeks after review, six (6) copies of the final manuals shall be submitted. Each copy shall be clearly titled to show all of the information required by the Specifications.

.4 Submit complete operations manuals and maintenance information as soon as possible after review of project submittals but no later than 120 calendar days before the date of Substantial Performance.

1.7 Quality Assurance

.1 Compatibility and Integration:

.1 To ensure compatibility and integration, the design and installation of feed systems and ancillary systems supplied by others must be reviewed by the THPS Supplier. These systems include as a minimum:

.1 Pre-dewatered WAS and fermented primary sludge system including centrifuge feed tanks and associated pumps, centrifuges, centrate tanks and pumps, polymer system, dilution water System, THPS feed pumps, and digester feed pumps.

.2 Steam Supply System.

.3 Hydrolysed Sludge Cooling System.

.2 Supply equipment free from defects in design, manufacture, workmanship and materials.

.3 All electrical components and products used must be certified to CSA CAN/CSA-C22.2 No. 0 standards by a Standards Council of Canada (SCC) accredited Certification Organization (CO) and be marked with that Certification Organization’s certification mark.

1.8 Safety

.1 The THPS must comply with all Standards and Codes of Practice in Canada and Manitoba.

.2 A safety plan must be produced and submitted, demonstrating compliance and demonstrating that the principles of designing for safety have been followed.

.1 An overall HAZOP Study must be completed during the design phase of the THPS. As a minimum the process, electrical and I&C Engineers from the THPS Supplier must attend, along with representatives from the City, and Design Builder. The HAZOP Study shall be held in the City of Winnipeg.

.2 As part of the HAZOP a Safety Integrity Level (SIL) and Layers of Protection Analysis (LOPA) is required.

.3 A HAZOP facilitator will be selected and paid for by the City.

.4 The THPS Supplier will provide the P&IDs and models for the equipment under their scope of supply. The Design Builder will provide the rest of the P&IDs and models for the complete System.

.5 After the HAZOP, refinements to the System to provide safe working environment are the responsibility of the THPS Supplier to incorporate at no additional cost.

2. PRODUCTS

2.1 Description

.1 The THPS will hydrolyse a blend of PDWAS and PDPFS. The combination of PDWAS and PDPFS is referred to as PDS.

.2 A dewatering system will be installed upstream of the THP, which will include but not limited to, centrifuge feed tanks (receiving TWAS and FPS), centrifuge feed pumps, centrifuges, a dewatered sludge collection storage and conveyor system. The dewatering system will be supplied by Design Builder.

.3 THPS feed pumps will distribute the feed sludge to the THPS. The dewatering system and THP feed pumps will be supplied by Design Builder.

.4 The THPS will thermally hydrolyze the delivered PDS, converting it to Hydrolyzed Sludge. The function of the THPS is described in this Section.

.5 The HS pumps will pump the thermally HS into the digesters. The HS pumps will be supplied by Design Builder.

2.2 Function of the THPS

.1 The THPS will be located upstream of mesophilic anaerobic digestion and final dewatering. The sludge from the final dewatering process will be at approximately 30 percent solids concentration for land application, soil manufacturing, and/or landfill reclamation.

.2 The THPS must be a complete system designed for the sole function of hydrolyzing PDS. The HS will achieve the following benefits:

  .1 Reduce viscosity, allowing the downstream mesophilic anaerobic digestion to be operated at higher solids concentrations reducing the required number of digesters.

  .2 Enhance anaerobic digestion performance in terms of solids destruction and biogas yield.

  .3 Enhance dewaterability of the digested sludge reducing overall polymer use, sludge storage and disposal costs.

  .4 Produce a sludge that meets the time and temperature requirements for pathogen requirements for Class A product as defined by Title 40 of the Code of Federal Regulations (CFR) Part 503, Subpart D.

.3 To heat the contents of the THP reactors, directly inject live steam. Incorporate steam recycling within the THPS to minimise live steam requirements. Design the THPS to operate efficiently in terms of electrical power and steam consumption.

.4 Provide arrangements to bypass individual pressure vessels to allow a vessel to be taken out of service for annual inspection, as per code requirements, while maintaining System operation with the remaining equipment, operating at maximum month flow conditions.

2.3 Equipment Standardization

.1 The City has standardized on specific electrical and automation manufacturers. The Electrical and Instrumentation Standardization Summary (Appendix 18E) provides a list of the equipment that has been standardized.

.2 It is the City’s preference that the equipment listed in Appendix 18E be used in the THPS. However, if in the opinion of the THPS Supplier there is a technical or safety reason that the standardized equipment should not be used, the THPS Supplier shall include in their proposal justification for using an alternative and provide a solution for communication with the rest of the automation system.

.3 The Supplier shall provide a solution to address changes to the Suppliers system over the life of the THPS. This includes the potential for the control system to become obsolete or unsupported. Provide an outline describing how replacement parts can be integrated seamlessly over a series of technological upgrades.

2.4 Materials of Construction

.1 Reactors and Pressure Vessels: Material to be suitable for the intended use.

.2 Miscellaneous Metals: Grating and checker plants to anodized aluminum. Structural metal framing to be stainless steel, aluminum or galvanized steel.

.3 Anchor Bolts, nuts, threaded components: Type 316 Stainless Steel.

.4 Control panels:

  .1 Provide control panels in accordance with Division 16 and the Technical Requirements.

2.5 Redundancy

.1 Provide N+1 redundancy at maximum month flow conditions as defined in this Section for THP reactors.

.2 Provide redundancy for all vessels such that if one tank is out of service, the THPS can remain in operation at maximum month flow conditions with the remaining tanks in service.

.3 Provide all recirculation/feed and other process pumping within the THPS with at least 100 percent capacity redundancy.

.4 Design the THPS with redundancy for the complete System as supplied, including vessels, pumps, ancillary equipment, piping, valves, instruments, controls and connections, such that if any one unit, item, section of pipe or connection is out of service, the THPS can remain in operation at maximum month flow conditions.

2.6 Design Conditions

.1 Ambient Conditions:

  .1 North End Sewage Treatment Plant THP Building Grade Elevation: 231.6 m.

  .2 Atmospheric Pressure: average of 98.54 kPa.

  .3 Ambient Temperatures:

    .1 Design Max: 35°C.

    .2 Design Min: minus 35°C.

2.7 Room Conditions

.1 Design Max: 35°C.

.2 Design Min: 5°C.

.3 Maximum relative humidity: 100 percent.

.4 Minimum relative humidity: 15 percent.

.5 Maximum ambient sulphide concentrations: 1 ppm.

2.8 THPS

.1 Design the THPS for the PDS feed predicted to occur in the design year (estimated to be 2050), but ensure it has the flexibility to efficiently operate at initial conditions and in all yeas leading up to and including 2050.

.2 Design the THPS to be expandable to allow for future growth.

Table 1: Design Parameters

Parameter	Unit	Value
Feed PDS Flow (at 16.5 %DS):		
Minimum 7 day rolling average (2031)	m^3/d	265
Annual average (2031)		531
Maximum month (2031)		820
Minimum 7 day rolling average (2050)		281
Annual average (2050)		563
Maximum month (2050)		866
Feed PDS Mass Loading:		
Minimum 7 day rolling average (2031)	tDS/d	45
Annual average (2031)		90
Maximum month (2031)		139
Minimum 7 day rolling average (2050)		48
Annual average (2050)		96
Maximum month (2050)		147
Feed PDS Concentration:		
Minimum	%DS	14
Average (Design)		16.5
Maximum		18
Feed PDS Temperature:		
Minimum	°C	9
Maximum		20

Parameter	Unit	Value
Volatile Solids Fraction:		
Average	%	65
Maximum		75

.3 Based on the above design conditions, provide heat and mass balances for the following cases for year 2031 and year 2050:

.1 Average Flow Condition: Average annual flow at Design Year with a feed PDS concentration of 16.5 percent total solids.

2.9 Sludge Cooling

.1 The thermally hydrolyzed sludge will be cooled using heat exchangers prior to being sent to anaerobic digestion.

.2 The sludge must be cooled to a temperature suitable for mesophilic anaerobic digestion.

.3 The THPS Supplier will provide all cooling requirement information to Design Builder.

2.10 Utilities Service Conditions

.1 The THPS Supplier will provide all utility system information requirements (quality and quantity) to Design Builder.

.2 Provide tie-in connections for all utility systems, clearly identified, including, steam, treated effluent water, process gas, instrument air, electrical and communication services, drains, etc. that serve the THPS. Clearly identify these tie-in conditions on the Drawings.

2.11 Area Classifications

.1 Mechanical, electrical, instrumentation and control equipment in the process areas of the THP building is considered unclassified relative to Class 1, Group D. Instruments in direct contact with the sludge or the headspace above the sludge must be rated for Class 1, Group D, Division 2.

2.12 Pressure Vessels

.1 Pressure vessels to be designed, fabricated, tested and code stamped in accordance with the latest edition of Section VIII, Division 1, Pressure Vessels of ASME Boiler and Pressure Vessel Code and addenda and must meet Province of Manitoba Code requirements. A Canadian Registration Number (CRN) is required for each pressure vessel.

.2 Design pressure vessels rated for maximum hydrostatic test pressure as per the ASME Boiler and Pressure Vessel Code Section VIII and full vacuum.

.3 Flanges to comply with ASME B16.5.

.4 Where required, provide properly installed blind flanges, corrosion resistant, selected for the intended service, securely tightened using Type 316 stainless steel spiral wound gaskets and ASTM A193/A193M Grade B8M bolts.

.5 Provide top and bottom skirts as required for stiffening and support with access openings and pipe penetrations, as required, including drain holes and drain piping at low points.

.6 Include manways, with davit and handlebars for easy removal, minimum 900 mm diameter, one at a low point in each vessel and a second hatch 900 mm in diameter on the roof or side of each vessel near the top.

.7 Insulate vessels as required to minimize heat loss and for thermal protection.

.8 Nozzles to penetrate a minimum of 150 mm into the vessel unless otherwise indicated.

2.13 Steam

.1 Provide steam quantity, quality and operating conditions at all throughputs, including peak instantaneous steam demand (defined as the load required to heat all the reactors required to treat maximum month throughput), durations (including short-term surges), steam use patterns, reliability requirements (i.e., how long can the THPS sit in “hold” mode without steam, and any other operating constraints.

.2 All steam piping (by THPS Supplier on equipment skids and by Design Builder for interconnecting piping) to meet the code requirements of ASME and Province of Manitoba.

.3 Provide the necessary monitoring elements and transmitters to measure and report to the THP control system and the Schneider based PLC control system, the mass flow, temperature and pressure of the steam to the THPS and calculate and record cumulative mass flow and daily average temperature and pressure in the THP control system.

2.14 Process Gas System

.1 Any process gases arising from the THPS must be treated and returned to the THPS or digester headspace. Venting process gas directly to atmosphere is not acceptable as part of normal operations.

2.15 Pressure/Vacuum Relief Valves (PVRVs)

.1 Provide relief valves capable of relieving pressure and vacuum on the pressure vessels.

.2 Equip the inlet side of all safety valves, which otherwise would be in constant or intermittent contact with sludge and particulate, with rupture disks. Provide pressure indication between rupture disks and PVRVs, including transmission to the local control system.

.3 Mount PVRVs on the roof of each pressure vessel.

.4 Emergency venting of process gas into the interior of the THP building is not acceptable.

.5 PVRVs on pressure vessels to meet ASME steam safety valve requirements and SPPA certification requirements as well as API 520 and API 521 code requirements.

.6 Provide full-bore valves designed to meet maximum venting requirements, clearly marked with correct pressure settings, readily accessible for testing and recertification.

.7 Select materials resistant to organic gases at a pH between 2.0 and 7.0.

2.16 Metal Work

.1 Provide all platforms, stairways, handrails, anchor bolts, and ladders as required, to provide convenient and safe access to all areas of equipment requiring maintenance or access to instrumentation.

.2 Maintenance platforms must allow maintenance personnel access to equipment drive systems, lubrication points, sample points, valves, relief valves, instrumentation, and other equipment items commonly requiring attention, within reasonable and safe reach for a person on the platform and must not require additional stools or ladders for work to be performed.

.3 Platforms located in areas where wet material is handled, around sample points, and around material transfer points must incorporate tray sections to prevent material from falling through to the floor level below.

2.17 System Equipment and Appurtenances

.1 General:

.1 Provide all other equipment and appurtenances required for a complete package that meets the criteria of this Section.

.2 Select all equipment for type and function and size the equipment to accomplish the performance requirements specified herein.

.3 Material of Construction: Materials to be resistant to corrosion and suitable for the anticipated operating conditions, for a design service life minimum of 20 years.

.2 Bearings: All rotating equipment antifriction bearings must be rated for a minimum ABMA 9 and/or ABMA 11 L10 life of 100,000 hours.

.3 Coupling guards must meet WSHA requirements.

.4 Thermal Expansion Provisions: Design the THPS with all necessary provisions to accommodate the effects of thermally induced movement and stress on all parts of the THPS. The provisions must allow operation of the THPS under all normal and abnormal upset thermal conditions and must prevent overstressing the THPS materials of construction and excessive movement of THPS components.

.5 Sampling Points:

.1 Permanent sampling provisions must be provided for the sampling of the following materials in the general locations indicated:

.1 PDS feed to the THPS at the inlet to the pulper tank or reactors.

.2 HS output from the THPS.

.3 Additional sampling points as recommended by the THPS Supplier to monitor performance, and as required during testing and commissioning.

.2 Provide flushing connections and proper drains for sampling points.

.3 Provide sampling locations with easy access, arranged in a manner that is safe for the operator and minimises or eliminates material leakage and/or spillage while sampling is conducted.

.6 Grounding: All equipment, piping, and ductwork must be electrically continuous and attached to a grounding conductor. Internal components of equipment must be static conducting and connected to the equipment grounding conductor.

.7 Fail-Safe Provisions:

.1 Make provisions for safe operating and shutdown conditions in the event of power failures and equipment failures.

.2 Include automatic controls to shut off valves and gates to prevent uncontrolled sludge, steam, gas, or liquid flow. On loss of power, ensure valves fail to a safe position that prevents unsafe conditions or equipment damage.

.3 Design the System to provide safe failure mode. This will be reviewed and confirmed during the HAZOP.

2.18 Equipment Lifting and Removal

.1 Provide individual hoists, lifting hooks and roof anchors or lifting beams on the underside of the platform mounted directly over each component as an integral part of the supplied skids or modules as required to enable each component to be lifted and removed to a suitable laydown area.

.2 Lifting Lugs: Provide lifting lugs or other provisions for easy handling on all equipment and removable parts weighing over 25 kg.

2.19 Piping, Ductwork and Valves

.1 General:

.1 All piping, piping supports, miscellaneous piping appurtenances, and valves for the THP skids or modules must meet ASME and SPPA requirements. Route and install piping so as to provide headroom and easy access to all process components and instruments. Deliver skids or modules pre-piped. Extend piping to the boundary of the skid terminating in flanges for the connection of interconnecting piping installed by Design Builder.

.2 Design Builder will provide all necessary interconnecting piping, piping support systems, miscellaneous piping appurtenances, and valves required to connect skids/modules to other skids/modules or equipment to provide a complete and operable System.

.3 Use standard long radius elbows for all sludge piping except PDS piping. Use 3D elbows for all PDS piping.

.4 Design piping to accommodate thermal displacement. Conduct stress analysis and expansion/contraction design on all piping systems 100 mm in diameter or greater.

.5 Design piping supports to handle thrust, gravity, dynamic forces, and seismic forces.

.6 Provide each piece of equipment having a baseplate or other drainage connection with a piping connection extending from the baseplate or other drainage connection to allow for tie-in by the Design Builder.

.7 Welding procedures for stainless steel piping must comply with ASME and SPPA requirements.

2.20 Valves

.1 Provide manual valves and pneumatic operated valves. Select valves in conformance with ASME and SPPA requirements.

.2 Provide self-contained automatic valves, solenoid valves, and valves for modulating service sized to meet the process requirements and installed where necessary to provide a complete and functional System.

.3 Provide isolation valves at all process equipment connections to allow for maintenance. Include spectacle blinds in addition to the isolation valves as a means of double blocking on tank connections where personnel access is required in accordance with WSHA.

.4 Provide drain and air release valves as required to facilitate easy start-up, shutdown, operation and cleaning of the System. Provide valves for each process stream. Include flushing connections to allow for pipe cleaning during maintenance.

.5 Include open and closed limit switches on manual isolation valves that are operated more than once per month or that need to be open for another piece of equipment to operate.

.6 Select materials suitable for the process fluid and conditions. For sludge valves, select abrasion resistant materials.

2.21 Actuators

.1 Provide visual position indicators, manual override and limit switch for OPEN and CLOSE indications for both pneumatic and mechanically actuated valves.

.2 For modulating valves include position indicators with indication at the local control and PCS.

.3 On a local control station in close proximity to each actuated valve, include selector switches to select hand/off/remote control modes and open/close switches or toggles as appropriate. In the “Hand” position provide hold-to-start spring return switch.

.4 Provide the contacts necessary to transmit the position of hand/off/remote switch positions in the local control system and provide this information to the PCS.

2.22 Insulation

.1 Provide insulation/barriers to limit the surface temperature of stacks, ductwork, piping, and other hot surfaces.

.2 Insulate equipment, ductwork, piping and other cold surfaces to minimise condensation build-up.

.3 Provide protective, heat-dissipating barriers to prevent surface temperatures of all equipment, vessels, ductwork, and piping that is reachable from the ground, stairs, walkways and platforms from exceeding 50°C.

.4 Provide aluminium recovery jackets on all insulated piping and tanks.

2.23 Electrical Systems

.1 All Products provided shall be CSA Certified.

.2 Provide a complete electrical power distribution system including local control panels, operator stations and accessories.

.3 Motor control centres and VFDs are by Design Builder. Coordinate with Design Builder to ensure that the motors are compatible with the selected VFDs.

.4 Pre-wire each skid or module. Provide electrical wiring within the boundary of the skids, with terminations at junction boxes, for connection to the Plant's electrical power supply by Design Builder.

.5 Make all power and signal wiring between Sub-systems suitable for wet and corrosive locations in accordance with CSA 22.1 requirements as per Sections 18, 20 and 22.

.6 Power Supply:

  .1 Available power will be 600 V from Design Builder. As an alternative 12.47 kV could be available from Design Builder if required.

  .2 Control system voltages as described in the City of Winnipeg Water and Waste Department Automation Design Guide.

2.24 Instrumentation and Controls

.1 General:

  .1 Provide control systems complete with all accessories and appurtenances, including control panels, instruments and devices, pneumatic tubing, airsets, and instrument air piping within the boundary of the skids/modules, and connections at the boundary of the skid/module for interconnection by Design Builder.

  .2 Provide a reliable, effective method of cooling for control panels containing electronic components or control elements. Plant standard uses compressed air for panel pressurization and cooling. Ensure that the maximum temperature in the control panel does not exceed 75 percent of the design maximum temperature of any component.

.3 Configure the THP control systems such that no single failure will render the THPS inoperable.

.4 Provide a THPS standalone digital based control system for overall control and monitoring of the complete THPS. Configure the THPS controls to shut down the THPS to a safe and stable condition in the event of emergency shutdown conditions. Provide hardware, software, and software configuration for a fully operational system as further described herein.

.5 Interface the THP control system with the PCS.

.6 The PCS will send a permissive to the THPS to start or modulate the THPS feed pumps, based on available digester capacity or blend tank storage capacity.

.7 The PCS will give a permissive to start or modulate the HS pumps based on the amount of capacity available.

.8 Include security settings to prevent operators from accidentally altering the controls that could damage the equipment, the building or cause safety issues.

.9 Instruments used for safety must not be used for process control, must be of a higher reliability rating than standard control instrumentation and must be hardwired to the Plant control system for signalling alarms. Develop and provide a SIS based safety system for process critical parameters and parameters that can induce life safety failure (i.e., gas release).

2.25 Inputs and Outputs

.1 Provide a complete I/O list, including all support equipment.

.2 Provide adequate I/O space and connectivity with 25 percent spare capacity for each type of input required.

.3 Provide a list of critical I/O for the THPS, including all common support equipment. Critical I/O is defined as any field signal that results in a complete shutdown of the THP train on loss of signal, or any field signal that results in a safety hazard on loss of signal.

  .1 For all critical I/O provide duplicate sensors wired to separate I/O modules, such that no single point of failure will cause a loss of signal.

  .2 Provide diagnostic programming to automatically select the sensor to be used as the control signal. When an I/O fault occurs in the selected signal, provide for automatic and bump-less switchover to the duplicate sensor.

  .3 As a minimum, an I/O fault is to be detected and alarmed if any one of the following conditions occurs:

    .1 Instrument failure.

    .2 Loss of signal.

2.26 Digital Based Control System

.1 The NEWPCC automation system currently utilizes a Plant-wide Distributed Control System (DCS) architecture based on ABB Bailey which will be replaced by Schneider PLC based control system. The PCS is used as the primary operator interface to monitor and control the entire Plant. In addition, it collects and provides historical plant information. It is intended that the THPS control systems be tightly integrated into the Schneider PLC and PCS.

.2 Provide the THPS with digital controls using Schneider PLC based control hardware in accordance with the City of Winnipeg Automation Design Guide.

.3 Provide a LCP based on Schneider PLC controls in close proximity to each THPS or skid and a MCP to be located in a control room. Provide duplicate HMIs at the LCP and at the PCS based on Schneider PLC controls to achieve a seamless operating system including a fully integrated portable operator tablet.

.4 For the equipment, provide local operating stations (hand/off/remote or open/close/remote switches etc.) to facilitate local manual operation, testing, and maintenance.

2.27 Plant Communications

.1 Where hardwired control is necessary, provide volt free contacts for hardwired status information between the controls systems as detailed below.

.2 Communication with the PCS can be accomplished by means of an industry standard communication protocol on an Ethernet Communication Link, using either ModBus TCP/IP or Ethernet IP

.3 Provide alarms to indicate to Plant operators that maintenance attention is required or to indicate an extreme alarm condition in which the THPS performance or safety may be jeopardized.

.4 Provide the following signals, as a minimum, for each piece of equipment or instrument:

Signal Description	Type	From:	To:
Statuses			
THPS Run Status	DO	LCP	PCS
Status of each Reactor (Fill, React, Draw)	Comm	LCP	PCS
Valve Status	Comm	LCP	PCS
Pump Status	Comm	LCP	PCS
Process Gas Unit Status	Comm	LCP	PCS
Monitoring Parameters			
Instantaneous Sludge Feed Flow into each Reactor	Comm	LCP	PCS
Cumulative Sludge Feed Volume for each Reactor	Comm	LCP	PCS
Instantaneous Dry Mass of Sludge Feed	Comm	LCP	PCS
Cumulative Dry Mass of Sludge Feed	Comm	LCP	PCS
Sludge Feed Temperature	Comm	LCP	PCS
Reactor and Vessel Temperatures	Comm	LCP	PCS
Reactor and Vessel Pressures	Comm	LCP	PCS
Sludge Levels in Reactors and Vessels	Comm	LCP	PCS
Reaction Time	Comm	LCP	PCS

Signal	Description	Type	From:	To:
i	Rate of Temperature Increase	Comm	LCP	PCS
s	Instantaneous Live Steam Mass Flow Rate	Comm	LCP	PCS
t	Cumulative Live Steam Mass Flow Rate	Comm	LCP	PCS
	Live Steam Temperature	Comm	LCP	PCS
a	Live Steam Pressure	Comm	LCP	PCS
n	Flowrate for each THPS Feed Pump	Comm	LCP	PCS
Alarms y				
	THPS Fault: Priority 1 Alarm	DO	LCP	PCS
f	PRV Alarm (Lifting Detection)	Comm	LCP	PCS
u	High Level Alarms: Priority 1 Alarm	DO	LCP	PCS
n	High Pressure Alarms: Priority 1 Alarm	Comm	LCP	PCS
c	Low Pressure Alarms: Priority 1 Alarm	Comm	LCP	PCS
t	High Temperature Alarms	Comm	LCP	PCS
i	Process Gas System Fault: Priority 1 Alarm	Comm	LCP	PCS
o n s	Setpoint Temperature not Reached within Reaction Time: Priority 2 Alarm	Comm	LCP	PCS

available at the LCP that can be transferred to the PCS via Communications Link. Ensure that all information transmitted to the LCP is transmitted to the PCS.

.2 Allow for an Operator to manually adjust the reaction time/cycle time through the HMI connected to the PCS.

.3 Allow the Operator to change the following setpoints through the HMI on the PCS:

.1 THPS feed pumping rate by adjusting the flow setpoint and using the controls to change the VFD speed so that the flow matches the setpoint.

.2 HS pumping rate by adjusting the flow setpoint so that the flow matches the setpoint.

.3 THPS throughput.

.4 Reactor total cycle time.

.5 Reaction time.

.6 Reaction Temperature.

.7 Alarm set points (excluding safety alarms).

.4 Control Signals: Provide the control signals for process interlocks between the THPS control system and the PCS:

.1 Storage tank high-high level shuts down HS pumps. Blend tank mid-high level will speed up the digester feed pumps (which normally operate at a constant rate set each day based on a level averaging system). On a blend tank high alarm, THPS will remain in operation under a “Maintain” mode for a set period (two (2) to three (3) hours) to see if the issue downstream (at the digesters) can be rectified before the THPS starts shutting down, initiated by the blend tank high-high alarm.

.2 Blend tank mid-low level starts or speeds up HS pumps. Blend tank mid- low level will also slow down the digester feed pumps. If the blend tank level reaches the low setpoint the digester feed pumps drop to minimum speed. If the blend tank level drops to low-low setpoint, the digester feed pumps will shutdown.

.5 Provide status information, alarms, and analog values for remote monitoring by the PCS HMI.

.1 Status information, alarms, and analog values must be in contiguous blocks of data registers in the THP control system.

.2 Provide for 25 percent spares within the contiguous block of data registers.

.6 Application Software: The THPS Supplier must provide all application software and system configuration necessary to make the THPS control system fully functional and integrated with the Plant control system. Provide communication processors, LANs, Ethernet switches, and communication interfaces to communicate with the PCS.

2.28 Control Panels

.1 Furnish a self-contained process control system in the MCP for automatic and manual control (to the extent possible for testing and maintenance without sacrificing the safety and process functionality) of the THPS fully assembled, wired, pre-programmed, and factory tested.

.2 Refer to the City of Winnipeg Water and Waste Department Automation Design Guide for specifications on control panels.

2.29 Control System Programming

.1 Provide Schneider PLC and HMI based MCP located in the main control room that communicates with local control panels dedicated to each THP train or skid.

.2 Provide all control and monitoring functions as required for the operation and monitoring of the THPS including, but not limited to, timing, interlocks, and permissive functions required for safe operation.

.3 Transmit status information, alarms, and analog values for remote monitoring of each THP train or skid to the Plant control system.

.4 All control system programming for control and monitoring of the THPS including programming language, program structure, tagging, file structure, generic functions, memory allocation, and documentation must meet the requirements of the City of Winnipeg Automation Design Guide.

.5 Utilize Schneider trained and qualified system integrators.

2.30 Operator Interface

.1 The Plant monitoring system uses a portable wireless touch screen interface allowing operators to view the HMIs from the Plant automation system to allow comprehensive operator interaction and fault diagnosis. Include the capability to show the THPS HMIs on the portable wireless devices.

.2 Provide a menu-driven operator interface with automatic fault message windows appearing upon alarm conditions.

.3 Coordinate with Design Builder so that all displays and graphics are consistent with other areas of the plant.

.4 The process graphic displays developed for the THPS must have the following display and operator interface features developed in accordance with the City of Winnipeg Automation Design Guide:

  .1 Display process flow streams with labels and colour coding.

  .2 Illustrate all major equipment items.

  .3 Illustrate all control devices such as gates, valves, dampers, etc.

  .4 Display equipment operational status and alarm conditions.

  .5 Display process signal values for all measuring devices.

.5 Provide for selection of control functions and access to associated graphic displays.

  .1 Real-Time Trending Displays: Real-time trend displays must be configured to display the last four hours of trend data for all field analogue values monitored. The trend display time period shall be operator adjustable.

2.31 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

.2 Spare parts are to be supplied by the THPS Supplier and are intended to include all parts which normally would be required within the first two (2) years of operation for normal preventative maintenance and where fabrication requirements for special parts would delay delivery and could keep an item of equipment out of service for an extended period.

3. EXECUTION

3.1 Shop Painting and Corrosion Protection

.1 Provide factory applied prime coat protective and maintenance coatings. Such equipment will be finish painted by Design Builder to meet colour coding requirements.

.2 All factory-primed equipment must have removable tags attached by the Manufacturer identifying the applied coating system, paint manufacturer, and product name and number, where applicable.

.3 For all surfaces, use corrosion-resistant materials or protect with corrosion protection systems. Materials or protection systems must adequately protect the equipment and appurtenances from corrosion caused by the service environment including chemicals and pH extremes.

.4 Edge Grinding: Grind sharp corners of cut or sheared edges to a radius by multiple passes of a high-speed grinder as required to ensure satisfactory paint adherence.

.5 Surface Preparation: Shop clean by sandblasting, or an equivalent process, all ferrous metal surfaces except motors, speed reducers, and stainless steel, in conformance with the paint Manufacturer's recommendations. Remove all mill scale, rust, and contaminants before shop primer is applied.

.6 Coating Repairs: Repair all damage to coating systems prior to acceptance by the Design Builder at delivery. Design Builder will be responsible for any coating repairs after delivery and acceptance on Site and due to installation of the THPS equipment. Design Builder’s repairs will be performed according to the paint Manufacturer's recommendations. Provide required touch up paint to Design Builder at no additional cost.

3.2 Source Quality Control (Factory Testing)

.1 Complete factory testing to meet ASME and local code requirements.

.2 All factory fabricated system components must be factory tested and inspected for compliance with the quality and functional requirements specified herein, and a certification of the results of these tests must be submitted to Design Builder. Notify Design Builder a minimum of 14 Calendar Days prior to factory testing of equipment to allow Design Builder time to schedule witnessing of shop tests at Design Builder’s discretion.

.3 Perform non-destructive testing on factory welds on tanks and piping assemblies as per the requirements in this Section.

.4 Conduct hydrostatic testing of all vessels and piping assemblies as per the requirements of ASME BPVC Section VIII.

.5 Factory test all pressure/vacuum relief valves in accordance with ASME BPVC Section VIII and SPPA requirements.

.6 The complete THPS control system, including network communications, must be tested in the factory for all required functions. Provide sufficient software and hardware simulations to allow Demonstration Testing of the required functions. Factory Acceptance Test will test 100 percent of the control loops by simulation and 20 percent of all DI/DO and AI/AO and fieldbus interfaces.

.7 Operating noise levels must be such that the average noise level measured around the periphery of the complete assembly does not exceed 85 dBA (in simulated free field) when tested at the manufacturing facility. If operating noise levels exceed 85 dBA at 1 m, take appropriate measures to attenuate the sound.

3.3 Product Delivery, Storage and Handling

.1 Coordinate the delivery, storage and handling with Design Builder.

.2 Ship equipment in fabricated assemblies, when applicable, match marked, painted and knocked down for shipment.

3.4 Welding and Non-destructive Testing

.1 Weld in conformance to CSA W47.1, CSA W59, AWS D1.1, AWS D1.6, ASME BPVC-IX and ANSI B31.3. Use CSA W47.1 or AWS D1.6 qualified welders. Use inert gas backing (GMAW or GTAW) for field and shop welds. For stainless steel, solar flux welding is not acceptable. Adhere to latest edition of NACE SP0178. Use an all stainless steel shop and equipment to prevent mild steel particles from contaminating stainless steel surfaces and joints.

.2 The THPS Supplier is to engage an independent welding inspection firm to conduct a series of factory weld tests. Any site welds performed will also be subject to these requirements.

.3 The THPS Supplier must retain the services of a CSA W178.1 certified weld testing agency that provides the services of a CSA W178.2 or an AWS QC1 certified welding inspector experienced with the referenced governing welding codes indicated above. The testing agency must be certified in accordance with the current CSA/CWB standards for Non-destructive Testing (NDT). The welding inspector must be present for the welding of the Systems outlined above, whether in the shop or in the field. The welding inspector's responsibilities include:

.1 Monitoring conformance with the approved welding procedure Specifications.

.2 Checking weld quality.

.3 Ensuring that welding finishes conform to the Specifications listed below.

.4 Checking welding and welding operator qualifications.

.5 Supervising of non-destructive testing personnel and evaluation of test results.

.4 Provide 100 percent visual inspection in accordance with AWS D1.6. Provide CSA W178.2 Level 2 & 3 Certified Welding Inspectors or AWS QC1 Certified Welding Inspectors (CWI).

.5 Provide Ultrasonic Testing (UT) of 10 percent of all butt/groove welds using acceptance criteria per ASME BPVC Section VIII, Div. 01, Appendix 12. Provide CGSB 48.9712 Level 2 Certified UT Inspectors or ANST Level 2 UT Inspectors Certified in accordance with SNT-TC-1A.

.6 Provide Die Penetrant Testing (PT) of 10 percent of all fillet welds (minimum 10 percent of total weld length) using acceptance criteria per ASME BPVC, Section VIII, Div. 01, Appendix 8.

.7 In the event of test failure(s), the THPS Supplier will be directed to undertake additional weld tests, of a number up to 10 times the number of failures, at the Suppliers cost.

.8 Further failures will result in another group of welds being tested, again of a number equal to 10 times the number of failures. This re-testing will be repeated until there are no failures.

.9 All factory welds which fail the tests must be repaired and re-tested at the THPS Supplier's expense. All site welds which fail the tests must be repaired and re-tested at Design Builders expense.

.10 Welding of piping must meet the requirements of ASME standards.

.11 Seal watertight by continuous welds all welded joints which are exposed to view or in contact with the process streams. Partial welds are not acceptable.

.12 Pickle and passivate all stainless steel welds according to the applicable codes and standards.

3.5 Installation Inspection

.1 THPS equipment items must be installed in accordance with the THPS Supplier’s written installation instructions.

.2 Before commencing installation of equipment, the Design Builder will arrange for the attendance of the THPS Supplier's Representative to provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.

.3 The THPS Supplier's Representative will be responsible for checking certain settings, measurements, etc., as required to ensure satisfactory installation.

.4 The THPS Supplier’s Representative shall conduct and document a detailed inspection of the installation including alignment, electrical connections, instrumentation, control systems, safety equipment, belt tensions, rotation direction, running clearances, lubrication, workmanship and all other items as required to ensure successful operation of the equipment. Design Builder to provide Installation Inspection template.

.5 The THPS Supplier’s Representative shall identify any outstanding deficiencies in the installation and shall provide a copy of the Site Inspection Report to the Design Builder.

.6 All strain from attached piping must be eliminated from equipment and any evidence of noisy operation or other signs of improper setting must be corrected by Design Builder under the direction of the THPS Supplier.

.7 The deficiencies will be rectified by the Design Builder and the THPS Supplier’s Representative shall re-inspect the installation. A Formal Inspection Report must be provided to the Design Builder after final inspection.

3.6 Field Painting

.1 Final field painting will be by Design Builder.

.2 For field fabricated equipment, prepare and coat exposed exterior ferrous metal surfaces.

3.7 Field Quality Control

.1 Several tests will need to be conducted in progression. The following paragraphs outline the general sequence:

.1 Installation Inspection: Review installation as necessary to verify that the equipment has been installed in accordance with the THPS Supplier's directions and according to Section 3.5. Any remedial measures identified during the Installation Inspection will be completed prior to running the Demonstration Test. Regulatory approval will also be required from Manitoba Inspection and Technical Services.

.2 Demonstration Test: Run equipment dry for one (1) hour to illustrate that motor, drive, and ancillaries function as required. Conduct measurements and checks that ensure that the equipment is functioning as expected.

.3 Functional Tests:

.1 These tests consist of equipment and system operational tests. Testing involves three (3) successful days of testing using “clean water” (treated Plant effluent is acceptable), demonstrating that the process mechanical, structural, electrical and instrumentation and control elements related to a process equipment have been installed as intended and operate over the range of design conditions specified. Once the individual pieces of equipment have been tested, the System Operational Testing will commence.

.4 System Operational Testing:

.1 System Operational Tests will be conducted over a period sufficient to achieve seven (7) days of successful operation, of which, the last three (3) days must be consecutive, with sludge being fed to the various components that constitute the overall THPS. Each item of equipment will undergo an operational test as required to prove successful operation at the maximum or most severe, average, and minimum or least severe conditions. Conduct hydrostatic tests for each tank, or vessel and piping assembly on the skid(s) using clean water. Conform to the applicable code requirements for hydrostatic testing of pressure vessels. Perform hydrostatic tests on the valves and gates to ensure water-tightness as per applicable code requirements. Vibration and noise tests will be conducted during the operational test period as required.

.5 Final Commissioning: Validating the performance of the THPS in terms of sludge throughput, reaction temperatures and pressures, steam consumption, and energy consumption will be undertaken after Plant commissioning during a period of relatively stable operation with the full facility in operation. T he entire THP Facility (from the centrifuge feed tanks to the digester feed pumps) will be operated with sludge and steam over a minimum 30 day period sufficient to confirm this step has been successfully completed.

3.8 Functional Test with Clean Water - Specific Requirements

.1 This test can only proceed after installation of the units and after all accessories are in an operable condition and Demonstration Tests have been documented. System controls do not need to be completely functional at this time. Equipment must be able to operate in manual mode.

.2 In conjunction with the initial periods of the Functional Testing, Design Builder is to perform a field mechanical test under the supervision of the THPS Supplier as described below:

.1 Submit each unit to complete normal start, normal stop, and emergency stop cycles. Submit each unit to a minimum twelve (12) hour running test when the THPS is being fed with clean water. During this running test, observe and record all thermometers, pressure gauges, and flow indicators at the beginning, at two-hour intervals, and end of the test. Check all safety devices for satisfactory operation.

.1 Correct any malfunctions appearing during the tests and extend the test period to ensure that the defective or misadjusted equipment will perform satisfactorily after adjustment.

.2 In conjunction with the start-up of the facility and after the field mechanical test, make the THPS equipment available to assist with start-up activities related to auxiliary equipment, including sludge dewatering, conveyance, and storage, steam feed, and other related equipment. The start-up of this auxiliary equipment requires the THPS to be on-line. The THPS Supplier's field Representative is to operate the THPS equipment throughout this period.

.3 Complete demonstration, operational testing and system operational testing step 1 with clean water.

.4 The THPS Supplier's Representative will be responsible for ensuring satisfactory operational testing and will complete documentation agreeing to such.

.5 Documented all results of Functional Testing activities in accordance with the Technical Requirements, the Final Design and the Commissioning Plan, and delivered all such results to the City for review in accordance with Schedule 13 – Document Management System including:

.1 consolidated electronic copy of all completed test forms, including Functional Testing Completion forms using the standard forms provided by Design Builder and previously accepted by the City. Submit forms in a categorized and logical order;

.2 manufacturer’s written certification that the equipment functions as intended by the manufacturer and was tested in accordance with its recommendations;

.3 deficiency log identifying Deficiencies and corrective actions taken by Design Builder;

.4 certification from the Engineer of Record or qualified professional that the construction was completed in accordance with the Final Design; and

.5 certification that Functional Testing was conducted in accordance with the Technical Requirements, the Final Design and the Commissioning Plan.

3.9 System Operational Testing

.1 Conduct System Operational testing with sludge and steam on a system basis. During operational testing and commissioning with sludge, steam and process gas, conditions will be simulated which represent maximum or most severe, average, and minimum or least severe conditions.

.2 Test system for a minimum 7 day period.

.3 Test systems in steps to ensure that each component is operating correctly before sludge is fed to the next step in the THPS.

.4 The THPS Supplier, with support from Design Builder, will provide an initial detailed Commissioning Plan. The final Commissioning Plan will be prepared by the THPS Supplier and Design Builder.

.5 Operate the system or sub-system in all modes and scenarios of operation, including at peak capacity as set out in the Technical Requirements, the Final Design and the Commissioning Plan and demonstrate that it can function as set out in the Technical Requirements and the Final Design. Either individual trains or facilities with multiple identical trains can be utilized with proportional flows and/or the flows shall be augmented using temporary equipment to simulate the peak capacity flows. If the number of units in service is varied to demonstrate the performance of the system at the peak capacity flows and loads, Design Builder shall repeat the test for each hydraulic component until all components in the system have been successfully tested.

.6 Increase the flows and loads directed to the system or sub-system in a controlled manner to prevent process upsets within the Infrastructure;

  .1 ensure that all process fluids during Systems Operational Testing are representative of conditions that will be encountered during operation of the Infrastructure as set out in the Technical Requirements and the Final Design;

  .2 refine and calibrate all electrical, instrumentation and control systems and sub-systems to optimize its performance during operation in its intended service condition;

  .3 confirm that all data acquisition, process control algorithms, equipment interlocks, alarms, events and notifications, process and gas monitoring and other data acquisition and supervisory control features are fully operational;

  .4 operate the system or sub-system automatically and continuously under PCS control without major alarms or shutdowns, without manual intervention (except that reasonable manual intervention will be allowed if required by the Technical Requirements, Final Design or to simulate service conditions to carry out testing) and continuously over 7 consecutive days at operating conditions representative of service conditions set out in the Technical Requirements and the Final Design;

  .5 if applicable to the system or sub-system, demonstrate in the field to the City Representative, or any City Party designated by the City Representative, that the SOPs for the following are accurate and comprehensive by performing each procedure set out in the SOPs in accordance with the instructions set out therein:

    .1 filling and removal of consumables from vessels (including chemicals, polymer, etc.);

    .2 field instrumentation calibration;

    .3 PCS control calibration or optimization; and

    .4 additional SOPs as requested by the City.

.7 The THPS Supplier will ensure all backup provisions function satisfactorily.

.8 All minor and major alarm conditions will be induced to ensure that the process reacts as intended, the applicable alarms are annunciated.

.9 For clarity, the City will be responsible for removing residuals generated during Systems Operational Testing.

3.10 Final Commissioning

.1 For this test to occur, in addition to the equipment supplied under this Contract, the centrifuges, centrifuge feed tanks and pumps, polymer system, storage tanks, digester feed pumps, and other ancillary systems as required to operate the entire System as a whole, must have their Operational Testing successfully completed and documentation signed off. Coordinate with Design Builder and other equipment suppliers.

.2 Collect samples at each appropriate step of the Operational Testing and Commissioning process, as to determine the operation of the systems, and have the samples analysed at a certified third-party lab. Record all operating data and field observations. As a minimum, sample the sludge at the THPS feed pump discharge, inlet to the THP reactors and at the discharge of the HS pumps and determine the solids concentrations. Employ a certified, third-party laboratory to test all samples. The THPS Supplier shall bear all costs of sampling and analysis. The City, at its discretion, may request duplicate samples for testing at the City lab and at the City's expense. The THPS Supplier will provide a method and equipment for the safe sampling of sludge.

.3 Once each System has been successfully tested, the entire THP Facility (from the centrifuge feed tanks to the digester feed pumps) will be operated with sludge and steam over a period sufficient to achieve 30 successful days of operation, of which, the last seven (7) must be consecutive.

.4 If more than one train is provided, both trains must be tested to prove performance requirements can be met. Simulate the maximum month loading condition by shutting off some equipment so that the maximum month loading can be simulated in the equipment remaining in service.

.5 Maintain steady state operation throughout each test for each of the design operating conditions. The THPS will be required to maintain acceptable performance as defined in Table 2 at each of the throughput conditions specified.

.6 Record all operating data and field observations. Sample the sludge at the THPS feed pump discharge, inlet to the THPS reactors, and at the discharge of the HS pumps and determine the solids and E. coli concentrations. Employ a certified, third-party laboratory to test all samples. The THPS Supplier shall bear all costs of sampling and analysis. The City, at its discretion, may request duplicate samples for testing at the City lab.

.7 As a minimum, test the THPS under the following flow conditions:

  .1 Minimum Flow and Load Condition: Minimum solids loading at Start-Up with a feed DS concentration of 16.5 percent total solids.

.2 Maximum Flow and Load Condition: Maximum month solids loading at Design Year with a feed DS concentration of 16.5 percent total solids. This sludge loading will need to be simulated by shutting off parts of the System. Test each part of the System at the simulated maximum month loading condition.

.3 Average Flow and Load Condition: Average annual loading with a feed DS concentration of 16.5 percent total solids.

.8 Configure the testing to demonstrate that the THPS is capable of stable and safe operation at a solids feed rate anywhere between 40 and 100 percent of the maximum month design solids feed rate. This can be achieved by running fewer reactors and/or adjusting the cycle times. At 40 percent flow, the System can be operated intermittently.

.9 Demonstrate that the THPS operates at the optimal steam consumption (t steam/t DS).

.10 Demonstrate the ability to bypass individual pressure vessels to allow a vessel to be taken out of service for annual inspection, as per Code requirements, while maintaining System operation with the remaining equipment, operating at maximum month flow conditions, and meet Class A pathogen requirements.

.11 Both the certified third-party testing and the City testing results will be used to prove compliance with the performance requirements prior to acceptance of the equipment.

.12 Should the equipment not achieve consistent compliance (greater than 95 percent of the time) with any of the proposed performance characteristics during the commissioning period then the THPS Supplier is to modify the equipment and repeat the performance tests.

.13 Should the equipment fail to meet any of the design requirements, the equipment will be rejected and must be replaced with acceptable equipment.

.14 Equipment replacement will include all costs (including engineering) for removal of any failed equipment, disposal costs, downtime, installation of any new equipment, and all retesting required proving compliance with the performance requirements.

3.11 Commissioning Report

.1 The THPS Supplier shall submit a written report within two (2) weeks of completing operational testing and commissioning with sludge. Include all data collected during field testing, including, but not limited to, the following:

.1 Conclusions from extended duration testing utilizing the average of the data collected, including solids throughput and steam consumption.

.2 Steam consumption rates including peak instantaneous demands and thermal requirements (kJ/tonne dry solids processed).

.2 If Operational testing does not meet all process requirements, systems will be retested to identify issues and to alter processes to meet requirements.

.3 Process Requirement:

.1 Thermal Efficiency:

.1 Thermal efficiency (kJ/tDS) is defined as the total amount of heat energy (kJ) required by the THPS to process a tonne of dry material (tDS) in the feed PDS.

.2 Processing Capacity (Throughput):

.1 During the performance test, the THPS will be tested with PDS at a minimum solids concentration of 16 percent and operated at the operating conditions specified. Should the tested feed capacity of the THPS be below the specified throughput capacity, the THPS Supplier may, at his expense, retest the THPS to establish the capability of the THPS to meet the performance requirements.

3.12 Design Support Services

.1 THPS Supplier Review of Deign Builder Drawings:

.1 Allow sufficient time to review and provide comments on the Design Builders drawings at four distinct stages of design completion (i.e., 30, 60, 90 percent, and Issued for Construction).

.2 Provide three (3) trips of two (2) person-days each for at least two (2) people to attend Review Meetings with the Design Builder and the Project Manager in the City of Winnipeg.

.3 Provide one (1) trip of two (2) person-days for at least two (2) people to attend a HAZOP Review with the Design Builder and the Project Manager in the City of Winnipeg.

3.13 Field Services

.1 The THPS Supplier will need to provide relatively continuous support for a period during installation witnessing, training, Demonstration Testing, Operational Testing, and commissioning.

.2 At least thirty (30) days prior to commencing equipment performance verification and process performance verification, the THPS Supplier with information from the Design Builder shall submit a detailed start-up plan to indicate the schedule and sequence of equipment installation checks and tests required for the Design Builder’s review and input. No testing work can commence until this plan has been discussed by all parties involved and accepted by the Design Builder.

.3 Allow for a minimum onsite service by the THPS Supplier’s Representatives for the following activities:

.1 Installation assistance, supervision and inspection.

.2 Completion of documentation certifying proper installation.

.3 Attendance at Demonstration Testing, Operational Testing, and commissioning planning meetings.

.4 All pre-commissioning checks.

.5 Operational testing and completion of documentation certifying satisfactory System and Sub-system performance.

.6 Commissioning assistance and completion of documentation. Two (2) THPS Supplier's Representatives will be required to provide full coverage for 45 days during Certificate of Satisfactory System Performance.

.7 Commissioning coordination with other areas related or interconnected to THPS (such as commissioning of centrifuges and related dewatering equipment, steam generation equipment, blend tanks and digester equipment).

.4 Ensure THPS Supplier's Representative(s) are fully qualified to provide troubleshooting services on process, mechanical, electrical, instrumentation and controls issues. Provide the services of multiple THPS Supplier's Representatives as required.

.5 Provide the services of a qualified technical THPS Supplier's Representative at the Site for the minimum person days listed in Table 3.

.6 Training:

.1 See requirements of Appendix 18G.

.2 Two categories of training sessions are required under this Contract: one prior to or concurrent with the System Operational Testing (initial training), and one during the warranty period, approximately six (6) months after award of Substantial Performance of the Work Package (final training). The intent of the latter training session is to enable The City's personnel to ask particular questions on the operation of the specified equipment, based on their actual experience.

.3 The intent is that the City's Personnel should receive sufficient training on the equipment system that they are going to operate and maintain. The City shall have the authority to determine the duration and content of each training session required.

.4 Provide site services at a minimum as designated in the following table:

Table 3: THPS Supplier Services

Item	Services to be Provided to the Design Builder	Total Hours	Form
1	Review of Engineering Drawings at 30, 60, 90 percent completion and IFC	160	TBD
2	HAZOP Review	30	TBD
3	Equipment Delivery and installation instruction	24	TBD
4	Installation Supervision and Assistance	200	TBD
5	Equipment Installation Inspection and Certification	80	TBD
6	Software Uploading, Testing and Commissioning for the Control System	160	TBD
7	Equipment Demonstration Tests and Initial Operator and Maintenance Training	256	TBD
8	Assistance in Operational Testing (including at least three (3) consecutive days)	240	TBD
9	Assistance during Commissioning (including at least fourteen (14) consecutive days)	360	TBD

Item	Services to be Provided to the Design Builder	Total Hours	Form
10	Final Operator and Maintenance Training	256	TBD
11	Control System Trouble-Shooting and Outstanding Operator and Maintenance Classroom and Site	40	TBD
12	Follow-up Operations and Maintenance Training	40	TBD
14	THPS Supplier to allow for 20 trips to Winnipeg		

TBD – Sign-off forms to be developed

END OF SECTION

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 01300, 11000 and 11300 and the following:

- .1 Manufacturer's descriptive literature for materials.

1.3 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A276 - Stainless Bars and Shapes.
- .2 ASTM A322 - Steel Bars, Alloy, Standard Grades.
- .3 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 40,000 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 a minimum Brinnell hardness of 600.

.2 Impeller: Ni-hard or hardened high-chrome iron, ASTM A532, with a 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 the shaft and secure by a shrouded bolt and lockwasher or connect by babbitting 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. The 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. The 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 that discharge vertically upwards.

.2 Use either three-piece construction with a separate rear liner and suction pipe to allow front or back pull-out, or a one-piece casing with integral suction and discharge nozzles plus a back plate with an 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 The minimum casing thickness shall be 19 mm. Pressure test casings at 1.5 times the pressure developed by the pump at the shut-off head.

.6 Solidly foot-mount casings to allow each access to the 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 double 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.

.7 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.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests to be conducted on the 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

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 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A48 - Gray Iron Castings.

.2 ASTM A108 - Steel Bar, Carbon And Alloy, Cold-Finished.

.3 ASTM A216 - Steel Castings, Carbon, Suitable For Fusion Welding, For High-Temperature Service.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 The pump shall be designed for chemical transfer.

.2 Gear pumps shall be designed for positive displacement requirements.

.3 Design to meet area classification in Section 01450.

.4 The operating characteristics for the following parameters shall conform to the Final Design:

 .1 Capacity at the 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 the pump specially adapted for the service specified.

.4 Provide housings designed for the 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 the 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 the motor selected for the pump.

.1 Provide the relief valve and connecting piping with the full capacity of the pump.

.2 Provide an external rupture pin-type valve for each pump as specified in Section 15100.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed in accordance with Schedule 18 Technical Requirements and the following:

  .1 For each pump:

    .1 One (1) complete set of gaskets and O-rings.

  .2 For each set of pumps of the same size and performance:

    .1 One (1) set of gears.

    .2 One (1) shaft and set of bushings.

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

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 01300 and 11000 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 screw 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:

.1 The compressor shall be a single-stage oil-free rotary screw compressor, flanged to an integral speed increaser.

.2 Silencers, lubricating system, cooling system, control system, and driver shall be mounted as part of the package.

.3 Provide a common base frame for the compressor system and driver.

.4 Provide a sound enclosure over the compressor and driver.

.5 Equipment shall be designed for economical and rapid maintenance.

.6 Casing components, bearing housings, and other major parts shall be shouldered, dowelled, or designed with other provisions to facilitate accurate alignment or reassembly.

.7 Shaft seals and bearings shall be accessible for inspection or replacement with a minimum of disassembly.

.3 Compressor Casings:

.1 Casings shall be cast iron, ductile iron, cast steel, or fabricated steel.

.2 Casing stresses shall be within the limits allowed by ASME BPVC SEC VIII D1.

.3 Casings, supports, and baseplates shall be designed and fabricated to preclude excessive and injurious distortion from temperatures, pressures, and forces encountered in service conditions.

.4 Provide jackscrews, lifting lugs, eyebolts, guide dowels, and casing alignment dowels to facilitate disassembly and reassembly.

.5 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.

.6 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.

.7 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:

.1 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:

.1 Rotors shall be high efficiency, steel, and of one-piece construction, with an asymmetric profile to minimize leakage losses.

.2 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.

.3 Rotors shall be dynamically balanced for vibration-free operation.

.6 Gears:

.1 Gears shall be of alloy steel, ANSI/AGMA 2009 and ANSI/AGMA 2011 Quality Number 12 or better for both bull and pinion gears.

.2 Gears shall be hardened to 275 Brinell for bull gear and 320 Brinell for pinion.

.3 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.

.4 All gears shall be pressure lubricated.

.5 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:

.1 Seals shall be suitable for all operating conditions including suction throttling, start-up, and shutdown.

.2 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.

.3 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.

.4 Provide an air space vented to the atmosphere between the air and oil seals.

.8 Thrust Bearings:

.1 Thrust bearings shall be anti-friction ball or roller type or hydrodynamic (fluid film) type.

.2 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.

.3 Hydrodynamic thrust bearings shall be Kingsbury type or other acceptable type and adequate to withstand all operating conditions.

.4 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:

.1 Radial bearings shall be anti-friction roller or ball type or hydrodynamic type.

.2 Anti-friction bearings to have an L-10 life of 40,000 hours in accordance with ABMA 9 or ABMA 11.

.3 Hydrodynamic bearings shall be precision-bored sleeve or pad type, designed for easy replacement by a split design or axially removable arrangement.

.4 High-speed hydrodynamic pinion bearings shall be anti-oil whip, tilting pad type.

.5 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:

.1 The speed increaser shall be an integral part of the compressor unit and to include the main drive shaft and bull gear.

.2 The main drive shaft shall be supported through anti-friction bearings.

.11 Lubrication System:

.1 Include an integral sump, positive displacement pump, oil cooler, and twin filter\strainer (readily replaceable cartridges while operating).

.2 Provide a prelube lubrication oil pump for start-up and standby for hydrodynamic bearings or if required by the compressor design.

.3 System shall be factory assembled and tested. Lubricating oil shall conform to recommendations of the compressor manufacturer.

.4 Spray lubricate drive gear, anti-friction bearings, and timing gear in each stage. Pressure lubricate hydrodynamic bearings.

.5 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:

.2 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 1.15.

.3 Size the motor so that the nameplate power rating is not exceeded under the entire range of operating conditions specified.

.4 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.

.5 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.

.6 Electrical service shall be as required for the Final Design.

.7 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.

.8 Provide RTDs attached to or imbedded in motor winding for control system.

.9 The motor shall meet the requirements of NEMA MG 1 with Class F insulation.

.10 Provide space heaters for protection of windings during motor shutdowns.

.11 Accessory and Related Equipment Motors:

.1 Motors less than 0.375 kW shall be single-phase 120 Volt, 50Hz, induction motors and is to conform to NEMA MG 1.

.2 Motors 0.375 to 3.75 kW shall be three-phase 600 Volt, 50 HZ induction motors and is to conform to NEMA MG 1.

.3 Single-phase and three-phase motors shall have bimetallic disk thermostats attached to or embedded in the motor winding.

.4 Motors shall have NEMA MG 1 Class B insulation.

.5 Motors shall have CSA certification, premium efficient.

.13 Control Panel:

.1 Control unit panel shall conform to NEMA ICS 6, floor- or frame-mounted, factory designed, and assembled, and provided complete.

.2 The panel shall be fabricated of formed stretcher-leveled sheet steel, reinforced, and assembled into a rigid unit.

.3 Gasketed access doors shall be provided as required.

.4 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 be mounted separately from panel.

.4 Control panel shall be CSA or cUL certified.

.5 Provide hard wire and Modbus communication port for interface with plant PCS.

.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 a distance 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, 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, 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 label 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 135ºC	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 that are identical to and interchangeable with similar parts installed in accordance with Schedule 18 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 Schedule 18 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

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 Canadian Standards Association (CSA):

  .1 CSA C747 – Energy Efficiency Test Methods for Small Motors.

.2 Institute of Electrical and Electronics Engineers (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 01300, 11000 and 11300 and the following:

  .1 Manufacturer's descriptive literature for materials.

  .2 Pump performance data including curves showing flow rate versus 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.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single Manufacturer.

.2 Acceptable Manufacturers:

  .1 Pulsar.

  .2 Prominent.

  .3 Or approved equivalent.

2.2 Performance Criteria

.1 Provide diaphragm chemical metering pumps designed for the required flow, fluid characteristics, and pressure.

.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, flow switch and an auto de-gassing 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 conditions 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 gearbox with oil-flooded moving parts.

.5 Prevent leakage through hydraulically-actuated balanced diaphragm design.

.6 Provide an adjustable, spring-loaded internal pressure relief valve to protect the pump against excessive hydraulic pressure.

.7 Power supply: 120 VAC, 1-phase, 60 Hz.

.8 The manufacturer shall provide the motor and motor controller.

.9 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.

.10 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.

.11 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.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 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 Two (2) ball checks assemblies.

.4 Two (2) seats.

.5 Five (5) sets of check valve O-rings/gaskets.

.6 Two (2) complete sets of gaskets.

.7 One (1) assembly tool for pump diaphragm if required.

.8 One (1) of each type and material back pressure regulator with one spare diaphragm and spring for each.

.9 One (1) spare diaphragm and air valve for each discharge pulsation dampener.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on the pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpret results.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of progressive cavity polymer pumps, motors, gear reducers, variable frequency motor controllers, and appurtenances.

1.2 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 and the following:

- .1 Manufacturer's descriptive literature for materials.
- .2 Material Certification:
  - .1 Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified in DBA. 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 specified in the DBA.
  - .2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and as required for the Final Design.

2. PRODUCTS

2.1 Performance Criteria

.1 Provide progressive cavity polymer pumps for the appropriate flow, pressure, fluid characteristics, and equipment classification according to Section 01450.

.2 The pump speed at duty points shall not exceed 80 rpm.

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 equivalent.

2.3 Configuration, Components and Features

.1 General:

.1 Type: Progressive cavity, self-priming, helical rotary pumps based on Moineau Principle.

.2 Provide each pump with the number of stages as specified and indicated employing a convoluted rotor operating in a similarly convoluted stator.

.3 Provide the convolutions configured to form a cavity between the rotor and stator, progressing from the pump's inlet to the discharge port with the operation of the rotor.

.4 Provide the fit between the rotor and stator at the point of contact to compress the stator material sufficiently to form a seal and to prevent leakage from the discharge back to the inlet end of the pumping chamber.

.5 Provide the stator molded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid.

.1 Gaskets or O-rings to form this seal shall not be permitted.

.6 Provide pumps driven as required for the Final Design.

.7 Pump Arrangement:

.1 Horizontal.

.2 Capable of forward and reverse rotation.

.8 Connections:

.1 Flanged suction and discharge connections faced and drilled to Class 150 ANSI B16.5, raised face.

.2 Polymer services: Type 316 stainless steel.

.9 Bearings:

.1 Grease-lubricated anti-friction type.

.2 Outboard bearing shall be a combination thrust and radial type; inboard bearing radial type.

.3 Provide bearings in a dust-and moisture-proof enclosures.

.4 Provide means in bearing housing, such as removable plug diametrically opposite grease fitting, to prevent over greasing of bearing.

.10 Provide pumps driven through a positively sealed and lubricated pin joint.

.1 Provide the pin joint with replaceable bushings of air-hardened tool steel of 57-60 HRc, in the rotor head and coupling rod.

.2 Provide the pin constructed of steel, air-hardened to 60-65 HRc.

.3 Provide the joint lubricated with a high temperature (230°C) PTFE-filled synthetic grease.

.4 Provide the assembly covered with a Buna-N sleeve and positively sealed with Type 316 stainless steel hose clamps.

.5 Provide a stainless steel shell covering the rotor side universal joint assembly to protect the elastomer sleeve.

.6 Joint Warranty: 10,000 operating hours, unconditional in regards to damage or wear.

.2 Stator:

.1 Provide pump stator of two-piece construction to allow vertical pull out of the rotor. Provide with a cleanout opening on each side of the inlet fitting.

.2 Provide a 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 the installation of a water lubrication system.

.3 Polymer Transfer and Feed Pumps:

.1 Stator:

.1 Pure Viton.

.2 Outer casing: Type 316 stainless steel.

.2 Rotor:

.1 Precision machine rotor: Type 316 stainless steel.

.3 Pump Body:

.1 Type 316 stainless steel.

.2 Provide a suction port capable of 360-degree rotation in 90-degree increments.

.4 Shaft:

.1 Type 316 stainless steel, chrome-plated through the stuffing box.

.4 Seals:

.1 Single-acting Mechanical Seals:

.1 Acceptable Product:

.1 Bergmann MG1-Q1Q1VGG.

.2 Or approved equivalent.

.2 Seal faces: silicon carbide.

.3 Elastomers:

.1 Viton.

.2 Or approved equivalent.

.4 Metal parts: Type 316 stainless steel.

.5 Pump control panels:

.1 Integrate all controls with the SCADA system.

.2 Provide a control panel for automatic and manual operation of the entire polymer feed system.

.3 Provide a local control panel for the polymer dosing pumps.

.4 The local control panels shall be completely pre-wired and housed in stainless steel Type 316 NEMA 4X enclosures.

.5 The control panel shall be furnished with all control devices (e.g. push buttons, selector switches, indicating lights, emergency stops, displays, appurtenances.) as required for the Final Design and specified in this Section, and as recommended by the equipment Manufacturer. Emergency shut down control devices shall be mounted on the control panel, or in the field, or both, as required for the Final Design and specified in this Section.

.6 Provide PLC I/O points required for incorporating the polymer feed system into Plant PCS system. Provisions for all I/O points to be provided. All points shall be terminated in terminals. Analog points shall be optically isolated. Digital points shall be isolated by voltage-free dry contacts. All analog signal shall be 4-20 mA.

.7 The control panel shall be furnished with motor starter(s) and VFDs as required for the Final Design. All necessary circuit breakers, starters, transformers, switches, control relays, timers, hardwired controls, process and safety interlocks shall be provided to form a complete standalone system capable of operating in manual and automatic mode.

.8 Alarm handling: All detail alarms and status shall be displayed on the local control panel. Provide interface to all alarms and status (a voltage-free dry contact) wired to SCADA. Provide an Alarm Reset push-button to clear alarms.

.9 At a minimum, the system shall include the following control features:

.1 Selector switch (Remote- Off – Local).

.2 Main power disconnect switch.

.3 Emergency STOP push button.

.4 System ON-OFF (reset).

.5 One-turn potentiometer for mixer speed control.

.6 Ten-turn potentiometer; one (1) for each pump.

.10 At a minimum, the system shall include instruments to provide the following status and alarm indicators:

.1 Main power ON.

.2 Flow meter display of polymer metering pump rate (L/s).

.3 Low water differential pressure alarm.

.4 Polymer pump line high pressure alarm.

.5 Polymer low flow alarm.

.11 At a minimum, the system shall include the following inputs:

.1 Remote Start-Stop (dry contact).

.2 Pump speed.

.3 Pacing signal based on process flow (4-20 mA).

.12 At a minimum, the system shall include the following outputs:

.1 System running (discrete dry contact).

.2 Remote mode (discrete dry contact).

.3 Common alarm (discrete dry contact).

.4 Polymer pump rate (4-20 mA).

.6 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.

.7 Over-pressure protection:

.1 Provide each pump with a pressure sensor annular ring with a dual-mounted gauge and single-point pressure switch.

.2 Provide the pressure ranges for the switch and gauge selected for each service specified.

.8 Drain, vent and seal water piping:

.1 Provide drains from the stuffing box and casing vent and drain piping and valves to discharge into directly into drains.

.2 Provide seal water piping, valves and accessories at the pump as specified and indicated in Section 11399.

.9 Motors:

.1 Provide in accordance with Section 16223 and as specified and indicated. Provide Variable Frequency Drive in accordance with Section 16228 and as specified and indicated.

.2 Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

.3 Provide motors for horizontal pumps with mounts for bolting to baseplate.

.4 Overall sound-pressure level of each motor shall not exceed 88 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 or more readings at evenly spaced points, 3 feet from motor.

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

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

.7 Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

.8 Rating: 600 Volt, 3-phase, 60 Hertz.

.9 Site Altitude: 230 m above sea level.

.10 Baseplates:

.1 Horizontal Pumps:

.1 Mount each pump, drive and appurtenances on a common base.

.1 Material: 304 stainless steel skid.

.2 Provide structural steel shape bases, bent form bases are not acceptable.

.3 Provide bases with provisions for grouting and for anchor bolts.

.4 Design baseplates to support pump, driver and accessories as indicated on Equipment Data Sheet.

.5 Provide planed surfaces of bearing pads for pumps and drives.

.11 Couplings:

.1 Non lubricated, polyurethane flex material type.

.1 Split design.

.2 Spacer type.

.3 Manufacturer: Rexnord Omega.

.4 Provide guards for protection for personnel, conforming to OSHA requirements.

.1 Guards and Hardware: Type 316 stainless steel.

.12 Dilution supply:

.1 Provide dilution supply for post-dilution of polymer solution at pump discharge including the following:

.1 Pressure reducing valve, check valve, isolation valve, open/close solenoid valve, flow meter, modulating valve for dilution control.

.2 Include a static mixer at pump discharge to mix polymer solution and dilutions supply.

.13 Flushing Connections:

.1 Provide flushing connections at pump suction, pump discharge and solution discharge with isolation valve and camlock fitting.

.2 Flushing connection at pump suction should be hard piped with the dilution supply (W2) and include an open/closed solenoid valve for automated pump flushing for operator set duration prior to pump shutdown. This operation shall be controlled by the pump local control panel.

.14 Gauges:

.1 Provide pressure sensors and gauge assemblies for suction and discharge of each pump in accordance with Division 40 and as indicated.

.2 Suction Gauges: Compound type with operating range at approximately midpoint of the gauge range.

.1 Scale: 0 – 80 psi.

.3 Discharge Gauges: Provide standard range with top limit above pump shutoff head at maximum pump speed.

.1 Scale: 0 – 80 psi.

.15 Calibration Standpipes:

.1 Equip each pump 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 not acceptable.*

.3 Equip each standpipe with flanged connection to suction piping, and fitted with ball valve for air venting, as indicated on drawing. Provide fittings of socket weld type. Provide valves and fittings as specified under other sections referenced.

.4 Provide the calibration standpipe of a height and diameter such that the measurable capacity of the standpipe is approximately one and one-half minutes discharge of each pump at maximum pumping capacity. Permanently calibrate each standpipe in litres and 10 millilitre increments.

.5 Provide valves and flanges at each pump suction for attachment of calibration standpipes. Install pump suction and discharge piping so as not to interfere with location and use of standpipes.

2.4 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed in accordance with Schedule 18 Technical Requirements and the following:

.1 For each pump:

.1 One (1) complete set of gaskets and O-rings.

.2 One (1) mechanical seal repair kit or replacement set of mechanical seal.

.3 One (1) shaft sleeve.

.2 For each set of pumps of the same size and performance:

.1 One (1) set of rotors and stators.

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on the pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpret 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 Standards

.1 American Society for Testing and Materials (ASTM):

.1 ASTM A48 - Gray Iron Castings.

.2 ASTM A322 - Steel Bars, Alloy, Standard Grades.

.3 ASTM A570 - Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300, 11000 and 11300 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 a pump that is chemically compatible with all expected commodities that will 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 the 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 the 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). The 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 Drive rating: Continuous twenty-four (24) hour operation, 40°C ambient.

.9 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.

.10 Housing: enclosure: NEMA 4X. Unpainted housings, including Type 316 stainless steel shall not be permitted.

.11 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 the operator to set the maximum speed of the pump within 0.1 to 220 RPM.

.12 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 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.

.6 Local speed control.

.2 Status outputs:

.1 Four dry relay contacts, 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.

.13 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.

.14 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 the 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 fittings. 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 in 10 millilitres increments.

.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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following for each pump size:

.1 Three (3) replacements for each size of tube or hose.

.2 Two (2) complete sets of gaskets.

.3 One (1) of each type and material back-pressure regulator with one (1) spare diaphragm and spring for each.

.4 One (1) spare diaphragm and air valve for each discharge pulsation dampener.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Testing:

.1 Factory Acceptance Tests: Factory tests shall be conducted on the pump and motor assembly in accordance with Section 11330. Copies of all shop test data and interpret results.

END OF SECTION

VACUUM EDUCTORS

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of vacuum educators for priming pumps.

1.2 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

   .1 One (1) complete eductor for spare parts.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of compressed air dryers and filters.

.2 The air dryers and filters condition compressed air so that it is suitable for use in the instrument air and service air systems.

1.2 Submittals

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

   .1 Manufacturer's descriptive literature for materials.

   .2 Air dryer fabrication details including pressure vessel and support construction.

   .3 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 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.

2.2 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.

2.3 Materials

.1 Fabricate of materials suitable for the intended service.

.2 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.

.3 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.

2.4 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Provide and test inline sludge screens, motors, gear reducers, valves, controls and control panels and appurtenances as indicated and specified.

1.2 Standards

.1 American Bearing Manufacturers Association (ABMA):

  .1 ABMA 15 - Ball Bearings. Local Bearings and Fatigue Life.

.1 American National Standards Institute (ANSI):

  .1 ANSI B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.

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

.2 American Society for Testing and Materials (ASTM):

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

  .2 ASTM A48 - Specification for Gray Iron Castings.

  .3 ASTM A480 - Specification for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet and Strip.

  .4 ASTM A500 - Specification for Cold-Formed Welded and Seamless Steel Tubing in Rounds and Shapes.

  .5 ASTM G65 - Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests (Procedure A).

.3 American Welding Society (AWS).

.4 Instrument Society of America (ISA).

.5 National Electrical Code (NEC).

.6 National Electrical Manufacturers’ Association (NEMA):

  .1 NEMA MG1 - Motors and Generators.

.7 Underwriters Laboratories Inc. (UL).

1.3 Submittals

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

.1 Manufacturer's descriptive literature for materials.

.2 Typical system description of operations. List component identification on schematic diagrams. Identify all inputs/outputs to PLC and identify all deviations from those shown on the contract drawings.

.3 Material Certification:

.1 Provide certification from the equipment Manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. 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 specified and indicated. Provide proposed materials at no additional cost to the City.

.2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

1.4 Quality Assurance

.1 Design Builder shall obtain the sludge screens, motors, gear reducers, valves, controls and control panels and appurtenances from the sludge screen Manufacturer, as a complete and integrated package to ensure proper coordination and compatibility, and operation of the system.

.2 Provide all components made of stainless steel passivated by full submergence in a pickling bath for perfect surface finishing. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.

.1 Fully submerge all stainless steel parts in a pickling bath (nitric and hydrofluoric acids) for at least 8 hours to remove welding spots and to protect the stainless steel against corrosion. Sand or glass bead blasted or brushed or otherwise not equivalently treated stainless steel is not acceptable.

.2 After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel.

.3 Manufacturer of sludge screens shall 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.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Inline Sludge Screens:

.1 Screenings shall meet the minimum moisture content of 45% and pass the slump test for landfill disposal.

.2 Coordinate screening equipment dimensions and weights with hoists and bridge cranes as specified in Division 14 and as indicated.

.2 Acceptable Manufacturers:

.1 Huber Technology.

.2 Hydro International.

.3 Or approved equal.

2.2 Inline Sludge Screen Construction

.1 Use the Manufacturer's standard for equipment sizes not specified.

.2 All equipment and components furnished as complete assemblies with all internal wiring, piping, valving, and control devices, inline sludge screen type, specifically designed for dewatering wastewater plant residuals with the addition of polymers.

.1 Like items of equipment shall be the product of one Manufacturer to achieve standardization of operation, spare parts, maintenance and Manufacturer's service.

.2 The equipment provided shall be complete in all respects including, but not limited to, lubricants, components, calibration, alignment, and adjustments to place the equipment in operation to perform its specified functions.

.3 Provide the screw presses designed and constructed to operate continuously.

.4 Provide the design to facilitate lubrication, adjustment or replacement of all parts.

.5 Provide the sludge screen assembly designed for disassembly of the unit including removal of the rotating assembly, within the space and headroom indicated and with the hoisting equipment specified.

.3 Arrangement:

.1 The contract drawings indicate the required general arrangement and layout of the sludge screens.

.2 Changes to the arrangement to accommodate the selected equipment are the responsibility of Design Builder and shall be at no additional cost to the City.

2.3 Conditions of Service

.1 Provide all equipment and appurtenances designed for exposure to splash and spill conditions, 0 to 95 percent non-condensing humidity, and temperatures ranging from 4 to 40°C (40 to 104 degrees F).

.2 Provide all equipment and appurtenances designed for operating continuously for 24 hours per day, seven (7) days per week and designed to operate under conditions where it is started and stopped frequently in short time intervals as specified.

2.4 Performance Criteria

.1 Minimum screen performance requirements:

	Primary/Fermented Sludge	**Phosphorus Released Sludge**
Number of Screens	2 (1 duty and 1 standby)	3 (2 duty and 1 standby)
Capacity (each), L/s	21	21
Screen opening size, mm (inches)	5 mm (0.2 inch)	
Orientation	Horizontal	

.2 Provide the fine screen designed to handle the maximum flow with the maximum solids loading.

.3 Provide the nominal screen opening size specified as the diameter of the circular perforated openings.

.1 Screen designs which define the bar spacing as the distance between rectangular openings using a wedge wire screen or a fixed bar element and a moving adjacent bar element are not acceptable.

.2 Screens using rotating rakes, screw flight mounted brushes, or traveling filter media are not acceptable.

.4 Average screen flow through velocity: Not to exceed 1.0 m/sec (3.3 feet/second) under any flow condition up to the maximum flow specified above.

.5 Provide the screen consisting of a cylindrical screen with an integral screw conveyor and screenings press.

.1 Provide the screen using a single drive for screening, conveying, dewatering and compressing the screening material.

.6 Provide operation of the screen automatically initiated at a preset high pressure level.

.1 Screens which operate continuously or by timer only are not acceptable.

.2 Provide the screenings transported through a compaction and dewatering zone and then discharged to storage vessel.

.7 Provide all open spaces of the screen cleaned by the rotating screw.

.8 Provide the screening equipment designed to produce dewatered screenings capable of passing the EPA Paint Filter Test as described in method 9095 of EPA Publication SW 486.

.9 To minimize odors and nuisance, provide the conveyance, dewatering and compaction zones completely enclosed.

.10 Provide the control system designed such that the operating characteristics of the screen can be changed by the programmable controller.

2.5 Screw Press Construction

.1 Provide all components arranged so that they can be serviced from the operating floor.

.2 Multiple units to have interchangeable parts.

.3 Provide all components balanced so that jamming at any point will not result in structural failure, but will cause the drive motor to stall.

.4 Provide all components, including the gear reducer designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.

.5 Screen:

- .1 The inlet sludge flow is fed to the unit by pumping.
- .2 Sludge containing coarse solids enters the screen inlet to the inside of the straining section. The sludge will pass through the screen and exit through the outlet while coarse material is retained inside the screening area.
- .3 Provide all structural and functional parts sized for the loads encountered during screening, conveying and pressing operations.
- .4 Provide the screen divided into two sections; a screening section and a pressing section.
  - .1 Provide the screening zone equipped with flanged inlet and outlet connections.
    - .1 Flanges: Slip-On type with a welded face ring.
    - .2 ANSI type bolt pattern and be manufactured equivalent to Class 150 ANSI/ASME B16.5 rated flanges (PN10).
- .5 Provide the screening and compaction zones in two sections with a flanged connection for opening allowing easy access to the internal components of the sludge screen.
  - .1 Provide the screen section mounted on fixed stainless steel supports with feet permanently attaching to the finished floor.
  - .2 Provide the compaction section supported on four (4) adjustable castors for movement during maintenance and inspection.
    - .1 Provide a restriction plate to separate the two sections restricting screened sludge flow into the pressing zone area but allowing filtrate from the compaction zone to drain into the screen area to the screen outlet.

.6 Provide the screen basket of a conical shape.

.1 Provide perforated openings around the entire basket circumference, size as specified herein.

.2 Bars or wedge wire are not acceptable.

.7 Provide the compaction zone basket of a cylindrical shape.

.1 Provide perforated openings around the entire basket circumference, size as specified herein.

.2 Bars or wedge wire are not acceptable.

.8 Provide the sludge screen designed and built to withstand static and hydraulic forces exerted by the liquid to the screen.

.1 Provide all structural and functional parts sized for the loads encountered during the screening, conveying and pressing operations.

.2 All submerged components and all components of the rotary screen in contact with the screened solids of stainless steel construction.

.6 Conveyor and Press Screw:

.1 Provide a shafted auger screw that is entirely made of stainless steel to transport and dewater the screened material.

.1 Provide screw flights of decreasing width approaching the compaction zone matching the decreasing width of the screening section basket.

.2 In the compaction section of the screen, provide the shafted auger with flights with a continuous width to match the conical compaction zone basket.

.3 Shaft-less screws are not acceptable.

.2 Provide a compaction zone as an integral part of the screenings screw conveyor and transport tube design.

.1 Provide the compaction zone designed to form a screenings plug of material and to return water released from the screened material back to the system as indicated through circular holes that are machined into the screenings compaction basket.

.3 Provide the auger shaft fitted with the screen end and discharge end solid stub shafts.

.1 Provide the stubs and screw shaft machined and shrink-fitted.

.4 Provide the screen end of the screenings conveyor supported by the screen gearbox.

.1 Where the shaft protrudes through the screen section enclosure, seal the shaft with the housing with dual lip seals.

.2 Provide the lip seals lubricated with a battery operated automatic lubricator.

.3 Provide the system designed so that the gear box bearing does not take any thrust load from the screw conveyor.

.5 Provide the discharge end of the conveyor screw supported by a self-aligning roller bearing and incorporating two screw adjustment/locking nuts used to maintain positive contact between the screw and conical screening basket.

.7 Compaction and Discharge Zone:

.1 Provide a compaction zone as an integral part of the screw conveyor and tube.

.2 Provide the compaction zone designed to form a plug of screenings material and to return water released from the screened material to the outlet through perforations with a diameter as specified herein.

.3 Provide the discharge section provided with an adjustable pneumatic solids retention cone of high strength plastic (Polyamide PA 6 G) and pneumatic cylinders to maintain a positive pressure against the screenings plug.

.4 Provide the retention cone to maintain a positive pressure against the screenings plug by two (2) automatically adjusting pneumatic cylinders.

2.6 Materials

.1 Provide the entire screen manufactured from Type 316L stainless steel shapes (rods, angles, and channels), pipes, and sheets, unless otherwise specified herein.

.1 Hardware: Type 316 stainless steel.

.2 Provide all mechanical parts designed to handle the forces that are exerted on the unit during fabrication, shipping, erection, and operation according to the Manufacturer's O&M Information.

.3 Provide all equipment manufactured of stainless steel manufactured in a stainless steel only factory to prevent contamination of the stainless steel with foreign contaminants.

.4 After fabrication passivate (pickling) the equipment to ensure maximum resistance to corrosion.

.1 Provide all stainless steel components and structures submerged in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacturing, or handling.

.2 After removal from the pickling bath, wash the equipment with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel.

.3 Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are not acceptable due to their inability to provide complete and uniform corrosion protection.

2.7 Control Panel

.1 Provide a separate control panel for each screen containing all operating and adjustment controls including the main disconnect device, motor circuit protectors and full-voltage starters, 600/120-volt control transformer, indicating lights PLC and Panel mounted HMI.

.2 Voltage source: 600V, 3-phase, 60 Hz.

.3 Control panel shall be CSA or cUL certified.

.4 Controls designed to permit automatic start-up and shut-down, and unattended operation in Local and Remote mode through plant PCS.

.5 Provide Modbus communication for interface with plant PCS.

.6 Control Panels:

.1 Provide a separate control panel for each screen with all controls necessary for the fully automatic operation of the screen, including the main control panel and a local control station in accordance with Section 01450.

.2 Provide the electrical control system for automatic control of the screen by means of pre-set pressure levels using pressure transducers mounted in the screen inlet and outlet sections.

.1 Monitor a differential pressure level across the screen section using the two (2) inlet and outlet section mounted pressure transducers.

.3 Provide the main control panel for wall-mounting.

.4 Enclosure: NEMA 4X Type 316L Stainless Steel with lockable door latch including the following:

.1 Door-interlocked and fused disconnect.

.2 600 VAC terminal block.

.3 NEMA reversing motor starter and MCP type circuit breaker for screen motor.

.4 Panel heater with thermostat.

.5 Control power transformer with 120 VAC transient voltage surge compressor (TVSC) and fused primary and secondary.

.6 Schneider PLC modicon M580.

.7 Operator Interface HM, schneider electric.

.8 Pilot lights for:

.1 Control power on (white).

.2 Screen running forward and reverse (green).

.3 Screen high pressure (amber).

.4 Screen fault (red).

.9 E-stop push button (red).

.10 Screen reset push button (black).

.11 Analogue inputs for the following:

.1 Inlet pressure (4-20 mA).

.2 Outlet pressure (4-20 mA).

.12 Remote dry contact outputs for the following:

.1 Screen ready.

.2 Screen running.

.3 Screen fault.

.4 Screen E-stop.

.5 Screen high pressure level.

.6 One (1) spare output.

.13 Flashing alarm light and alarm horn with silencer-reset button.

.14 Modbus communication to Plant PCS.

.15 Plastic Nameplates.

.5 Provide a local operator station for wall-mounting.

.1 Enclosure: According to Section 01450 and shall include the following:

.1 Hand-Off-Auto selector switches for the following:

.1 Screen drive.

.2 Screen forward-off-reverse:

.1 Screen drive.

.3 E-stop pushbutton (red).

.6 Main power disconnect switch (pad-lockable).

.7 Control power transformer.

.8 Surge arrester.

.9 Sludge flow meter flow indication in (L/sec).

.10 Spare terminals (control- and power voltage) shall be provided to accommodate for remote control operation and to interface with other equipment components such as the sludge feed pumps and screenings conveyor.

.11 Control panels shall be factory wired and pre-tested.

.12 Screenings Conveying Equipment: Provide auxiliary contacts necessary to interlock screen shutdown with feed pump and conveyor shutdown.

2.8 Motors and Gear Reducers

.1 Provide in accordance with Division 16 and as specified and indicated.

.2 Horsepower rating of motors: Not less than the maximum brake horsepower requirements of equipment under any condition of operation specified and indicated without operating in the motor service factor.

.3 Motor enclosure and motor speed: As indicated in the Screw Press Equipment Schedule.

.4 In addition to the requirements for bearings specified under Electric Motors in Section 16223, provide motors with a ball or roller bearings. Provide vertical motors with at least one (1) bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

.5 Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on a flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine the overall sound-pressure level as an average of four or more readings at evenly spaced points, 1 m (3 feet) from motor.

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

.7 Service Factor: 1.15, with 1.0 inverter duty rating for equipment with variable frequency motor controllers.

.8 Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

.9 Rating: 600V, 3-phase, 60 Hz.

.10 Insulation: Class F with Class B temperature rise, 40°C ambient.

.11 Site Altitude: Less than 1000 m (3300 feet) above sea level.

.12 A gear box support flange with a minimum thickness of 0.7 inches shall be welded to the screen section end of the screenings transport tube for attachment of the drive assembly.

.13 Provide the basket mechanism and transport screw driven by a shaft mounted geared motor with a minimum service factor of 1.50.

2.9 Gauges

.1 Provide gauges assemblies for sludge inlet and outlet and as indicated.

.2 Gauges: Scale: 0 to 7 kg/cm^2 (0 to 100 psi).

2.10 Outdoor Weather Protection

.1 Provide the screens with thermal insulation of mineral wool, riveted Type 316 stainless steel protective covers and a heat tracing system for outdoor weather protection to enclose the screenings transport tube, compaction and dewatering zone and all piping and valves.

.2 The outdoor weather protection system shall include (Class I, Division 2, Group D) self-regulating heat tracing, adjustable thermostat, insulation and a Type 316 stainless steel protective jacket.

.3 Provide the heat tracing system suitable for operation down to a minimum temperature of minus 25°C (minus 13°F) and powered from the main control panel.

2.11 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

  .1 One (1) replacement screw for the screening zone.

  .2 One (1) self-aligning roller bearing.

  .3 One (1) set of shaft seals.

  .4 Two (2) automatic greasing devices.

  .5 One (1) set of all O-rings, seals and gaskets that are considered wear parts.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Install units on a concrete pad and align them thereon.

.4 Polymer Selection:

  .1 For start-up, the screw press Manufacturer shall recommend and provide one (1) month supply of polymer-based upon similar applications.

.5 Test piping connections to prove the equipment nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with equipment nozzles. This must be performed and the piping acceptable prior to any field performance testing.

  .1 Samples will be collected at one-hour intervals during each test for the purpose of determining the following:

    .1 Feed residuals concentration.

    .2 Cake solids concentration.

    .3 Centrate solids concentration.

    .4 The laboratory analysis of the samples shall be performed by a competent laboratory, accepted by Design Builder, and in accordance with the applicable standard methods. Provide written analytical results.

  .2 Continuously monitor energy use and residuals feed rate during the test interval. The residuals feed rate together with the solids concentration tests shall be used to develop a complete solids balance. The calculation shall be used to verify the accuracy of the measured quantities. Test equipment used for power measurements to be calibrated before and after testing, with certified reports submitted to the designer.

  .3 Demonstrate removal of the screw press intervals with the equipment specified.

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 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.

1.3 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.

1.1 Submittals

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

.1 Manufacturer's descriptive literature for materials.

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 Non-potable water: Model SFD.

.2 Or approved equivalent.

.2 The Flow Techno:

.1 Non-potable water: The Flow, Model TFT/W03.

.2 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 the 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 the 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 the seal water pressure to the equipment Manufacturer's recommendations.

.4 Adjust seal water flow to the equipment Manufacturer's recommendations.

.5 Adjust the low-flow switch set point to the 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 the 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 the pump Manufacturer. Set seal water supply operating pressure within 20 percent to 80 percent of the gauge range.

.9 Cleaning mechanism: push-clean button or other appurtenance that allows the unit to be cleaned while equipment is running without triggering the 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 the 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 a 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 Five (5) rotameters of each size if different.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Provide dielectric connections between dissimilar metal piping, including copper to stainless steel.

.4 Mount seal water control units on a specified mounting stand at each pump or piece of equipment.

.5 Mount solenoid valve, strainer, and regulator at equipment.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of digester gas equipment which includes flame arresters, pressure/vacuum safety relief valves and safety selector valves.

1.2 Standards

.1 Canadian Standards Association (CSA):

  .1 ANSI/CSA-B149.6-15, Code for digester gas, landfill gas and biogas generation and utilization.

.2 Associated Factory Mutual Laboratories (FM).

.3 Underwriters Laboratories of Canada Inc (ULc).

1.3 Definitions

.1 Sludge Gas Flow Rate: Standard cubic metres per hour (Sm^3/h) at 15 °C and 101.3 kPaA.

.2 kPaA: Absolute pressure in kilopascals.

.3 kPa: Gauge pressure in kilopascals.

.4 WC: Pressure in height of water column.

1.4 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 Varec.

  .2 Groth

  .3 Or approved equivalent.

2.2 Performance Criteria

.1 Digester gas is expected to be comprised of 55% - 65% methane by volume, with carbon dioxide and the remainder comprised primarily of hydrogen sulphide at, fine particulates and other trace gases.

.2 The digester gas is at a temperature of 35 - 40 °C and saturated with water vapour and is expected also to contain fine particulate matter, grease, and oils.

.3 The operating pressure for the digester gas system is set at 450 mm WC.

.4 Capacity listed is based on the design standard equipment at 15 °C and 101.5 kPaA.

.5 Pressure / vacuum relief valves have the following parameters:

Pressure Relief Valve Parameters	
Description	**Capacity**
Temperature of Relief Vapor	37 °C
Pressure Setting (digester gas system pressure)	450 mm WC
Relief Pressure	475 mm WC (450 mm WC + 25 mm WC)

Vacuum Relief Valve Parameters	
Description	**Capacity**
Atmospheric Temperature (range max/min)	30°C -10°C
Vacuum Setting	50 mm WC

2.3 Function

.1 Minimum of two (2) pressure /vacuum safety relief valves, two (2) flame arresters and one (1) three-way selector valve for each digester shall be connected to the digester gas piping. The outlets of the two pressure/vacuum relief valves shall each have a pipe stack for venting to height. The Design Builder shall provide and install the relief pipe stacks, height of 5 m in accordance with requirements of ANSI/CSA B149.6-15.

.2 Flame arresters stop the propagation of a flame by absorbing and dissipating heat through the surface area of the multiplate bank assembly.

.3 Pressure/vacuum safety relief valves vent digester gas from the system to atmosphere to relieve excess pressure from the gasholder; conversely when a vacuum develops in the gasholder which exceeds the vacuum setting, the valve opens allowing air into the gasholder, relieving the vacuum condition.

.4 The pressure/vacuum safety relief valve assembly is configured with two (2) pressure/vacuum safety relief valves and two (2) flame arresters and one three-way safety selector valve for each digester in accordance with CSA Group ANSI/CSA B149.6-15 requirements. The safety selector valve is a diverter valve that allows operation of one pressure/vacuum safety relief valve while the other is out of service.

.5 The pressure/vacuum safety relief valve assembly is connected to the digester gas system and to each vent pipe. Design Builder shall be responsible for the supply and installation of the piping and valving connection from the pressure/vacuum safety relief valve assembly to the digester gas system and to the vent pipes to a height as indicated on the Drawings.

2.4 Configuration, Components and Features

.1 Flame Arrester (FA):

.1 Vertical type with Class 125 ANSI flanged connections; housing construction cast aluminium; size 200 mm diameter.

.2 Aluminum bank assembly arranged for easy removal from the housing to facilitate cleaning and inspection.

.3 Required net free area through the bank assembly shall not be less than four times the corresponding pipe cross sectional area.

.4 Multiplate bank assembly are individually stamped rectangular-shaped sheets and arranged for individual removal.

.2 Pressure/Vacuum (P/V) Safety Relief Valve:

.1 Cast aluminium body, seat rings, pallets and pipe-away connection; size 200 mm diameter.

.2 Protective wire mesh screens at the intake and exhaust ports, and located external to the pallets.

.3 Seat rings and pallets anodized and removable and all weather teflon.

.4 Pressure and vacuum pallets the same diameter, and the effective diameter not to exceed the port diameter by more than 14 percent.

.5 Pallets centre and side guided and incorporate replaceable all weather teflon seat inserts.

.6 Pressure pallets include removable lead or aluminium weights for adjusting the setting over not less than a 100 mm range in 12.5 mm increments.

.3 Safety Selector (SS) Valve:

.1 Rotary style cast aluminum body; Type 316 stainless steel rotor, indicator and seat; and connection size 200 mm diameter.

.2 Standard accessories to include bleed valves on process connections, a visible position indicator and a padlocking device.

.4 Weather Enclosure:

.1 Design Builder to supply and install insulated weather enclosure to house the FA, P/V safety relief valve and SS valve assembly. The enclosure shall be ventilated and shall provide suitable access for servicing of the pressure/vacuum valve assembly as indicated on the Drawings and in accordance with CSA Group ANSI/CSA B149.6-15.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) flame arrester internals including gaskets for each size.

.2 Two (2) P/V safety relief valve internals for each size.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

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 the removal of moisture and sediment from saturated digester gas, complete with sight glass, removable screen, and appurtenances.

1.2 Standards

.1 Canadian Standards Association (CSA):

.1 ANSI/CSA-B149.6-15, Code for digester gas, landfill gas and biogas generation and utilization

.2 Associated Factory Mutual Laboratories.

.3 Underwriters Laboratories of Canada Inc.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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 for sediment and condensate traps:

.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 Design sediment and condensate traps to remove liquid and solids from moisture-laden digester gas and to protect downstream equipment.

.5 Design sediment and condensate traps to produce not more than a 10 mm water column pressure drop at the temperature of 15°C and pressure of 101.3 kPaA.

.6 Design sediment and condensate traps suitable for continuous exposure to digester gas.

.7 Identify sediment and condensate traps by the equipment number.

2.3 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.

2.4 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 the 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 a concrete pad.
- .4 50 mm diameter blowdown connection.
- .5 Two (2) 50 mm diameter drip tanks 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 a drain cock on the lower valve for draining the glass tube.

.3 Provide 12 mm diameter purge isolation valves complete with a threaded plug at all purge nozzles.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing and commissioning of a digester gas conditioning system.

.2 Meet the gas quality requirements of the thermal hydrolysis boiler system and HVAC boiler system.

.3 Ensure the digester gas conditioning system is compatible with all other parts of the Facility, and that all piping, materials, electrical and control equipment, and all other devices necessary for a fully functional system are provided.

.4 Provide nitrogen purge access ports on the full digester gas conditioning system so that individual components of the conditioning system can be purged with nitrogen prior to maintenance activities.

1.2 Standards

.1 Canadian Standards Association (CSA):

- .1 ANSI/CSA-B149.6-15, Code for Digester Gas, Landfill Gas and Biogas Generation and Utilization.

.2 Associated Factory Mutual Laboratories.

.3 Underwriters Laboratories of Canada Inc.

1.3 Submittals

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

- .1 Manufacturer's descriptive literature for materials.
- .2 Details of insulation provided to prevent galvanic corrosion between mating surfaces constructed of dissimilar metals.
- .3 All supplementary information required for the design of structural supports for the digester gas conditioning system including all live (wetted) and dead loads, special reinforcing requirements, drainage passages, floor slopes.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

- .1 Unison Solutions, Inc.

.2 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Digester gas conditioning system inlet conditions:

.1 Digester gas Flow Rate Annual Average: 1,782 m^3/h.

.2 Digester gas Flow Rate Maximum Month: 2,539 m^3/h.

.3 Digester gas Flow Rate Peak Design Flow (Safety factor of 1.2): 3,047 m^3/h.

.4 Temperature: 27°C minimum, 38°C maximum.

.5 Pressure: 2 kPa minimum, 2.5 kPa maximum.

.6 Water Saturation: 100 percent.

.7 H_2S input maximum: 500 ppmv.

.8 Methane: 55 - 60 percent.

.2 Required treated digester gas conditions:

.1 Pressure: 34 kPa.

.2 Temperate: 27°C.

.3 Dew Point Temperature: below 0°C.

.4 Hydrogen Sulphide: 10 ppmv.

.5 Particulate Removal: 99 percent >3 micron.

.3 Number of digester gas conditioning system trains (minimum): 4.

.4 Number of duty digester gas conditioning trains (minimum): 3.

.5 Minimum number of standby digester gas conditioning trains (minimum): 1.

.6 A digester gas conditioning system consists of:

.1 First stage treatment:

.1 H_2S removal.

.2 Second stage treatment:

.1 Moisture and particulate filtration.

.2 Compression, chilling, and re-heating (moisture and condensate removal).

.7 First stage treatment removal efficiency requirements:

.1 H_2S removal: minimum of 90 percent of inlet conditions and removal to 10 ppmv, whichever is lower.

.8 Second stage treatment removal efficiency requirements:

.1 Moisture removal: minimum of 80 percent of inlet conditions.

.2 Particulate removal: minimum of 99 percent >3 micron of inlet conditions.

.3 As required by the thermal hydrolysis boiler system and HVAC boiler system manufacturers.

.9 Digester gas conditioning system general requirements:

.1 All equipment supplied to be suitable for continuous operation in a corrosive environment in a wastewater treatment facility.

.2 All equipment including tanks, media, all internals, required water supply piping internal to chamber, pumps, control valves, instrumentation, control systems and panels, and all ancillary equipment to be supplied as a complete package.

.3 The digester gas conditioning system to be designed to operate twenty-four (24) hours per day, seven (7) days per week.

.4 Minimum actual media bed life for each stage of treatment to be as follows:

.1 First stage treatment: minimum one (1) year.

.5 For media systems, provide access manways with bolted and hinged covers sufficient to enable replacement of media without the need for special equipment, ladders, or hoisting devices. If manway is above 1.5 m from operating level, provide ladder, safety cage, and platform with railing.

.6 For all accessories including ASME safety pressure/vacuum relief valves, provide pressure gauges, flanged piping connections, drains, vents, and isolation valves.

2.3 Materials

.1 Type 316L stainless steel for all metal components. Passivate all stainless after fabrication.

.2 Elastomer gaskets to be Buna-N or equivalent material for wet digester gas.

2.4 Digester Gas Compression, Chilling and Re-Heating Systems

.1 The digester gas compression and chilling system to consist of inlet moisture and particulate filter, gas blower, heat exchangers, glycol chiller, programmable logic controller (PLC) controls package, and all auxiliary equipment.

.2 Provide a digester gas chilling system to maintain a discharge digester gas temperature of no greater than 4°C.

.3 Provide a digester gas re-heating system to re-heat the digester gas following the digester gas chilling system consisting of a re-heat heat exchanger and all auxiliary equipment.

.4 The digester gas to be re-heated through the digester gas re-heating system to achieve a relative humidity leaving the reheat heat exchanger of less than 25 percent and meet the minimum manufacture moisture requirements of the thermal hydrolysis boiler system and HVAC boiler system.

.5 Coordinate the requirements for moisture and condensate removal with other systems and components to be supplied within the overall digester gas collection, piping and storage system as required to meet minimum moisture content for proper function of the H_2S removal system, as well as to meet the moisture requirements to protect the Thermal hydrolysis boiler system and the HVAC boiler system.

.6 Heat exchangers to be provided in accordance with Section 15630.

2.5 Equipment and System Controls

.1 Integrate all controls with automation system.

.2 Instrumentation and controls to be provided to ensure proper operation of the digester gas conditioning system.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

  .1 Carry out testing on digester gas to confirm H_2S and moisture removal requirements of this Section are met.

END OF SECTION

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.

1.2 Definitions

.1 The terminology used in this Section conforms to the following definitions:

.1 Continuous operation: 24-hour-per-day operation for the design life of not less than 20 years, or 175,200 hours.

.2 Intermittent operation: Operation including starts and stops, with extended periods when not in use.

.3 Standard cubic metre per minute (SCMM): the volumetric flow rate in cubic meters per minute at standard conditions. Standard conditions are defined as 20°C, 101.3 kPa, and 36 percent relative humidity.

1.3 Submittals

.1 Provide submittals in accordance with Sections 01300 and 11000 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.

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 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.

2.3 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.

2.4 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 the compressor and driver. Provide a relief valve suitable for connection to a discharge pipe to relieve the 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. The discharge gauge shall have a range of 0 to 150 kPa. The 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 an 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Test piping connections to prove the compressor nozzles are installed with the pipe in a free supported state and without the need to apply vertical or horizontal pressure to align piping with compressor nozzles.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply and installation of a membrane gasholder for digester digester gas, complete with outer air membrane, inner digester gas membrane, inflation fans, level sensor, digester gas detection system, digester gas pressure relief valves and selector valve, air pressure regulating valve, condensate accumulator and all other appurtenances for a complete system.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A36 - Carbon Structural Steel.

.2 American Welding Society (AWS) - Structural Welding Code, AWS D1.1.

.3 Canadian Standards Association (CSA):

- .1 CSA B.149.6 - Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization.

1.3 Submittals

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

- .1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Membrane Gasholder and Air Pressure Regulating Valve:

- .1 Acceptable Manufacturers:
  - .1 WesTech.
  - .2 JDV Equipment Corp.
  - .3 Ovivo.
  - .4 Or approved equivalent.

.2 Provide all valves of the same type, size range and service from a single Manufacturer (i.e. all pressure relief valves from a single Manufacturer).

.1 Acceptable Manufacturers:

.1 Groth.

.2 Varec.

.3 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Digester gas membrane gasholder to consist of two (2) membranes. Inner membrane to store digester gas and may inflate and deflate as the digester gas supply varies. The inner membrane shall be connected to the outer membrane at its equator to form a concentric uniform shape of the inner membrane at all stages of inflation and deflation. The outer membrane shall be constantly inflated at the required pressure by duty and standby air fans, which maintain stored digester gas in the inner membrane at a constant pressure.

.2 Provide one (1) digester gas dual membrane gasholder with the specific design criteria presented:

.1 Volume: 1,800 m^3.

.2 Location: Outdoors.

.3 Area exposure designation: See Section 01450.

.4 Operating Pressure: 2.5 kPa.

.3 Materials: Fabric shall be specifically suited for the application and able to withstand all design loads including pressure, wind, seismic, snow, live and dead loads. The inner digester gas membrane fabric shall be absolutely impervious to digester gas. The outer air membrane fabric shall contain pressurized air but need not be absolutely impervious. All steel to conform to ASTM A36. All pipes shall be ASTM A53, grade B. All stainless steel shall be Type 304. All aluminum shall be Type 5052, 6061, or 6063 alloy unless noted otherwise.

.4 All membrane welds and seams shall be tested mechanically through the use of pressure and tension to prove weld and seam strength and integrity.

.5 Steel fabrication and welding shall be in accordance with the latest edition of the Structural Welding Code, AWS D1.1, of the AWS. All welded connections shall develop the full strength of the connected elements and all joined or lapped surfaces shall be completely seal welded with a minimum 5 mm fillet weld. Non-continuous welds will not be permitted.

.6 Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to eliminate sharp edges that may damage either the inner or outer membranes and to promote coating adherence.

.7 All fans, motors, instruments and controls shall be provided with Manufacturer’s standard paint system. No coatings are required for the outer or inner membrane stainless steel hold-down hardware.

2.3 Materials

.1 Digester gas inner membrane: The digester gas inner membrane shall be PVC-coated polyester sized to accommodate the required volume of digester gas. The membrane fabric and completed membrane shall be resistant and completely impervious to digester gas.

.2 Air outer membrane: The air outer membrane shall be a PVC-coated polyester fabric specially designed for use on air-supported structures and high-stress applications. The fabric shall be resistant to abrasion, weathering, and UV degradation in an outdoor environment.

.3 The fabrics shall resist all design loadings without the use of support cables.

.4 The air outer and digester gas inner membranes shall have independent anchorage and seal arrangements.

2.4 Configuration, Components and Features

.1 Fans:

  .1 Two (2) air fans shall be used; one duty and one standby. Fans shall meet the AMCA Class B spark-resistant construction.

  .2 Fan motors shall be premium efficiency and suitable for operation in the area exposure designated as per Section 01450.

  .3 Fan motors shall be CSA or cUL certified.

  .4 Flexible connectors shall be provided to connect fans to air inlet piping.

.2 Pressure regulation and relief:

  .1 Supply and install one air pressure regulating valve to maintain the air pressure within the outer membrane.

  .2 Supply and install two pressure relief valves, flame arrestors, and three-way isolation valves on the digester gas piping. All pressure relief valves, flame arrestors, and three-way isolation valves shall have flanged connections and the same diameter.

  .3 The flame arrestor shall be aluminum.

  .4 Three-way selector valve shall be constructed of aluminum with Type 316 stainless steel and Teflon internals.

  .5 Supply and install one (1) condensate accumulator as specified in Section 11464.

.3 Level transmitter:

  .1 Supply and mount the transducer, complete with cable, on the outside of the air outer membrane. Provide one transmitter, panel or wall mounted, for installation in the overall gasholder control panel. The ultrasonic transducer cable shall be minimum 50 m long so that there is no need for junction boxes between the transmitter and transducer.

.2 Certification: CSA or cUL

.3 Provide Siemens level transmitter per Appendix 18E - City of Winnipeg Standardized Good.

.4 Digester gas detection system:

.1 One (1) digester gas detection control unit, with lockable door, complete with common LOW, HIGH and FAULT relays rated at 5 A at 240 VAC and dedicated drives for alarms. Each channel to have LOW and HIGH alarm DPCO relays and 1 - 5 V or 4-20 mA user-selectable analogue outputs. Provide digital displays for level, channel number and units pointer for ppm, percent LEL and percent volume as well as a standby 0.8 Ah battery with additional terminals for an external battery of larger capacity. Power supply 120 VAC, 60 Hz. Alarms set at 20 percent and 4 percent LEL, calibrated to detect methane gas.

.2 One flammable remote digester gas detector using a poison-resistant pellistor sensor mounted in a stainless steel flameproof housing, complete with Ex(e) polyester junction box.

.3 Digester gas detector shall be calibrated to detect methane in the range 0 to 100 percent LEL.

.4 Certification: CSA or cUL

.5 Provide gas detection instrument per Appendix 18E - City of Winnipeg Standardized Good.

.5 Pressure switch:

.1 Provide explosion-proof pressure switch to detect discharge low pressure and alarm fans. Switch to have a SPDT 120 VAC rated contact suitable for the area exposure designation in Section 01450.

.2 Certification: CSA or cUL

.6 Anchor bolts and fasteners:

.1 All anchor bolts shall be chemical adhesive type anchors with a minimum diameter of 9 mm and shall be made of Type 304 stainless steel.

.2 All structural and flange fasteners shall be a minimum of 9 mm in diameter and made of Type 304 stainless steel.

.7 Manway:

.1 Provide manways for access to the space between the air outer and digester gas inner membranes and into the digester gas inner membrane gasholder. Manways shall be incorporated into the design of the fabric structures. The digester gas inner membrane gasholder access must be capable of gastight sealing after usage.

2.5 Equipment and System Controls

.1 Provide electrical and control system for automatic and manual control of the air supply fans for the digester gas membrane gasholder as a complete system fully assembled, wired, pre-programmed and tested.

.2 The air fans shall be operated in one of two modes, local or remote, as selected at the associated local control panel door with an installed HOA switch. In the local mode the associated fan shall be controlled locally by an operator and in the remote shall be controlled by the LCP supplied by the Manufacturer.

.3 Provide equipment with an emergency stop device (ESD) complete with reset push buttons. Provide one ESD pushbutton for both fans. The ESD for the fans shall be interlocked and shall stop both pieces of equipment. ESD shall be hardwired to the motor starters and mounted at the control panel door.

.4 Provide membrane gasholder equipment with one (1) LCP completely pre-wired with tags and tested, requiring only mounting and connection to external wiring in the field. Include in the LCP all equipment required to control the fans as specified herein. Provide NEMA 4X rated LCP enclosures, Type 316 stainless steel, wall mounted and CSA certified located close to the membrane gasholder but not in the hazardous location around the membrane gasholder with outdoor temperature rating -40 to +40 C°.

.5 The LCP is to house motor starters, overloads, and circuit breakers complete with door-mounted lockable handles and operating mechanisms, door-mounted overload fault reset push buttons, run (green) and fault (red) indication lights. The indication lights shall be LED push-to-test type.

.6 Provide an HMI in accordance with Section 17831 complete with an Ethernet port, touchscreen and power supply. Install at LCP panel door. The final version of the HMI application files shall be provided to the City.

.7 Provide a PLC in accordance with Section 17831 with one 4-20 mA analog input card and install in the local control panel.

.8 Control wire is to conform to CSA or cUL standards 600 VAC rated and shall be type THW or MTW.

.9 Provide surge protection module control instruments.

.10 Provide an industrial grade, compact 24 VDC power supply to rated components including Modbus TCP interface to plant PCS.

.11 Provide a wall-mount fiber patch panel complete with all required accessories and install in the local control panel. Provide Modbus TCP interface.

.12 Provide Schnieder Electric PLC and HMI per City of Winnipeg Standardized good agreement RFP.

.13 Provide communication datamap for the connection to the automation system to include but not limited to:

Signal Description	From	To
For each fan provide:		
Field Status (Local/Remote)	PLC	automation system
Run Status	PLC	automation system
Ready Status	PLC	automation system
Fault Alarm	PLC	automation system
Fans Discharge Pressure – Low-Pressure Alarm	PLC	automation system
Gas LEL Level indication (0-100)	PLC	automation system
Gasholder High LEL Alarm	PLC	automation system
Gasholder High-High LEL Alarm	PLC	automation system
Gasholder Level Indication	PLC	automation system
Gasholder Volume Indication	PLC	automation system
Gasholder High Level Alarm	PLC	automation system
Gasholder High-High Level Alarm	PLC	automation system
Gasholder Low Level Alarm	PLC	automation system
Gasholder Low-Low Level Alarm	PLC	automation system
Level Transmitter Fault	PLC	automation system
E-Stop Activated	PLC	automation system
PLC Heartbeat	PLC	automation system
Fan 1 – Lead (Alternator)	PLC	automation system
Fan 2 – Lead (Alternator)	PLC	automation system
Advance Alternator	PCS	automation system
No fan is available	PLC	automation system

2.6 Finishes

.1 Metals, excluding stainless steel, used for the fabrication of equipment shall be provided with protective coatings suitable for indoor service and exposure to H_2S.

.2 Shop prime and paint metals in accordance with the Manufacturer’s written recommendations.

.3 Prime coat: shop applied, coating material in accordance with Section 09905.

.4 Finish coat: field applied, coating material in accordance with Section 09905.

2.7 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

WASTE GAS BURNER

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, and testing of open and enclosed low-pressure waste gas burners complete with a control panel and appurtenances. The waste gas burner shall be designed for burning biogas generated from the anaerobic digestion of thickened primary sludge and TWAS.

1.2 Standards

.1 American Society for Testing and Materials (ASTM):

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

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

.2 Canadian Standards Association (CSA):

.1 CSA B.149.6 - Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization.

.3 American Welding Society (AWS):

.1 AWS D1.1- Structural Welding Code.

1.3 Submittals

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

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply products for a waste gas burner package from a single supplier.

.2 Two (2) enclosed and one (1) open waste gas burners serve to flare excess digester gas. The open burner operates as a standby unit when the peak safety gas flow must be flared.

.3 Acceptable Manufacturers:

.1 Varec.

.2 Groth.

.3 Or approved equivalent.

2.2 Performance Criteria

.1 Enclosed type waste gas burner to consist of the enclosed burner, designed to have no visible flame, with the automatic pilot ignition system, inlet manifold, flame arresters, thermal shut-off valves and control panel.

.2 Open type waste gas burner designed to have a true stoichiometric, non-smoking flame, and to consist of burner base, anti-clog orifice burners, retention and venturi nozzles, burner wind shield and thermocouples. High-tension leads and sparking devices shall be located a safe distance from the flame.

.3 Enclosed and open type waste gas burner to provide a removal efficiency of methane in excess of 99 percent and low NO_x and CO emissions.

.4 Equipment shall be suitable for continuous and intermittent duty under all weather conditions for burning excess digester waste biogas that is produced by anaerobic digesters.

.5 Waste gas burner design criteria:

 .1 Minimum capacity per burner for the enclosed type: 1,900 m^3/h @ 15 °C/ 101.3 kPaA.

 .2 Minimum capacity per burner for the open type: 2,031 m^3/h @ 15 °C/ 101.3 kPaA.

 .3 Location: outdoors.

 .4 Outdoor temperature rating 40 to -40C°.

 .5 Area exposure designation: see Section 01450.

.6 Relative humidity expected range of 40 to 100 percent.

.7 The characteristics of the waste biogas are:

 .1 Methane content: 55-65 percent.

.8 Materials: Burner shall be specifically suited for the application and able to withstand all design loads including pressure, wind, seismic, snow, live and dead loads. All steel to conform to ASTM A36. All pipe shall be ASTM A53, grade B. All stainless steel shall be either Type 304 or 316.

2.3 Materials

.1 Combustion stack, burner base and pedestal: Type 304 stainless steel.

.2 Burner inlet manifold: Type 304 stainless steel.

.3 Pilot gas piping: Type 316 stainless steel.

.4 Thermocouples: Type 316 stainless steel.

2.4 Configuration, Components and Features

.1 Supply enclosed and open type waste biogas burner packages with the specific design criteria listed.

.2 Natural gas for pilot light operation supplied at a minimum pressure of approximately 35 kPa. Equip pilot natural gas supply line with a valve and regulator mounted below the system controls.

.3 Supply and install all natural gas piping between the control system and waste gas burner.

.4 The pilot ignition system to include an electronics package that controls pilot gas supply, ignition and monitoring. Provide an explosion-proof solenoid valve to fail close during system power failures to prevent the release of natural gas.

.5 Equip the waste gas burner control panel enclosure with a heater and thermostat for outdoor installation.

.6 Steel fabrication and welding shall be in accordance with the latest edition of the Structural Welding Code, AWS D1.1, of the AWS. All welded connections to develop the full strength of the connected elements and all joined or lapped surfaces shall be completely seal-welded with a minimum 5 mm fillet weld. Non-continuous welds are not permitted.

.7 Anchor bolts and fasteners:

  .1 Provide supports and anchor bolts suitable for the design conditions listed. All anchor bolts shall be chemical adhesive-type anchors and made of Type 304 stainless steel.

  .2 All structural and flange fasteners shall be suitable for the conditions listed and made of Type 304 stainless steel. The Manufacturer shall provide all fasteners required for the assembly and installation of the equipment.

2.5 Equipment and System Controls

.1 Provide electrical and control system for automatic and manual control of the waste gas burners as a complete system fully assembled, wired, pre-programmed and tested.

.2 The waste gas burners shall operate in two modes, local or remote, as selected at the associated local control panel door with an installed HOA switch. In the local mode the associated burner is controlled locally by an operator and in the remote mode the associated burner to be controlled by the PLC supplied by the Manufacturer.

.3 Provide each waster gas burner package with a control panel completely pre-wired with tags and tested, requiring only mounting and connection to external wiring in the field. Include in the control panel all equipment required to control the burners as specified herein. Provide the following:

  .1 Equipment and control devices of corrosion-resistant construction.

  .2 Pedestal-mounted NEMA 4X panel, Type 316 stainless steel.

.3 Provide rated dry contacts for remote monitoring of pilot on-off status and pilot flame failure alarms. Install close to of the burner, but outside of the hazardous classification zone.

.4 Provide solid-state timers and relays as required.

.5 Provide selector switches and pilot lights as required.

.6 Equip the waste gas burner control system with a 120 VAC/1 phase/60 Hz, electric heater and thermostat for use when the ambient temperature drops to the minimum temperature set by the Manufacturer.

.7 Provide remote start-stop signal input and remote status pressure switch.

.4 The control panel shall be complete with door-mounted lockable handles and operating mechanisms, door-mounted overload fault reset push buttons, run (green) and fault (red) indication lights. The indication lights shall be LED push-to-test type.

.5 Provide flame-monitoring thermocouple complete with set point adjustments, pilot lights and alarm relay.

.6 Install at control panel door.

.7 Provide an Ethernet switch complete with power service in the control panel to interface with automation system.

.8 Provide surge protection module to protect PLC and control instruments.

.9 Provide ground fault duplex receptacle for instrument use only.

.10 Provide surge protection module to protect PLC and control instruments.

.11 Provide an industrial grade, compact 24 VDC power supply to rated components including Modbus TCP interface.

.12 Provide a wall mountable fiber patch panel, if required, complete with all required accessories and install in the local control panel.

.13 Provide CSA or cUL certified control panel and associated instrument.

.14 Provide Schneider Electric PLC and HMI per City of Winnipeg Standardized good agreement RFP.

.15 For each burner provide communication datamap for the connection to the automation system to include but not limited to:

Signal Description	**From**	**To**
Field Status (Local/Remote)	PLC	automation system
Run Status	PLC	automation system
Ready Status	PLC	automation system
Fault Alarm	PLC	automation system

Signal Description	From	To
PLC Heartbeat	PLC	automation system
Burner 1 – Lead (Alternator)	PLC	automation system
Burner 2 – Lead (Alternator)	PLC	automation system
Advance Alternator	PCS	automation system
No burner is available	PLC	automation system
Burner Fault	PLC	automation system

2.6 Finishes

.1 Procedures in accordance with Section 09900.

.2 Finish metals with protective coatings suitable for outdoor service and exposure to H_2S. Stainless steel shall not be coated.

.3 Shop prime and paint metals in accordance with Manufacturer's written recommendations.

.4 Prime coat: shop-applied material in accordance with Section 09905.

.5 Finish coat: field-applied material in accordance with Section 09905.

2.7 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, installation, testing, and commissioning of water-to-sludge tube-in-tube, counter-flow, and horizontally-mounted heat exchangers to pre-heat boiler feed water from thermally hydrolyzed sludge. They are also used for heat energy transfer from a blend of circulating digested sludge from the digesters and diluted thermally hydrolyzed undigested mixed sludge feed.

1.2 Standards

.1 American National Standards Institute (ANSI):

  .1 ANSI B16.5 - Flanged Fittings.

.2 American Society of Mechanical Engineers (ASME):

  .1 ASME Section V - Non-Destructive Examination.

  .2 ASME Section VIII - Boiler and Pressure Vessel Code; Rules for Construction of Pressure Vessels.

  .3 ASME Section IX - Qualification Standard for Welding and Brazing Procedures, Welders, Blazers, and Welding and Brazing Operators.

.3 American Society for Testing and Materials (ASTM):

  .1 ASTM A182 - Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, Valves and Parts For High-Temperature Service.

  .2 ASTM A312 - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

  .3 ASTM A380 - Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

  .4 ASTM A967- Chemical Passivation Treatments for Stainless Steel Parts.

1.3 Submittals

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

  .1 Manufacturer's descriptive literature for materials.

  .2 Performance curves developed for specified operating conditions showing relationship between flow, pressure loss, and heat duty; also provide thermal, mechanical and hydraulic guarantees from the manufacturer for the best exchange being furnished.

.3 A Manufacturer's Data Report for Unfired Pressure Vessels, Form U-1, as required by the provisions of the ASME Code Rules, signed by a qualified inspector, holding a National Board commission, certifying that construction conforms to the latest revision of the ASME Code.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Alfa-Laval Group.

.2 DDI Heat Exchangers Inc.

.3 Claro.

.4 WesTech.

.5 Walker Process Equipment.

.6 Napier-Reid.

.7 Or approved equivalent.

2.2 Performance and Design Criteria

.1 The design of heat exchanger should comply with pressure and temperature requirements of the THP system.

.2 Tube-in-tube heat exchangers shall operate continuously to cool down the blend of circulating digested sludge and thermally hydrolyzed mixed sludge feed consisting of fermented primary and thickened waste activated sludge.

.3 Design heat exchange with appropriate materials to prevent corrosion of the units from both the cooling water and from the hydrolyzed sludge.

.4 Design in accordance with Section 01450.

.5 Design heat exchange for high efficiency.

.6 Heat exchanger shall be non-clogging under normal operation.

.7 Heat exchanger to have built in features that allow it to be flushed manually for cleaning and to remove blockages through the use of valving from the unit exterior.

2.3 Materials

.1 Sludge, potable water and flushing water piping: Type 316L stainless steel, ASTM A312.

.2 Heat exchanger: Select material that is corrosion-resistant to the fluids.

.3 Flanges: Type 316L stainless steel, ASTM A182.

.4 Insulation: a minimum of 50 mm fibreglass insulation, maximum k: 0.04 W/(m°C).

.5 Gaskets: Neoprene.

.6 Bolts and nuts: Type 304 stainless steel.

2.4 Configuration, Components and Features

.1 Heat exchangers shall not obstruct tube flow.

.2 The tube-in-tube heat exchanger shall withstand the full design pressure on one side of the concentric passages with no pressure in the other. All piping and return bends shall be considered pressure parts.

.3 The heat exchanger and piping shall be completely factory assembled.

.4 Provide air vents with ball valves on water tubes on all high points of modules.

.5 Provide 25 mm NPT drain coupling with plug on all low points of modules.

.6 The tubes shall be joined by neoprene-gasketed end castings designed to prevent leakage to the exterior of the heat exchanger.

.7 Provide the tubes supported by minimum 19 mm thick steel end plates with structural steel members serving as supports and framing for the exterior steel paneling.

.8 The sludge and water tubes shall be independently removable and arranged to prevent contamination of the heating water by material circulated through the sludge tubes.

.9 Sludge tube end castings shall be removable for tube inspection without having to drain the jacket water.

.10 All sludge passageways shall pass the size sphere as developed in the detailed design to prevent plugging of the heat exchanger.

.11 Provide two (2) - 20 mm NPT connections with capped couplings for each sludge and water inlet and outlet for temperature and pressure gauges.

.12 The entire sludge-water tube bundle shall be wrapped with a minimum of 50 mm of insulation.

.13 Passivation:

  .1 Passivate the inside and outside of all stainless steel pipes and stainless steel parts of the equipment.

  .2 Comply with ASTM A380 and ASTM A967.

2.5 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) set of all O-rings, seals and gaskets.

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

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION

DEWATERING CENTRIFUGE

1. GENERAL

1.1 Summary

.1 This Section specifies the supply, delivery, installation support, testing, and commissioning of horizontal, solid-bowl, continuous-feed, scroll-type, high-solids centrifuge, complete with electric motors, controls and LCP, auxiliary equipment, and accessories as specified herein.

.2 Provide a dewatering system complete with:

.1 Centrifuge machine.

.2 Main drive.

.3 Back drive.

.4 Vibration isolation and seismic restraint systems.

.5 Diverter gates for sludge cake and centrate.

.6 Sludge cake and centrate sampling ports.

.7 Flexible pipe connection at sludge inlet and dewatered sludge outlet.

.8 Oil lubrication unit.

.9 Washwater solenoid valve.

.10 LCPs complete with but not limited to VFDs, Disconnect Switches, Line and Load Reactors, Controller, Ethernet Switches, 24 VDC power supplies, and HMI's.

.11 All other components and ancillary devices required for a complete and operable installation.

1.2 Submittals

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

.1 Vibration and critical speed analysis in accordance with Section 11020.

.2 Anticipated polymer consumption rate.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Supply all products from a single Manufacturer.

.2 Acceptable Manufacturers:

.1 Andritz.

.2 Alfa-Laval.

.3 Westfalia.

.4 Or approved equivalent.

2.2 Performance Criteria

.1 The dewatering centrifuge to be designed for both intermediate dewatering prior to the THPS and for final dewatering prior to disposal.

.2 Sludge dewatering prior to the THPS shall be to 17 percent solids as an average with a maximum range of 16 to 18 percent solids.

.3 Final dewatering shall be to 30 percent solids with a range of 28 to 32 percent.

.4 Centrifuges shall be designed for non-clogging operation with an automatic cleaning process on an adjustable basis.

.5 Centrifuges to be designed for consistent operation and production of solids at a uniform concentration.

.6 Intermediate dewatering centrifuge design criteria:

.1 Design for minimum input of 150,000 kg/day dry solids at maximum month flow.

.2 Minimum bowl diameter of 670 mm.

.3 Bowl shall be designed to operate at minimum of 3,000 G’s.

.4 Solids Recovery: 96%.

.5 Dewatered solids: 15 to 18% with design of 17% solids.

.6 Same base dewatering unit as Final Dewatering.

.7 Design for 24/7 operation, maximum month with 2 units on standby.

.7 Final dewatering centrifuge design criteria:

.1 Design for maximum month input of 53,800 kg/day dry solids.

.2 Minimum bowl diameter of 670 mm.

.3 Bowl shall be designed to operate at minimum of 3,000 G’s.

.4 Solids Recovery: minimum 96%.

.5 Dewatered solids: minimum 28%.

.6 Same base dewatering unit as Intermediate Dewatering.

.7 Design for 24/7 operation, maximum month with 2 units on standby.

.8 For the purpose of this Specification, solids capture is defined as:

C(F - E)/F(C - E) x 100

Where: C = percent dewatered cake solids (TS).
F = percent feed solids (TSS).
E = percent centrate solids (TSS).

2.3 Materials

.1 All wetted parts unless otherwise specified: AISI Type 316 stainless steel.

.2 Bowl shell: AISI Type 316/317 stainless steel.

.3 Scroll: AISI Type 316 stainless steel, as a minimum.

.4 Feed compartment: stainless steel AISI Type 316.

.5 Feed and discharge compartment axial walls: Polyurethane lining or sprayed carbide.

.6 All bolts, nuts, washers: AISI Type 304 stainless steel.

.7 Casing cover: stainless steel AISI Type 316, if the case is integrated into the cover. Fibreglass is permitted if only acting as a guard.

.8 Fasteners: stainless steel AISI Type 316 in process contact areas.

2.4 Configuration, Components and Features

.1 General:

.1 Provide centrifuge as a completely integrated unit designed for continuous and intermittent operation.

.2 Centrifuges shall be of the counter-current design.

.3 Dynamically balance each centrifuge prior to shipment.

.4 Provide vibration sensors.

.2 Bowl:

.1 Provide solid bowl type centrifuges. Cast Type 316 or duplex stainless steel. Welded bowls are not permitted.

.1 Nominal bowl thickness in the cylindrical and conical sections minimum 12 mm.

.2 Provide the front and rear bowl centrifugally cast with a nominal thickness of 32 mm for the front bowl and 20 mm for the rear bowl.

.2 The centrifuge bowl is a solid horizontal cylinder with a conical beach extension into which a scroll conveyor fits concentrically.

.3 Provide adjustable weir plates for pond depth adjustment.

.4 Cake discharge ports shall be field-replaceable with tungsten carbide lining.

.5 Design the bowl to withstand all centrifugal forces encountered at the maximum bowl speed.

.6 Inspect all centrifugally cast components for cracks, shrinkage, porosity, or other defects by means of a liquid penetrant test.

.7 Certify that liquid penetrant tests were performed, and all castings are free of defects.

.8 Configure the centrifuge such that the pool depth is readily adjustable through the use of weir plates at the large-diameter end of the bowl.

.9 The weir plates shall be readily accessible without the need to remove the centrifuge case top.

.10 Protect the bowl from wear by means of either a replaceable ribbed liner or longitudinal bowl strips. Material of construction shall be AISI Type 316 stainless steel.

.3 Main Bearings:

.1 The centrifuge shall be supported by two main bearings.

.2 Main bearings shall be spherical or cylindrical roller bearings.

.3 Main bearings shall be oil-lubricated. Centrifuges with grease lubricated bearings shall not be acceptable.

.4 Design main bearings for an ABMA L-10 rating life of at least 100,000 hours.

.5 Bearings shall be complete with 0.25 percent accuracy 100 ohm platinum RTDs.

.4 Conveyor:

.1 Independently mount scroll conveyor concentrically within the centrifuge bowl.

.2 Equip the scroll conveyor with helical flights:

.1 Protect the edges and faces of the conveyor against abrasion from the solids discharge end of the conveyor through the feed port area.

.2 Provide either sprayed-on tungsten carbide or sintered carbide tiles, on edges of scroll over a width of 30 mm.

.3 Design abrasion protection for the conveyor flights for a minimum of 15,000 hours of operation before refurbishment or replacement is required.

.3 Design the scroll conveyor to rotate at a slight differential speed to the bowl.

.4 Support the scroll conveyor by grease-lubricated ball-or roller bearings.

.5 Design the scroll conveyor bearings for an ABMA L-10 rating life of at least 100,000 hours.

.5 Conveyor Backdrive:

.1 Drive the scroll conveyor by a squirrel cage induction motor operated by a VFD rated for constant-torque operation through a gear reducer.

.2 Mount the backdrive system on a base separate from the centrifuge base or mounted in-line below the gearbox/speed reducer.

.3 Backdrive: Constant-torque rated VFD operated squirrel cage induction motor backdrive unit.

.4 Provide the backdrive system with a squirrel cage induction motor EEMAC torque rated for the load requirements, gear reducer, integral machine controls, and all appurtenances required to provide a complete, mechanical system.

.5 Gear reducer:

.1 Equip each centrifuge with a two-stage planetary gear cyclo-speed reducer that controls the differential speed between the centrifuge bowl and the scroll conveyor.

.2 Design the gear and speed-reduction units with a torque capacity required to meet the specified service conditions.

.3 Select appropriate gear reduction ratio as required to perform under the specified service conditions.

.4 Design gears in accordance with AGMA Class 10 and Class 11 quality requirements.

.5 Case-harden and grind the sun and planetary gears.

.6 Provide self-contained gear lubrication using high-performance gear oil.

.7 Balance the gear box and speed reducer independently of the centrifuge.

.8 Provide the gear reducer with independent protection from high torque overload.

.1 A thermal overload protection system on the drive motor that does not provide sufficient protection shall not be acceptable for independent protection of the gear reducer.

.6 Design the backdrive system to provide infinite speed variation between the scroll conveyor and the bowl of the centrifuge.

.7 Allow for the operation of the backdrive system in conjunction with the operation of the centrifuge in either a manual or automatic control mode.

.8 Provide monitoring of the backdrive torque loading and initiate shutdown of the centrifuge feed pumps upon detection of excessive torque, allowing a flushing and clearing of the internal solids inventory.

.9 Provide controls to allow feed pump to start automatically after a flushing cycle. Initiate a shut-down sequence if clean-in-place occurs four (4) times within 60 minutes.

.10 If torque continues to increase, the centrifuge and feed system shall shut down. Apply a brake to the pinion shaft to increase the conveyor's differential speed to a maximum to scroll the excess solids from the centrifuge as it costs down.

.11 Mount the backdrive system controls in the centrifuge control panel.

.12 Backdrive system controls consist of the pinion speed and torque indicators, speed adjustment potentiometers, and a forward-reverse direction selection switch.

.13 The backdrive control system shall be capable of full four-quadrant control and operation, and rapid switching between modes to maintain the specified speed requirements.

.14 Backdrive motor:

.1 Provide TEFC severe service duty backdrive motor.

.2 Provide energy efficient motor, inverter duty and rated for continuous operation. Operating voltage shall be 600 VAC, 3-phase, 60 Hz and CSA or cUL certified.

.3 Backdrive motor to start by means of a VFD.

.4 Motor rated for Manufacturer's standard speed at an altitude of 13 m at 40°C ambient temperature.

.5 Provide a tachometer generator rated at 50 VDC per 1000 RPM, or as normally provided by the Manufacturer compatible with the PLC input requirements.

.6 Provide motors with grease-lubricated anti-friction ball bearings with a minimum ABMA L-10 rating life of 60,000 hours.

.7 Connect backdrive motor to the pinion shaft of the differential gearbox through a V-belt drive or a cog belt.

.6 Main Drive Motor:

.1 Provide TEFC, energy efficient, horizontal, inverter duty, main drive motor rated for continuous operation at 600 VAC, 3-phase, 60Hz and CSA or cUL certified.

.2 Main drive motor to start by means of a VFD.

.3 Motor rated for Manufacturer’s standard speed at an altitude of 13 m at 40°C ambient temperature.

.4 Equip the main drive motor stator windings with a minimum of three (3) 0.25 percent accuracy platinum RTDs.

.7 V-belt Drive:

.1 The centrifuge main drive shall be V-belt driven.

.2 Design the V-belt drive to allow for relative movements caused by the vibration isolation of the main drive base and the centrifuge base if separate equipment bases are used.

.8 Vibration Isolation:

.1 Provide each centrifuge decanter and main drive with vibration isolators.

.2 Centrifuge decanter and main drive shall be mounted on a common base and provided with vibration isolation.

.3 Provide 95 percent isolation efficiency.

.4 Provide vibration isolation equipment and devices by a single Manufacturer with the exception of vibration isolators that are factory installed and standard equipment with the machinery.

.5 Size isolators at the Manufacturer’s optimum recommended loading. Do not load isolators above the limit specified in the Manufacturer’s literature.

.6 Provide a balanced set of isolators for each piece of equipment. Select all isolators in accordance with equipment weight distribution to provide the minimum static deflections stated above.

.7 Meet the minimum static deflection specified in the final installation, with each isolator having no less than 80 percent of the static deflection specified.

.8 Mark code numbers and colours on shop drawings, on each isolator, and on each base to guide proper placement. Clearly tag all springs to show undeflected height and static deflection.

.9 If more than one type of neoprene element is used, clearly identify the durometer of each.

.10 Provide spring mounts complete with leveling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate-plated hardware.

.11 Size neoprene sound pads for a minimum deflection of 1 mm. Use dynamic stiffness for sizing elastomers and do not exceed 50 durometer.

.12 Maintain a nominal 50 mm clearance below the equipment and the bases.

.13 Provide flexible piping connectors meeting the operating requirements, including nature of material, temperature, and pressure conditions, as well as the following requirements for vibration isolation:

.1 Provide flexible piping connectors as per the Manufacturer's standard for the intended service.

.2 Mould and cure flexible piping connectors in hydraulic rubber presses.

.3 No steel wires or rings shall be allowed as pressure reinforcement.

.4 Provide straight connectors with two spheres. Neoprene elbows shall be manufactured with a single sphere forming the corner of the joint itself.

2.5 Equipment and System Controls

.1 General:

.1 All electrical materials and equipment shall be CSA approved and manufactured in accordance with standards established by EEMAC. This approval applies to complete control system assemblies as well as individual components.

.2 Functions pertinent to the operation of the centrifuge and associated equipment shall be controlled by the centrifuge PLC. Associated equipment to be controlled through automation system.

.2 Scroll Drives (Backdrive):

.1 Arrange controls to run the drive in the delta-rpm mode or the torque mode via the HMI.

.1 In the delta-rpm mode, the backdrive speed is automatically adjusted to maintain constant delta-rpm.

.2 In the torque mode, the backdrive speed is automatically adjusted to maintain constant torque, compensating for varying feed characteristics while optimizing residence time and separation.

.3 Centrifuge Control Panel and HMI:

.1 HMI Programming Philosophy:

.1 Software switches shall be easily adjustable via the HMI and via password security.

.2 Software timers shall be adjustable via the HMI and via password security.

.3 Software set points (e.g. controllers) shall be easily adjustable via the HMI and via password security.

.4 Alarms shall be prioritized based on Appendix 18 D - City of Winnipeg Standards.

.5 Include provisions to print reports on a report printer.

.6 Include trending for all continuous measurements.

.7 Flows shall be totaled and reset daily at midnight and transferring the total to another register. The daily totals for the current month and the previous month shall be displayed. The daily totals for the past 12 months shall be retrievable and printable.

.8 Motors shall have an accumulated run time indicator.

.9 Software controllers shall have an adjustable deviation alarm.

.10 Continuous measurements to have a minimum of four adjustable set points shall be used for interlocking and alarming.

.11 The HMI to indicate in real time the mass of dry sludge being fed and the polymer dose in kg of dry polymer per dry kg of feed sludge. This screen to also indicate cumulative total sludge mass.

.12 Provide CSA or cUL certified control panel.

.2 Provide the HMI with the following minimum displays:

.1 Scroll drive HOA selector.

.2 Scroll drive mode selector: delta-RPM/torque, which is enabled when the HOA is in AUTO.

.3 Scroll drive speed.

.4 Bowl speed.

.5 Scroll drive delta speed controller.

.6 Bowl drive motor load in percent FLA and backdrive motor load in percent FLA.

.7 Residuals flow rate controller. In auto the controller output to control through a PID loop, the speed of the centrifuge feed pump based on flow. In manual, the operator to adjust the set point to directly set the speed of the residuals feed pump.

.8 Centrifuge feed pump HOA selector. In the HAND or AUTO mode arrange the pump to start and ramp to minimum speed, then seek the speed desired by the residuals flow rate controller.

.9 Calculate and display hydraulic loading rate based on sludge feed rate and expressed as a percentage of machine capacity.

.10 Provide for operator input of feed sludge solids concentration and utilize to calculate the solids loading rate based on sludge feed rate and sludge feed concentration and expressed as a percentage of machine capacity.

.11 Centrifuge feed pump On-Off status.

.12 Polymer flow ratio controller, which is the ratio controlled to the residual flow. In auto arrange the controller output to set the speed of the polymer feed pump based on residuals flow. In manual, provide operator adjustable set point to directly set the flow rate of the polymer feed pump.

.13 Conveyor On-Off status.

.14 Diverter gate position.

.15 On-Off selector for conveyor wash-water valve.

.16 On-Off selector for centrifuge wash-water valve.

.17 Centrifuge LOCAL-REMOTE selector. In the hand mode arrange the centrifuge to bypass the AUTO logic. In AUTO, centrifuge is to start if the conveyor is running.

.18 Centrifuge vibration.

.19 Bowl drive On-Off status.

.20 Scroll drive On-Off status.

.21 Bowl drive Local-Remote status.

.22 Scroll drive Local-Remote status.

.23 Bowl drive cumulative run-time indicator.

.24 Scroll drive cumulative run-time indicator.

.25 Cumulative residuals flow.

.26 Centrifuge feed pump LOCAL-REMOTE status.

.27 Centrifuge feed pump cumulative run-time indicator.

.28 Centrifuge feed pump seal water flow switch status.

.29 Polymer metering pump On-Off status.

.30 Polymer metering pump cumulative run-time indicator.

.31 Polymer metering pump HOA selector.

.32 Polymer metering pump flow rate indicator.

.33 Polymer metering pump cumulative flow indicator and controller.

.3 Arrange the HMI with the following alarms, at a minimum:

.1 Centrifuge feed pump fault.

.2 Centrifuge bowl drive fail.

.3 Centrifuge scroll drive fail.

.4 Centrifuge high vibration.

.5 Centrifuge bowl speed deviation high.

.6 Centrifuge scroll speed deviation high.

.7 Conveyor safety shutdown.

.8 Conveyor fail.

.9 Diverter gate fault.

.4 Arrange the HMI with the following shutdown alarms, at a minimum:

.1 Centrifuge feed pump VFD trouble.

.2 Centrifuge feed pump high temperature.

.3 Residuals feed pump high discharge pressure.

.4 Low residuals flow to centrifuge.

.5 Polymer system fault.

.6 Centrifuge water valve fail.

.7 Centrifuge bowl drive high temperature.

.8 Centrifuge scroll drive high temperature.

.9 Centrifuge bowl VFD fault.

.10 Centrifuge scroll VFD fault.

.11 Centrifuge high vibration.

.12 Centrifuge bowl speed deviation high high.

.13 Centrifuge scroll speed deviation high high.

.14 Conveyor overload.

.15 Conveyor high torque.

.4 Control system operation:

.1 Control system must allow for totally automatic operation of the centrifuge with torque controlled regulation.

.2 Arrange the centrifuge to start automatically or manually. To automatically start the centrifuge, select AUTO on the HOA selector switch.

.3 The PLC is to issue a “run” command to the centrifuge main drive motor and the bowl to begin to accelerate. The polymer and feed systems shall be interlocked with the centrifuge controls to prevent their operation at this time. During this start up sequence diverter gate will need to be opened based on torque.

.4 Backdrive to run at a pre-programmed start-up speed as set in the PLC to provide maximum scrolling of residual solids from the bowl. After a pre-set, timed interval, the feed and polymer pumps to start automatically. As process requirements vary, the backdrive speed shall be infinitely adjustable via the PLC.

.5 Once operation stabilizes, the auto-torque mode may be selected. In this mode, the backdrive torque shall be maintained while the speed is allowed to vary, within pre-set limits, to maximize the residence time. If torque begins to rise above the set point, the differential speed shall increase to scroll solids out of the bowl at a faster rate, thereby lowering the torque to the set point.

.6 Arrange the centrifuge to also start manually, by selecting the appropriate graphic symbols as prompted by the HMI.

.7 Upon stopping the centrifuge by pressing the “Auto Stop” key on the HMI, or via a fault condition, the feed and polymer is stopped. The main drive motor shall stop allowing the bowl to coast to rest. The backdrive shall again be automatically set to a minimum speed to provide maximum scrolling of residual solids from the bowl during coast down. Diverter gate will need to close at some point based on a torque. The backdrive shall be automatically de-energized at the end of the coast down by a shutdown timer. An automatic flush valve shall open for a pre-determined time user-adjustable during shutdown.

.8 If a fault occurs, an alarm shall sound, the machine shall shut down and a specific alarm message displayed on the HMI. An Alarm Acknowledge display shall flash during fault conditions. Activating the alarm acknowledge shall silence the alarm and reset the flashing light to illuminate steadily. When the alarm is reset, the light shall extinguish.

.9 Provide Modbus TCP/IP communication to plant PCS. Provide an independent port for Modbus communication to isolate equipment and PCS networks.

.10 Provide Schneider PLC control per Appendix 18E - City of Winnipeg Standardized Good.

.11 Provide CSA or cUL certified control panel.

.12 Provide a separate control panel for each dewatering centrifuge system.

.5 Clean-in-place:

.1 The local control panel shall include a manually-initiated clean-in-place cycle.

.2 An auto stop shall automatically start the CIP cycle.

.3 CIP cycle shall include provisions for rotating the scroll conveyor in either or both forward and reverse directions at timed intervals.

.4 During CIP, flushing water shall be automatically introduced at high rates as per Manufacturer requirements.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) set main bearings and seals.

.2 One (1) set scroll bearings.

.3 One (1) set O-rings.

.4 Thrust bearing.

.5 Thrust bearing seal and lockwasher.

.6 One (1) spare set of belts of each size required.

.7 Sufficient lubricating oil or grease for two (2) years of normal operation.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Optimize the overall performance of the centrifuge based on the following criteria:

.1 Polymer selection.

.2 Cake solids.

.3 Solids loading rate.

.4 Hydraulic loading rate.

.5 Polymer dosage rate.

.6 TSS recovery rate.

.7 Timing sequences of fully automated start-up and shutdown/cleaning.

.4 Operational Testing shall be conducted for a period of 15 consecutive Business Days (five (5) days for each of the design solids loading rates set out in Schedule 18 to verify the equipment meets the requirements of the Design and Construction Specifications and the Final Design. During the testing measure, record, and sample hourly the minimum parameters:

.1 Centrifuge feed sludge:

.1 Feed flow rate.

.2 Feed TS.

.3 Polymer feed flow rate.

.4 Polymer concentration.

.5 Polymer consumption.

.2 Centrate:

.1 TSS.

.3 Dewatered sludge cake:

.1 TS.

.5 During each test measure and record the following centrifuge operating information:

.1 Polymer usage kg/tonne.

.2 Vibration.

.3 Weir height and pond depths.

.4 Bowl and scroll differential speed.

.5 Bearing temperatures.

.6 Power usage.

.7 Scroll torque.

.8 Any other parameters necessary to demonstrate compliance with the Final Design and Manufacturer’s operating Specifications.

.6 Test the centrifuge operation at 75, 90 and 100 percent of design solids loading rate.

.7 Submit a report summarizing the test results, recommending setpoints and listing final testing data in concise tabular form at the conclusion of the test period.

.8 Within six (6) months following Substantial Completion a qualified Manufacturer's Representative is to visit the site (for a period not less than 15 Business Days) to review the performance of the Centrifuge Dewatering System and optimize the following:

.1 Solids Loading:

.1 Test each different solids loading rate with varying polymer dosages at 75, 90 and 100 percent of design solids loading rate.

.2 Hydraulic Loading:

.1 Test each different hydraulic loading rate with varying polymer dosages at 75, 90 and 100 percent of design hydraulic loading rate.

.3 Polymer Consumption:

.1 Optimize the performance of the Centrifuge Dewatering System with two (2) different polymers based on jar testing and provide unit cost/kg and kg/tonne usage for final selection.

.4 Sludge discharge TS.

.5 Solids recovery efficiency.

.6 Vibration.

.7 Weir height and pond depths.

.8 Bowl and scroll differential speed.

.9 Power usage.

.10 Scroll torque.

.11 Start-up and shut down sequences.

.9 Warranty Period Maintenance Services and Provisions

.1 Within 60 days of the end of the Warranties Period carry out a major overhaul of the centrifuges including the O&M requirements set out in Appendix 18F and the following:

.1 Replace the main bearings.

.2 Remove the scroll for inspection.

.3 Inspect the internal surfaces of the centrifuge for wear.

.4 Repair or replace all internal surfaces where tolerances for wear have been exceeded.

.5 Recommend the next date for internal inspection.

.6 Prepare a list with estimated replacement or refurbishment for all wearable components based on the condition observed during the site visit.

.10 Within 20 Business Days submit a report to the City summarizing the activities carried out during the overhaul, the estimated replacement and refurbishment plan and all other recommendations.

END OF SECTION

SLUDGE BIN

1. GENERAL

1.1 Summary

.1 Provide the hopper (sludge bin) complete with mounting and support frame, load stands, live bottom with twin reversing screw conveyors, VFDs for the live bottom screws, discharge chute, discharge slide gate, motor reducer, electrical controls, control panel, platforms and access ladder, safety accessories, and all appurtenances specified or required for a complete and operable system.

1.2 Standards

.1 Canadian Standards Association (CSA).

.2 American National Standards Institute (ANSI):

- .1 ANSI S1.11 - American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.

.3 American Society for Testing and Materials (ASTM):

- .1 ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.4 American Welding Society (AWS):

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

.5 Instrument Society of America (ISA):

- .1 Instrument Loop Diagrams.

.6 National Electrical Manufacturer Association (NEMA):

- .1 ICS 1: Industrial Control and Systems General Requirements.
- .2 MG 1: Motors and Generators.

.7 CEMA 300 - Screw Conveyor Dimensional Standards.

1.3 Submittals

.1 Provide calculations detailing effective storage volume.

.2 Provide calculations for dewatered biosolids truck loading rate.

.3 Submit the following shop drawings in accordance with Sections 01300 and 11000 and the following:

- .1 Manufacturer's descriptive literature for materials.

.2 Data regarding hopper equipment, motor characteristics and performance:

  .1 Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate drives, showing they meet specified requirements for capacity, performance and horsepower.

  .2 Results of shop performance tests as specified.

.3 Provide drive details, including calculations and procedures used for selection of drive components based on absorbed horsepower and installed motor horsepower.

.4 Equipment list including static loads, dynamic loads, vibrations loads and performance specifications of all items of equipment.

.5 Controls:

  .1 Front elevation of control panel with and without doors.

  .2 Instrument layout of control panels.

  .3 Wiring diagrams in accordance with NEMA ICS 1 using NEMA designations and symbols.

  .4 Provide instrumentation and control and wiring diagrams of instrumentation, control, and electrical components as follows:

    .1 Motor control, alarms, and power to motors and accessories such as analytical instruments, etc.

    .2 Include termination points in panels with every circuit assigned a number and every wire assigned a wire number. Show both termination point number (including wire number) and terminal strip identifier on the schematics for each wiring termination.

    .3 Complete electrical, instrumentation, and control schematics of control panels and field junction boxes. Complete ISA 5.4 STD Loop Drawings as specified in Specification Section 16010 and 16131.

.6 Certified setting plans, with tolerances, for anchor bolts.

.7 Bearing temperature operating range for the service conditions specified for each bearing.

.8 Bearing Life: Certified by the equipment Manufacturer. Include design data.

.9 Control philosophy provided in both written and schematic form.

.10 Certification that the entire equipment will be passivated.

.11 Elevation of local control panel and operator control station showing panel-mounted devices. Provide details of power distribution and full load current draw of panel. Provide list of all terminations required to receive inputs or a transmit inputs from the local control panel.

.12 Wiring diagrams of field connections with identification of terminations between local panel, junction boxes, equipment items, instrument devices, and the like.

.13 Complete electrical control schematic diagram.

.14 The latest ISO 9001 series certification.

.15 Material Certification:

.1 Provide certification from the equipment Manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. 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 specified and indicated including an installation list of a minimum of twenty-five (25) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the City.

.2 Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

1.4 Quality Assurance

.1 Live bottom hopper with shafted or non-shafted screw conveyor shall be the product of one Manufacturer.

.2 Live bottom hopper with shafted or non-shafted screw conveyor shall be Manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specifications and service conditions specified and indicated.

.3 The Contractor shall obtain hoppers, motors, conveyor drive units, live bottom slide gates, live bottom slide actuators, gear reducers, valves, variable frequency motor controllers, controls and control panels and appurtenances from the live bottom hopper with shafted or non-shafted screw conveyor Manufacturer, as a complete and integrated package to ensure proper coordination and compatibility and operation of the system.

.4 Provide variable frequency motor controllers in accordance with Sections 16225 and 16228.

.5 Provide all components made of stainless steel passivated by full submergence in a pickling bath for perfect surface finishing. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are also fabricated, in order to prevent contamination by rust.

.1 Fully submerge all stainless steel parts in a pickling bath (nitric and hydrofluoric acids) for at least 8 hours to remove welding spots and to protect the stainless steel against corrosion. Sand or glass bead blasted or brushed or otherwise not equivalently treated stainless steel is not acceptable.

.2 After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Jim Myers & Sons, Inc. (JMS)

.2 SPIRAC.

.3 Or approved equivalent.

2.2 Performance and Design Criteria

.1 Provide all equipment and appurtenances designed for exposure to splash and spill conditions, 0-100 percent non-condensing humidity, and temperatures ranging from minus 30 degrees C to 65 degrees C.

.2 Provide all equipment and appurtenances designed for operating continuously for 24 hours per day, seven days per week and designed to operate under conditions where it is started and stopped frequently in short time intervals as specified.

.3 Hopper capacity and operating data are indicated in the Hopper Schedule.

.4 Hopper Schedule:

.1 Intermediate dewatered solids bins hoppers shall be sized and selected to meet the following:

.1 Minimum 2 and maximum of 4 tanks.

.2 Stainless steel tanks with cover and odour control.

.3 Live bottom for removal of solids from the tank.

.4 Total usable volume minimum 450 m^3.

.5 Storage to be minimum 300 m^3 with one tank out of service.

.6 Minimum of 12 hrs storage at maximum month with one tank out of service.

.7 Include Manufacturer calculations of usable volume in vessel.

.2 Final dewatered solids bins hoppers shall be sized and selected to meet the following:

.1 Same number of bins as total number of centrifuges (a minimum of 4).

.2 Covered bins with odour control.

.3 Space to add additional same size bin in future.

.4 Configure so that any centrifuge can fill any bin with dewatered sludge with a conveyance system.

.5 Total minimum usable volume of bins to be 3 days at maximum month (850 m^3) with 2 units out of service.

.6 Provide live bottom for dispersing of solids from the bins.

.7 Provide 3 chutes complete with controlled knife gates on each bin.

.8 Provide fill distribution system for even filling of biosolids bins and maintaining level of the sludge within the bins.

.9 Include Manufacturer calculation of usable volume.

.10 Dispense solids of 22 m^3 within 10 minutes.

.11 Measure dispensed weight within 2% using load cells on the bins.

2.3 Materials

.1 Unless otherwise specified, the materials used in the fabrication of the equipment under this section shall conform to the following:

.1	Hopper:	304 Stainless Steel
.2	Inlet/Outlet Chutes:	304 Stainless Steel
.3	Supports:	A53, A36 Carbon Steel, HDG
.4	Discharge Gates:	304 Stainless Steel
.5	Live Bottom Screws:	304 Stainless Steel
.6	Live Bottom Pan/Trough:	304 Stainless Steel
.7	Bolts, Nuts, and Washers:	18-8 Stainless Steel
.8	Access Ladder and Platforms:	304 Stainless Steel

2.4 Configuration, Components and Features

.1 General:

.1 Hopper shall be self-supporting with structural steel support legs and framing complete with base plates drilled for mounting on concrete base. All necessary cross bracing and reinforcing members shall be fabricated within the support system. A 100 mm (4-inch)

Class 150 flanged connection shall be provided at the bottom of the hopper with 100 mm camlock fitting and valve to drain the hopper during maintenance activities. Intermediate supports within the hopper will not be acceptable. Support system to be designed and stamped by a licensed structural engineer.

.2 Flexible Drop Chutes:

.1 Provide a flexible rubber drop chute under the slide gate.

.2 Chute assembly shall have a 304 stainless steel flange to match the slide gate bottom flange.

.3 Flexible material shall be rubber, neoprene or vinyl covered canvas. Vertical seams of the material shall be glued, vulcanized, or stitched to prevent any sludge leakage at the splice.

.4 Backer plates of 304 stainless steel bars and fasteners shall hold the flex material to the flange.

.3 Flex drops length shall be as shown in the drawings. Welds: All welds shall be sealed watertight by continuous welds, unless otherwise specified. Edge Grinding: Sharp corners of all cut and sheared edges shall be made smooth by a power grinder.

.4 Hopper: Hopper shall be constructed of welded stainless steel plate of a thickness determined by the Manufacturer. It shall be designed to limit maximum deflection of no more than 1/270 of span. Minimum plate thickness shall be 6 mm (1/4-inch). Interior surfaces of hopper shall be smooth to allow unobstructed flow. All stiffening of hopper shall be welded to the exterior surface.

.5 Top Cover: Each hopper shall be supplied with a stainless steel checker plate solid cover to contain odor. Each cover to have two 660 mm x 760 mm (26 inch x 30 inch) manways complete with lockable hatches and odor ports as indicated on drawings.

.6 Access Ladder and Platforms:

.1 Manufacturer shall provide aluminum top grab rails complying with OSHA standards per wet cake hopper to top cover and inspection door.

.2 Platforms are to be designed and provided by the Manufacturer. Any intermediate supports required for platforms between hoppers to be designed and stamped by a licensed structural engineer registered in the Province of Manitoba.

.3 Handrails shall be located in all elevated areas around the two hoppers as indicated on the Drawings and shall be aluminum.

.7 Assembly Requirements:

.1 General: Include all material and equipment necessary to provide a complete working system. Provide all fasteners, whether shop installed or not, for structural supports and mechanical equipment.

.2 Clearances: Furnish equipment of the approximate dimensions shown or specified, to fit the spaces shown with adequate clearances, and capable of being handled through openings provided in the structure for this purpose. Provide equipment of such design that piping and electrical connections, ductwork and auxiliary equipment can be assembled and installed without causing conflict to the location or arrangement of any of the facilities.

.3 Fabricated Sections: Furnish all fabricated steel sections shop assembled into units as large as practicable and as shipping regulations will permit and match marked for field assembly. Provide mechanical equipment and components shop mounted on the stainless steel sections as much as practicable for shipment, in order to keep field assembly to a minimum. Furnish required lifting lugs.

.4 Miscellaneous Components: Shop assemble all screws, bearings, bolted end plates, and trough.

.5 Identification: Clearly identify all loose items by equipment number and erection mark numbers to facilitate assembly.

.6 Provide continuous seal welds in conformance with AWS D1.1 at all welded joints. Skip welds will be permitted on external reinforcements. Grind welds smooth and to a uniform finish.

.8 Equipment:

.1 Hoppers:

.1 Function: The hoppers will store dewatered sludge. The sludge will be transferred to the distribution conveyor which feeds the hoppers. The hoppers will distribute the sludge to the trucks as required.

.2 Equipment Components:

.1 Hoppers:

.1 Hoppers shall be designed such that each one may be shipped in three main sections with bolted fit-up connections for field erection by the contractor. After field fit the contractor shall field weld the flange seams for a watertight vessel.

.2 Provide flanges for connecting hopper gates to hopper.

.3 Side slope angles of not less than 60 degrees from the horizontal.

.4 Hopper shall be minimum 6 mm (1/4 inch) plate which external stiffeners as required.

.5 Design stiffening members to limit deflection of hopper to 1/270 of span.

.6 Design hopper to rest on the support structure as shown on the Drawings.

.7 Provide continuous welds at all welded hopper joints. Stiffeners do not require continuous welds.

.8 Provide connections for level elements as shown on the Drawings.

.9 Hoppers shall have integral support structure and anchors suitable for mounting to steel structure designed and constructed by others.

.10 Design integral hopper supports for dead loads and live loads assuming hoppers completely full of biosolids of 1040 kg/m^3 (65 lb/ft^3) density. Live loads are as specified on Drawings.

.11 Design the hoppers to have the minimum vertical clearance as specified on the Drawings.

.12 Provide anchor bolts for support structure.

.13 Make provision in structure for equipment and piping loads specified on Drawings.

.2 Live Bottom Screw Conveyors:

.1 Provide a live bottom consisting of two non-reversible screw conveyors.

.2 Live bottom screws shall be mounted in a stainless-steel trough assembly. The trough shall be minimum 10 mm (3/8 inch) plate with external stiffeners as required.

.3 Screw flights to be minimum 460 mm (18 inch) diameter.

.4 Single flights with standard pitch shall be provided. Flight outside diameter shall be CEMA standardized sizes. Flights shall be of the required diameter and thickness to convey the specified material at the specified rate.

.5 Sectional flights shall have a constant cross section. Flights shall be butt welded into a continuous helix, continuous throughout its entire section. Flights shall be ribbon type.

.6 Pipe shaft shall be A53 minimum schedule 80, 200 mm (8 inch) diameter pipe and shall deflect no more than 6 mm (1/4 inches).

.7 Flights shall be manufactured from A235 abrasion resistant alloy steel (304) with a Brinnell hardness of 220, and maximum yield strength of 550,000 kPa (80,000 psi). Pipe shafts shall be manufactured from carbon steel (304). Carbon steel flights and pipe shall be coated with one coat of epoxy shop primer only.

.8 Conveyor pitch design shall permit even distribution of biosolids across hopper during biosolids discharge.

.9 Provide radial and thrust flange bearings for screw flight drive and end shafts.

.10 Provide externally mounted bearings, double tapered, grease lubricated roller bearings having an AFBMA C-10 rating life of 100,000 hours.

.11 Provide grease fittings at each bearing and brought to an accessible location (Alemite brand.)

.12 Provide packing glands on outboard hopper wall to prevent contamination of bearings.

.13 Designs incorporating inboard bearings, intermediate supports, or bearings located inside the hopper are not acceptable.

.14 Fabricate screws to CEMA 300 Standards.

.15 Each screw shall incorporate a speed switch to detect low or no speed.

.16 The screw conveyor replacement shall be possible through the end plates, as a single piece.

.3 Conveyor Drive Units:

.1 Provide live bottom drive unit with gear motor.

.2 One drive will be provided for each live bottom screw.

.3 Provide inverter duty motors. Live bottom screw conveyor motors shall have space heaters and temperature sensing and protection.

.4 Ensure output speed of bottom screw conveyor secondary gear reducer is as required for specified discharge rate.

.5 Provide 600 volt, 60 Hertz, 3 phase motors with a 1.15 services factor, with Class F insulation and CSA certified. Provide motors with TEFC enclosure and Design B speed/torque characteristics.

.6 Provide all gear reducers with AGMA Class II, single or double reduction, helical gear units with high-capacity roller bearings. Design bearings for thrust loads from the fully loaded startup condition with an AFBMA B10 life of 30,000 hours. Provide standard air-cooled reducer units with no auxiliary cooling. Size the gear reducer with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

.7 Maximum continuous operating torque shall be determined by hopper Manufacturer for worst combination of service conditions, feed or discharge rate, and biosolids consistency.

.4 Live Bottom Slide Gates:

.1 General:

.1 Hoppers with live bottom screws shall utilize slide gates adequate to discharge from one or more screws as shown on the drawings. Gate opening shall be minimum one screw pitch in length and width. Where it is practical utilize an opening in the axial direction up to 1.5 times the screw flight or spiral pitch.

.2 The slide gate and actuator shall be fully supported by the gate frame or as otherwise indicated by the drawings.

.3 The slide gates shall be fabricated with material as stated herein includes frame, gate blade, and all wetted parts.

.4 Gates shall be factory assembled, adjusted, and tested.

.5 The slide gate body shall be 10 mm (0.375-inch) minimum thickness frame. Greater thickness shall be provided based on actual actuator thrust forces and over-head load.

.6 Construct gate frame of structural members or formed stainless steel plate welded, to form a rigid 1-piece frame.

.7 The frame shall incorporate a dust-proof cover plate (metal guard) to cover the blade retraction area. Any guards or covers shall be bolted to facilitate maintenance.

.8 Slide gate frame shall be flanged top and bottom with hopper or live bottom trough flange bolt hole patterns.

.9 Frame will have provision for a ramping system, mounted at the front and back of the gate frame that will ensure that the gate blade will make positive contact with the gate seal in the closed position.

.10 Frame shall be designed to support the gate actuator, accessories, and any required restraint connections.

.2 Blade:

.1 The minimum thickness of the gate blade shall be 25 mm (1-inch) minimum. Greater thickness or reinforcement shall be provided based on actual actuator thrust forces and head pressure.

.3 Guides & Seals:

.1 The gate shall be provided with UHMW PE plastic guides, stainless steel rollers and with a ramping mechanism to force the gate blade against and compress the seal when in the fully closed position. The seal shall be neoprene 60 Durometer, vulcanized at all corners or connections.

.2 Frame shall have ultra-high molecular weight polyethylene insert in contact with gate blade edges to eliminate racking and misalignment during the open and closing cycling of the gate.

.3 Sealing and sliding surfaces shall provide a low coefficient of friction with the surface of the slide.

.4 Slide gates shall be designed for a 70 kPa (10 psig) rating.

.5 Seals shall be neoprene vulcanized at corners to prevent separation and leakage. Seals assembled with adhesive is not allowed.

.6 Rollers shall be T-440C stainless steel. Guides shall be UHMW PE.

.4 Actuator:

.1 The conveyor Manufacturer shall provide electric motor operated actuators for modulating operation.

.2 The actuators shall have a rising stem with cover. The stem connection shall allow for movement of the blade during ramping. Stem shall be stainless steel machine cut or rolled threads.

.3 The actuators shall be 3/60/600, NEMA 4X.

.4 The actuators shall include an integral reversing motor starter, internal adjustable limit switches, manual hand-wheel back-up with clutch release.

.5 Electric actuators shall be Rotork IQ Series and meet the requirements of Section 16010.

.9 Finishes:

.1 After welding, clean stainless-steel components using a solvent free of chlorides. Remove embedded iron from stainless steel welds by pickling with nitric or hydrofluoric acid.

.2 All carbon steel shall be hot dipped galvanized (HDG) to ASTM 123.

.3 All purchased components shall utilize the Manufacturer’s standard epoxy coating.

.10 Electrical Control System:

.1 Power supply to the equipment will be 600 volts, 60 Hertz, 3 phase.

.2 Control Panel:

.1 Panels shall be NEMA 4X, stainless steel.

.2 Equipment control panel shall be factory assembled, wired, and shall contain all necessary control devices for the operation of the discharge gates, load cells and other devices specified herein. Control devices include VFDs, motor starter, overloads, control power transformer, control switches, pilot lights, relays, interlocks with upstream and downstream process equipment, and other devices as required for a complete and operating system.

.3 Entire control panel assembly shall be UL listed and mounted for operator control. Control panel shall include a main circuit breaker disconnect with externally operable handle lockable in the OFF position.

.4 An electric heater with integral thermostat shall be provided in the panel to prevent moisture accumulation.

.3 Load Cells:

.1 Each support on the hopper shall have a load cell (minimum of 8 per hopper) with controls to be used for continuously monitoring the amount of sludge within the hopper.

.2 Manufacturer to provide a closed loop level control system.

.3 Weighing assemblies shall be self-checking and have provisions for thermal expansion and contraction. Weighing assembly load plate shall be able to compensate for mounting surfaces up to 4 degrees off-level.

.4 A remote mounted 4-1/2 digit LCD indicator (minimum of one per hopper, total of two) shall be housed in a NEMA 4X, UL approved enclosure. LCD Indicator shall be backlit with 13 mm (0.5 inch) characters for ease of readability in low light conditions.

.5 Indicator shall output net weight via a 4-20 mA signal for remote monitoring. Indicator shall have two adjustable set points.

.4 Level Sensing Device Connection: The hopper shall be furnished with connections for a level metering system consisting of an ultrasonic (or radar) level transmitter for measuring the level of sludge in the hopper. An admittance probe, with level switch, shall be supported vertically from the top of the hopper such that it will normally not be in contact with any sludge.

.1 Ultrasonic Level Transmitter:

.1 Ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and interconnecting cable. Provide minimum four (4) ultrasonic level transmitters per bin.

.2 Sensor shall be encapsulated in a chemical and corrosion-resistant material such as CPVC and shall be suitable for operation over a temperature range of minus 30 degrees C to 65 degrees C, with a relative humidity of 10 to 100 percent.

.3 Ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probe is provided, it shall be mounted with or adjacent to the ultrasonic sensor.

.4 The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 13 mm (0.5 inch).

.5 The transmitter shall be designed to ignore momentary level spikes, false targets, or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output.

.6 Transmitter output shall be an isolated 4-20 mA DC signal linearly proportional to the measured level range. Calibration parameters shall be entered through a keypad on the unit and shall be stored in non-volatile EEPROM memory. Accuracy of the transmitted signal shall be within 0.5 percent of the level range.

.7 The transmitter shall contain four independently adjustable level alarm contact outputs. Contacts shall be single pole, double-throw, and rated not less than 5 amps at 120 volts AC.

.8 An appropriate length of sensor-to-transmitter signal cable shall be furnished with the instrument. The sensor shall be capable of being located up to 30 m (100 feet) away from the signal converter. The signal converter electronics shall be housed in a corrosion resistant NEMA 4X enclosure suitable for wall or pipe stand.

.11 Arrangement:

.1 The contract drawings indicate the required general arrangement and layout of the hoppers.

.2 Changes to the arrangement to accommodate the selected equipment are the responsibility of the Contractor and shall be at no additional cost to the City.

2.5 Motors

.1 Provide in accordance with Section 16223 and as specified and indicated.

.2 Horsepower rating of motors: Not less than maximum brake horsepower requirements of equipment under any condition of operation specified and indicated without operating in the motor service factor.

.3 Motor enclosure and motor speed: As indicated herein.

.4 In addition to the requirements for bearings specified under Electric Motors in Section 16223, provide motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

.5 Overall sound-pressure level of each motor shall not exceed 88 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 or more readings at evenly spaced points, 1 m (3 feet) from motor.

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

.7 Service Factor: 1.15, with 1.0 inverter duty rating for equipment with variable frequency motor controllers.

.8 Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

.9 Rating: 600 VAC, 3-phase, 60 Hertz.

.10 Insulation: Class F with Class B temperature rise, 40 degree C ambient.

.11 Site Altitude: 230 m above sea level.

2.6 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

.1 One (1) speed switch.

.2 One (1) E-stop switch.

.3 One (1) set of all special tools.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Provide and install necessary grade quality oils, greases and anti-seize compounds for initial operation of all equipment provided that requires oil, grease or anti-seize.

.4 Anti-seize shall be applied to the threads of all stainless steel bolts before assembly at the factory and field assembly.

3.2 Field Testing

.1 After testing and adjustment have been completed by the Manufacturer’s field service technician, conduct running test for each component according to Schedule 18 Technical Requirements – Functional test.

.1 The units shall be run at essentially steady-state conditions during the tests and at the design loading related to the residuals volume index of the residuals being supplied.

.2 Following steady state testing, the bins will be tested at full capacity in conjunction with the live bottom conveyor. Testing shall demonstrate that the bin can be emptied properly without bridging. Testing shall confirm that truck filling rates can be met at the specified solids percentage.

END OF SECTION

DRY POLYMER FEED SYSTEM

1. GENERAL

1.1 Summary

.1 The Section specifies the supply, delivery, installation, start-up, field testing, and commissioning of a dry chemical volumetric feed system to handle feeding, mixing, and pumping of dry polymer (solid grade) and its mixed solutions.

.2 The equipment to be provided for the polymer dosing system includes, but is not limited to the following:

- .1 Receiving hopper.
- .2 Conveying system.
- .3 Screw feeder.
- .4 Wetting chamber.
- .5 Mix tank.
- .6 Agitator.
- .7 Mixer(s).
- .8 Transfer pump(s), in accordance with Section 11365.
- .9 Feed and storage tanks.
- .10 Dosing pump(s), in accordance with Section 11365.
- .11 Liquid level controls.
- .12 Control panels.
- .13 Starters and VFDs.

1.2 Standards

.1 The work and materials shall comply with the Canadian Electrical Code and all applicable local regulations and ordinances. All panels and enclosures shall be provided with labels from either the Canadian Standard Association (CSA) or the Underwriter Laboratories of Canada (cUL). Following is a list of standards and applicable organizations for reference:

- .1 Institute of Electrical and Electronics Engineers (IEEE) - IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
- .2 National Electrical Manufacturer Association (NEMA) - MG 1, Motors and Generators.
- .3 American Society of Mechanical Engineers (ASME):

.1 ASME B31.1 - Power Piping.

.2 ASME B31.3 - Process Piping.

.4 Latest revision of Canadian Electrical Code (CEC).

.5 Occupational Safety and Health Administration (OSHA).

.6 Canadian Standards Association (CSA).

.7 Underwriters Laboratories Inc. of Canada (ULC).

.8 Manitoba Building Code.

1.3 Submittals

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

.1 Manufacturer's descriptive literature for materials.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers:

.1 Hayward Gordon.

.2 Nalco.

.3 Fluid Dynamics/PSG Dover.

.4 Acrison Inc.

.5 Velodyne.

.6 Veolia.

.7 Or approved equivalent.

2.2 Performance Criteria

.1 Produce an uninterrupted supply of clean polymer solution with no partially wetted particulate agglomerations or turbidity at the end of the mixing period.

.2 System to work automatically, producing a polymer solution of consistent concentration. Operators are to transport bulk bags of dry polymer as required to feed the system.

.3 Supply products modified as necessary by the Manufacturer to provide the specified features and to meet specified operating conditions.

.4 Provide sufficient heat and de-humidification at the polymer discharge point to maintain polymer dryness and to prevent plugging if room humidity exceeds 80 percent.

.5 Provide interface Modbus TCP/IP communication with plant PCS.

.6 Polymer Type:

.1 Dry polymer: microbead or powder type with cationic charge.

2.3 Materials

.1 Receiving hopper: Type 316 stainless steel.

.2 Screw feeder and trough: stainless steel.

.3 Mix tank: polypropylene or fibreglass.

.4 Feed tank: stainless steel.

.5 Wetted parts: Type 316 stainless steel.

2.4 Configuration, Components and Features

.1 Receiving Hopper:

.1 Provide a receiving hopper suitable to accept one-tonne “big bags” of polymer, loaded by an overhead monorail hoist.

.2 Provide dry powder level switches to alarm upon low level (LSL) and high level (LSH).

.3 Dry polymer hopper to be of adequate size to hold a minimum of two super sacks of dry polymer which shall be a minimum of 24 hours peak flow operation and shall be designed for dust suppression and collection.

.2 Screw Feeder:

.1 Provide a screw feeder to transport dry polymer from the receiving hopper. Screw feeder shall be anti-spark design and materials.

.2 Provide a minimum 0.18 kW double-auger volumetric screw feeder to transport dry polymer from the receiving hopper. The auger shall be driven by a variable speed motor to allow for calibration of the feeder.

.3 The feeder shall include a heated powder dryer at the discharge and a positive closure device to prevent after-run during shutdown.

.4 Polymer feed shall be operator-adjustable to produce polymer solutions with concentrations within the range of 0.1 - 0.3%.

.3 Wetting Chamber:

.1 Provide booster pump if higher water pressure is required than is available from the water supply system.

.2 Provide a non-mechanical wetting chamber for preparation of the polymer solution.

.3 Fabricate the feed spout of Type 316 stainless steel.

.4 Provide a brass solenoid valve for controlling flow water to the dispenser.

.5 No restrictions shall be present past the point of water-polymer contact.

.6 Provide high level overflow for the wetting system and a high level switch to provide an audible alarm upon malfunction of the wetting chamber.

.4 Mix Tank:

.1 Provide one mix tank, to mix polymer solution discharged from the dispenser prior to its transfer to the feed tank. Design the tank for the minimum specified aging time.

.2 Reinforce all flanged ports with gussets. Make flanges compatible with ANSI Class 125 flanges.

.5 Agitator:

.1 Drive the agitator for the mix tank by with a minimum 2.2 kW electric motor with a service factor of 1.15.

.2 Gear reduced to 350 RPM maximum output speed. Output torque designed for corresponding tank size and shall to mix the polymer solution without fracturing the polymer chains.

.3 For mixers with motors less than 3.7 kW, the mixer may be supported from a structure on the side of the tank, with the mixer shaft installed at an angle. For motors larger than 3.7 kW, the mixer shall be mounted vertically on a dedicated bridge frame structure above the mixing tank.

.6 Feed Tank:

.1 Provide a feed tank to receive solution from the mix tank and store it for feeding by the polymer feed pumps.

.2 Reinforce all flanged ports with gussets. Make flanges compatible with ANSI Class 125 flanges.

.7 Skid-mounted Piping and Valves:

.1 All piping shall be Type 304L or Type 316L stainless steel, schedule 10, rated for 150 lb at saturated steam temperature per ANSI/ASME B31.3. Threaded connections shall be avoided or minimized. Threaded joints shall be prohibited for piping with diameter of 50 mm and above.

.2 Flanges may be C.S. ASTM A-105, ANSI/ASME Class 150 lap joint, but with butt-welded, forged stainless steel stub ends similar to piping. Stamped stub ends shall be prohibited. Steel flanges shall be corrosion protected. Flange bolt holes shall straddle natural centre lines.

.3 Direct tapping on piping walls for instrument insertion shall be prohibited.

.4 All pressure welds shall be by welders certified as qualified according to the applicable code or standard.

.5 Equipment, pumps, valves, flow switches, and other in-line equipment shall be installed in that they are accessible and can be replaced or repaired without placing a strain on the piping. Breakout flanges and unions shall be provided between equipment and block valves, if any, to allow easy removal.

.6 Provide actuator electrical enclosures rated for the area classification. Electrical actuators shall be CSA approved. Provide each actuator with a built-in motor overload protection and fit each actuator with a manual override control of the valve.

.7 All piping, valves and equipment shall be supported and anchored to avoid undue stresses and vibrations during shipment and during normal operation.

.8 Provide valved drain connections at low points on tanks and lines, and on suction and discharge piping on pumps. Valved vent connections shall be installed on high points of lines.

.9 Valves: for stainless steel pipe 50 mm and less, use stainless steel ball valves with filled Teflon seats. For stainless steel pipe 75 mm and above, use stainless steel ball valves with filled Teflon seats or butterfly valves with stainless steel disk.

.10 Globe, check and control valves shall be installed correctly relative to flow direction.

.11 All pipe, fittings, flanges and other piping elements shall meet ANSI and ASTM standards.

.8 Liquid Level Control:

.1 Ultrasonic liquid level transmitter shall automatically operate the entire polymer feed system.

2.5 Electrical Components

.1 Electrical components shall be CSA or cUL certified.

.2 Electrical cables shall be type Teck 90 copper conductors, armored cables shall secured to the skid structure in a professional manner.

.3 All RW 90 wiring shall be coper and shall be installed in aluminum conduit or liquid tight flexible aluminum conduit.

.4 Electrical enclosures shall be NEMA 4X.

.5 Operating voltage is 600Volt, 3 phase, 60Hz.

.6 Motor starter and components shall be in accordance to City of Winnipeg Standardized agreement RFP. Refer to Specification Sections16226 and 16228.

.7 All electrical Circuit breakers shall be10kAIC rated or higher as required.

.8 Electrical motor shall comply with Specification Section 16223 - Electric Motors up to 250 kW.

2.6 Instrumentation and Control

.1 Provide NEMA 4X control panel with Schneider M580 PLC as per City of Winnipeg Standardized agreement RFP.

.2 Provide panel operator interface HMI for polymer feed system. Refer to City of Winnipeg HMI layout guide line.

.3 Provide following hard wire signals to plant control system PCS.

  .1 Run status.

  .2 Fault status (fail safe signal).

  .3 Hopper Low Level signal.

  .4 System Ready signal.

  .5 Command Run.

.4 Provide emergency stop for the system.

.5 All instrumentation shall be CSA or cUL approved.

2.7 Spare Parts

.1 Provide spare parts that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements and the following:

  .1 One (1) set of bearings and seals for each piece of equipment.

  .2 One (1) spare VFD for the screw feeder.

  .3 One (1) complete replacement mixer.

3. EXECUTION

3.1 General

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

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

.3 Measure and record the polymer discharge and water volume on each of three (3) consecutive days and determine the polymer strength (measured polymer mixing – percent active polymer kg/m^3).

.4 Measure and record the polymer strength in the aging tank (measured polymer mixed Product - percent active polymer – kg/m^3).

.5 Compare the polymer mixing strength, vs polymer mixed strength vs equipment calculated strength. Adjust the system to provide a consistent batch within 5 percent of the calculated strength.

END OF SECTION

SAMPLING EQUIPMENT

1. GENERAL

1.1 Summary

.1 This Section specifies supply and supervision of installation, testing, and commissioning of sampling equipment.

1.2 Submittals

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

  .1 Manufacturer's descriptive literature for materials.

.2 Provide coordination drawing indicating all locations samples are being collected and confirm the sample method is appropriate.

2. PRODUCTS

2.1 Manufacturers and Products

.1 Acceptable Manufacturers and product:

  .1 Sentry, Bristol-Isolok.

  .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 The 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 120 V or 208 V 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 that are identical to and interchangeable with similar parts installed and in accordance with Schedule 18 Technical Requirements 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 the Manufacturer’s recommendations and as required by the Final Design.

.2 Undertake commissioning phases as specified in the Schedule 18 Technical Requirements.

END OF SECTION