EQUIPMENT GENERAL PROVISIONS

1. GENERAL

1.1 Background

.1 The City of Winnipeg treats and supplies potable water to a population of approximately 632,000 people. The source of supply for the City of Winnipeg is surface water originating from Shoal Lake. The water is chlorinated at the intake and is conveyed via an Aqueduct to the Deacon reservoir, located just east of the City. The Deacon reservoir consists of four (4) open cells and holds approximately fourteen (14) to twenty eight (28) days supply for the City. Water is rechlorinated as it leaves the reservoir through two (2) branch Aqueducts. The Water Distribution System contains three (3) regional distribution reservoirs and pumping stations.

.2 The City of Winnipeg wishes to enhance the treatment of its potable water. Currently the City is in the process of working toward the commissioning of UV disinfection equipment, which will be located after the Deacon reservoir to assist in inactivation of *Giardia* and *Cryptosporidium*.

.3 The treatment process will be further enhanced by the construction of a filtration plant. The new filtration plant will consist of coagulation with ferric chloride, flocculation, clarification using DAF, ozonation, filtration, followed by disinfection using chlorine, UV light, and chloramination.

1.2 Requirements

.1 The provisions of this Section shall apply to all equipment except where otherwise indicated.

.2 Substantiating calculations and Drawings shall be provided at the time of submittal.

1.3 Reference Specifications, Codes, and Standards

.1 Equipment shall be in accordance with the latest edition of the following standards, as applicable and as indicated in each equipment Specification:

.1 AGMA

.2 ASTM

.3 ANSI

.4 ASME

.5 AWWA

.6 ASHRAE

.7 AWS

.8 NFPA

.9 NEMA

.10 Manufacturer's published recommendations and Specifications.

.11 General Industry Safety Orders (OSHA).

.12 CSA

.13 ULC

.2 The following standards are referenced in this Section:

.1 ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

.2 ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys.

.3 ANSI B46.1 - Surface Texture.

.4 ASME B1.20.1 - General Purpose Pipe Threads (Inch).

.5 ASME B31.1 - Power Piping.

.6 AWWA C206 - Field Welding of Steel Water Pipe.

.7 AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 in through 144 in (100 mm through 3,600 mm).

.8 AWWA D100 - Welded Steel Tanks for Water Storage.

.9 ASTM A 48 - Gray Iron Castings.

.10 ASTM A 108 - Steel Bars, Carbon, Cold-Finished, Standard Quality.

1.4 Contractor Submittals

.1 Shop Drawings: Furnish submittals in accordance with Section 01300 – Submittals.

.2 Equipment Installation: Complete all documentation as required within Section 01650 – Equipment Installation.

.3 Manuals: Provide manuals as specified within Section 01730 – Operation & Maintenance Manuals.

.4 Spare Parts List: A spare parts list complete with the name, address, and telephone number of the nearest distributor for each piece of equipment shall be provided. Include current prices for each spare part.

1.5 Quality Assurance

.1 Costs: Pay all costs of inspection, testing, adjustment, and instruction services performed by Manufacturer's representatives. The City will pay for power and water.

.2 Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

.1 Machine Work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1.5 mm for members 10 m or less in length, and not greater than 3 mm for members over 10 m in length.

.2 Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5% of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures.

.3 All materials shall meet the physical and mechanical properties in accordance with the reference standards.

.3 Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

.1 Surface roughness not greater than 1.575 µ shall be required for all surfaces in sliding contact.

.2 Surface roughness not greater than 6.25 µ shall be required for surfaces in contact where a tight joint is not required.

.3 Rough finish not greater than 12.5 µ shall be required for other machined surfaces.

.4 Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 0.8 µ.

2. PRODUCTS

2.1 General Requirements

.1 Noise Level: When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 85 dBA for one (1) hour exposure per day.

.2 Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. All components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the

maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical motors, load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Pumps		
centrifugal or rotary	1.0	Uniform
progressing cavity	1.0	Uniform

.3 Mechanical Service Factors

	Mechanical Service Factors
	Electric Motor
Uniform	1.25
Moderate Shock	1.50
Heavy Shock	2.00

.4 For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear Manufacturer sizing information.

.5 Where load classifications are not indicated, service factors based on AGMA 514.02 shall be used for standard load classifications and service factors for flexible couplings.

.6 Welding: Unless otherwise indicated, welding shall conform to the following:

.1 Latest revision of AWWA D100.

.2 Latest revision of AWWA C206.

.3 Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

.4 Welding shall be by the metal-arc method or gas-shielded arc method as described in the AWS "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

.5 In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and

dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 0.8 mm ($^{1}/_{32}$ in) on the flat.

.7 Protective Coating: Equipment shall be painted or coated as specified within each equipment Specification unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with food grade grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

.8 Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Equipment delivered to the Site with rust or corroded parts shall be rejected.

.9 Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per Manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

.10 Controls: Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 Equipment Supports

.1 Equipment Supports: Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10% of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in Manitoba, unless otherwise indicated.

2.3 Shafting

.1 General: Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

.2 Design Criteria: All shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M, - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of two (2) in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.

.3 Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be

taken into consideration. Materials shall be as indicated unless furnished as part of equipment assembly.

.1 Low carbon cold-rolled steel shafting shall conform to ASTM A108, Grade 1018.

.2 Medium carbon cold-rolled shafting shall conform to ASTM A108, Grade 1045.

.3 Other grades of carbon steel alloys shall be suitable for service and load.

.4 Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

.4 Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with two (2) sets of universal type couplings shall be provided.

2.4 Gears and Gear Drives

.1 Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94%. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used.

.2 Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

.3 Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

.4 Material selections shall be left to the discretion of the Manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two (2) positive seals to prevent oil leakage.

.5 Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be provided when necessary.

.6 Where gear drive input or output shafts from one Manufacturer connect to couplings or sprockets from a different Manufacturer, gear drive Manufacturer shall furnish a matching key taped to the shaft for shipment.

.7 Protect process streams from oil and grease leaks/spills.

2.5 Bearings

.1 General: Bearings shall conform to the standards of the AFBMA.

.2 To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

.3 Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

.4 Lubricated-for-life bearings shall be factory-lubricated with the Manufacturer's recommended grease to insure maximum bearing life and best performance.

.5 Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of five (5) years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life (years)**	**L-10 Design Life (hours)**
	(whichever comes first)	
8 hour shift	10	20,000
16 hour shift	10	40,000
Continuous	10	60,000

.6 Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the Manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

.7 Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing Manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing Manufacturer.

.8 Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the Manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, the Manufacturer shall provide necessary piping, filters, and valves.

.9 Protect process streams from oil and grease leaks/spills.

2.6 Piping Connections

.1 Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment.

.2 Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ANSI B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ANSI/ASME B1.20.1.

.3 Flexible Connectors: Flexible connectors shall be provided in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

.4 Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used.

2.7 Gaskets and Packings

.1 Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal".

2.8 Nameplates

.1 Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the Manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.9 Tools and Spare Parts

.1 Tools: Furnish one (1) complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of all supplied equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional Work and manufactured by Snap On, Crescent, Stanley, or approved equal. The set of tools shall be neatly mounted in a labelled toolbox of suitable design provided with a hinged cover.

.2 Spare parts shall be furnished as indicated in the individual equipment Sections. All spare parts shall be suitably packaged in a metal box and labelled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.10 Equipment Lubricants

.1 Supply and Install food grade lubricants for all equipment during storage and prior to initial testing of the equipment.

3. EXECUTION

3.1 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

3.2 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.3 Equipment Performance Testing

.1 The Manufacturer’s Representative shall ensure that all equipment, including all component parts, operates as intended.

.2 The Manufacturer’s Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.4 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

END OF SECTION

DEACON BOOSTER PUMP INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 571-2005.

.2 The Contractor shall comply with all Division 1 requirements.

.3 The Contractor shall Supply and Install all components, piping, wiring, connections, accessories, etc. as specified in the Contract Documents required to complete the installation.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the Deacon Booster Pumps as set forth in Bid Opportunity No.571-2005. The Deacon Booster Pumps including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

.5 Conform to Manufacturer's instructions for pump, motor and VSD installation.

1.2 Work by Contractor

.1 This Section covers the Work necessary by the Contractor to install the Deacon Booster Pumping equipment as described in Bid Opportunity No. 571-2005.

.2 Unloading and installation of the furnished equipment and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor.

.3 Install all horizontal split case pumps, motors, VSDs (Magnadrives), electric actuators, shafts, and supporting frames.

.4 All external conduit and wiring between separate equipment shall be Supplied and Installed by the Contractor as specified in Division 16.

.5 The Contractor shall touch-up any shipping or installation damage to the finish, following installation. Touch up paint for City Supplied Equipment will be supplied by the City.

.6 Concrete equipment pads, equipment anchor bolts, and grouting.

.7 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and furnishing a complete pump arrangement, and for coordination of all major equipment components. This includes, but is not limited to, proper sizing, testing, and performance of all pump components. There are a total of two (2) pump arrangements each including, but not be limited to, the following:

.1 335 kW Motor

.2 Horizontal split case pump

.3 MagnaDrive VSD

.4 Electric actuator

.5 Temperature transmitters, speed and vibration sensors

.6 Enclosures

.7 Frame

.2 Supply Contractor to provide services for the Deacon Booster Pumping Equipment Performance Testing and services including installation support, inspection, equipment testing, start-up, installation certification, and training of City personnel.

1.4 References

.1 Install the Deacon Booster Pumping equipment to conform to the latest editions or revisions in effect at the time of the Bid Submission Deadline the applicable, codes, standards, and regulations from the following regulating bodies:

.1 ANSI

.2 ASME

.3 ASTM

.4 Canadian Electrical Code

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 AWWA

.7 AWS

.8 CSA

.9 ESA

.10 ISA

.11 NFPA

.12 EEMAC

.13 Local codes, by-laws, and regulations

.14 NEMA

.2 Specific regulations for each equipment package are listed within the individual Specifications.

1.5 Submittals

.1 Complete all documentation in accordance with Section 01210 – City Supplied Equipment

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Division 16 and 17.

2.2 Mechanical

.1 All mechanical Work shall comply with requirements of Divisions 9, 11, and 15.

.2 Piping shall comply with requirements of Section 15200 – Process Piping, including all Subsections.

.3 Valves shall comply with requirements of Section 15202 – Process Valves and Operators.

.4 All valves shall include factory-mounted operator, actuator, hand wheel, chain wheel, and accessories for a complete operation. All manual valves mounted 1.8 m above finished floor shall have operator extensions or chains located at an elevation of 1.2 m from the finished floor.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.1 The Deacon Booster Pumping equipment shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 The Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 – City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment shall be received by the Contractor at the City Warehouse, in accordance with the Project Master Schedule. The Contract Administrator will arrange for a representative of the Supply Contractor to be present at the City Warehouse during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide on Site instruction for unloading of the Motors, Pumps, MagnaDrives, and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the Deacon Booster Pumping Equipment, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of City personnel.

.5 Do not route water piping directly above power supply units.

.6 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 m above finished floor. Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 m from the finished floor.

3.2 Deacon Booster Pumping Equipment

.1 The Supply Contractor will provide printed instructions for installation of all City Supplied Equipment to the Contractor.

3.3 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 1, including but not limited to Section 01210 – City Supplied Equipment, Section 01664 – Training, and Section 01670 – Commissioning.

END OF SECTION

PROCESS PUMP GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

.1 This Section specifies the general requirements for the supply of all pumps required for this Work.

1.2 Definitions

.1 The terms in the Specification generally comply with the definitions of the Hydraulic Institute.

.2 Definitions:

.1 Pump Bowl Efficiency: Pump efficiency shall be calculated as the pump delivered hydraulic power divided by the mechanical brake horsepower at the inlet shaft of the pump. It shall take full account of mechanical losses. Since this is difficult to measure in the field, it will be calculated based on the Overall Efficiency multiplied by the Electrical Efficiency of the Motor.

.2 Overall Efficiency: Pump and Motor overall efficiency shall be calculated as the pump delivered hydraulic power divided by the electrical power supplied to the motor. It shall take full account of mechanical and electrical losses.

.3 Electrical Efficiency: Motor efficiency shall be calculated as the motor delivered mechanical brake horsepower divided by the electrical power supplied to the motor. It shall take full account of mechanical and electrical losses and will be based on the published guaranteed efficiency of the motor.

.4 Performance curve: The performance curve is a graph of the flow delivered (L/s; x-axis) in relation to the discharge head (metres; y-axis). It generally denotes efficiencies as isopleths and may include NPSH requirements as a function of the flow.

.5 BEP: The BEP is the point in the pump performance curve where the pump operates at its highest pump efficiency.

.6 Rating Point: The pump rating point is the combination of discharge head and flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.). This condition is listed in the detailed pump Specification and must be satisfied by the pump supplied.

.7 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, minimum discharge head, etc.). The minimum system head is shown or described for each pump. The Manufacturer must ensure 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.

.8 Low Speed Point: The minimum flow and head conditions against which a variable speed pump is expected to operate.

.9 NPSH: The total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of Site atmospheric pressure and suction piping losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur. Required NPSH shall be measured 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.

1.3 Submissions

.1 Shop Drawings: Submit in accordance with Section 01300 – Submittals and 11000 – Equipment General Provisions. For all pump Shop Drawings in addition to the requirements of Section 11000 – Equipment General Provisions, include the following specific details:

.1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. With the performance curve, include efficiency isopleths and NPSHR variation with flow. Where required in the specific pump Sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.

.2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative Drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference Specifications for those materials.

.4 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.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.).

.6 Start-up instructions including lubricant requirements, electrical requirements, etc.

.2 O&M Data: Provide for incorporation in O&M Manual as specified in Section 01730 – Operation and Maintenance Manual. Include the following:

.1 Complete description of operation.

.2 General arrangement and detailed Drawings.

.3 Wiring diagrams for power and control schematics.

.4 Parts catalogues with complete list of repair and replacement parts with Section Drawings, illustrating the connections and the part Manufacturer's identifying numbers.

1.4 Delivery and Storage by Manufacturer's Representative

.1 Prior to delivery, ensure that the Form 101 – Certificate of Readiness to Install is completed to ensure that the Contractor is ready to receive the specified equipment.

.2 Ship pre-assembled to the degree that is possible. Inform Contractor of any Site assembly requirements.

.3 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

.4 Where pumps are to be stored on-Site for any period of time exceeding one (1) week, ensure there is no uneven wear or distortion of pump component parts.

.5 Identify any special storage requirements.

1.5 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

2. PRODUCTS

2.1 Pump Performance Requirements

.1 Supply pumps that are suitable for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency of within 5% of the efficiency at the BEP.

.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 within 10% of efficiency at the BEP.

.4 Ensure that motors are sufficiently sized to drive pumps at a maximum speed when the head is specified for the low head point.

.5 Supply pumps capable of operating at 30% of the flow at the rated capacity 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.

2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.

.2 For submersible pumps, supply only one (1) gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wet well.

.3 Gauges

.1 Supply gauges that are 100 mm diameter, 13 mm bottom connection, complete with shut off cock with stainless steel movement and Bourdon tube.

.2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.

.3 Calibrate the gauges to read pressure ranges approximately as follows:

	Actual Pressure	**Gauge Pressure Range**
Suction	-50 to 50 kPa	-50 to 350 kPa
	50 to 200 kPa	0 to 350 kPa
	200 to 700 kPa	0 to 1000 kPa
Discharge	50 to 350 kPa	0 to 700 kPa
	350 to 700 kPa	0 to 1000 kPa
	700 to 1500 kpa	0 to 2000 kPa

.4 Acceptable Manufacturers: Ashcroft, H.O. Trerice.

.4 Pressure Sensors

.1 Supply annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured, 25 mm diameter.

.2 Acceptable Products: Red Valve Series 42 or Robbins and Myers RKL Series W.

.3 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one leg of the tee. If a pressure indicator/transmitter/switch is shown on the Drawings, mount on the other side of the tee. Otherwise, plug the tee.

.4 Supply annular type pressure sensors with their initial fill of fluid.

2.3 Pump Seals

.1 Provide double mechanical seals, unless otherwise noted in the Specifications of the particular pump.

.2 Single mechanical seals can be used only where noted in the Specifications of the particular pump.

.3 Double mechanical seals are located adjacent to one another, with a cooling/flushing water filled space between. They are supplied as a single package.

.4 Provide non-destructive, self aligning seals of the stationary design which require no wearing sleeve for the shaft.

.5 Materials of construction:

Type of Service	Metal Parts	Spring(s)	O-Rings	Faces
Potable water.	316 or 316L Stainless Steel	316 or Hastelloy C	Buna-N or Viton	Silicon Carbide on Carbon

.6 Provide connections for cooling/flushing water.

.7 Acceptable Manufacturers are:

.1 Durametallic.

.2 John Crane.

.3 Chesterton.

2.4 Packing

.1 Packing can be used only where noted in the Specifications of the particular pump.

.2 Provide a minimum of five (5) rows of packing material suitable for the medium being pumped.

.3 Provide bronze lantern rings that are externally adjustable.

2.5 Stuffing Boxes

.1 Integrally cast the stuffing box with the motor mounting bracket, providing adequate area for the internal recirculation of the flushing/cooling fluid around the sealing medium.

.2 Provide a tapped and plugged hole for external flushing/cooling water.

2.6 Bearings

.1 Refer to Section 11000 – Equipment General Provisions.

2.7 Protective Guards

.1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11000 – Equipment General Provisions.

2.8 Couplings

.1 For all pumps other than submersible and where noted otherwise in the detailed Specifications, provide flexible, double disc spacer type couplings conforming to Section 11000 – Equipment General Provisions.

.2 Design couplings so that the pump unit can be disassembled without disturbing face piping.

2.9 Shafts

.1 Design shafts to absorb 1.15 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

2.10 Tagging Instructions

.1 Tag loose items associated with a particular unit with the equipment number. Use aluminum or stainless steel (no plastic) tags securely attached to each item.

.2 Identification used shall be the same as the symbol indicated in the Specifications or on the Drawings and shall be located in a conspicuous place as acceptable to the Contract Administrator.

2.11 Spare Parts

.1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one (1) set of pump bearings.

.2 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pump shaft and nut.

.3 For spare parts for positive displacement pumps, provide as a minimum, one (1) wearing element. Refer to related pump Specifications for the specific spare part requirements.

2.12 Factory Performance Testing

.1 Where required for specific pumps, as noted in the Sections related to those pumps, factory performance test all pumps.

.2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.

.3 Inform Contract Administrator at least three (3) weeks prior to the factory testing to allow for his attendance.

.4 Certify test results and summarize findings in a short report. Submit report to the Contract Administrator within three (3) weeks of completing factory tests.

.5 Where the pump(s) does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and re-test the pump(s), all at no additional cost.

.6 Do not ship the pump(s) until the test result report has been submitted to the Contract Administrator.

2.13 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings, or request deviation for approved equal at shop drawing submittal for Manufacturer's standard coating.

2.14 Motors

.1 Provide all motors in accordance with Section 11301 – Process Motors.

3. EXECUTION

3.1 General

.1 Comply with the requirements of the specific Sections for the pumps to be provided.

3.2 Installation

.1 Comply with the requirements of Section 01650 – Equipment Installation and any special requirements listed in the specific Sections related to each pump.

3.3 Testing

.1 The Contractor shall field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance. The Contractor shall record the results of the testing and provide as required, clarification of testing procedures, or any additional information necessary to complete testing in an appropriate manner.

.2 The Contractor shall provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.3 Flow Metering

.1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least five (5) minutes of pump operation at the flows that are to be tested, other than runout.

.2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Contract Administrator. Ensure that the permanent flow meters are calibrated to within 5% of the rated flow of the pump to be tested prior to testing.

.3 Temporary metering may be used if accepted by the Contract Administrator. Temporary meters must have an accuracy of plus or minus 5%, at the rated flow of the pump, to be acceptable.

.4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Contract Administrator. Measured flows during the testing will be certified by a qualified Representative of the Contract Administrator to be within 5% of the actual flows.

.4 Pressure Monitoring

.1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.

.2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5%. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.

.3 Provide evidence of pressure gauge calibration within three (3) months of conducting tests.

.5 Test pump(s) at a minimum of three (3) flow conditions, typically corresponding to the rating point flow, 75% of that flow, and 120% of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.

.6 For variable speed pumps, conduct the tests at two (2) speeds, typically 100% of the design speed and 30% of the design speed, plus other design tests as described in the individual pump specifications and data sheets.

.7 Field Test Report

.1 Compile field test results into a report for submittal to the Contract Administrator.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submissions.

.8 Where field tests do not verify compliance with specified performance requirements; investigate cause for noncompliance, undertake remedial Work as required to bring pump into compliance or replace the pump and all necessary ancillaries, and retest to prove compliance. All Work required to bring the pump into compliance is the responsibility of the Contractor and shall be performed at the Contractor's cost.

END OF SECTION

PROCESS MOTORS

1. GENERAL

1.1 Related Sections

.1 This Section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this Section.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 CSA C22.2 No. 100, Motors and Generators.

.2 CSA C22.2 No. 145, Motors and Generators For use in Hazardous Locations.

.3 CSA C390, Energy Efficiency Test Methods for Three-Phase Induction Motors.

.4 ABMA:

.1 9, Load Ratings and Fatigue Life for Ball Bearings.

.2 11, Load Ratings and Fatigue Life for Roller Bearings.

.5 ANSI: C50.41, Polyphase Induction Motors for Power Generating Stations.

.6 IEEE:

.1 85, Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.

.2 112, Standard Test Procedures for Polyphase Induction Motors and Generators.

.3 114, Standard Test Procedures for Single-Phase Induction Motors.

.4 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Motors.

.5 841, Standard for Petroleum and Chemical Industry – Severe Duty TEFC Squirrel Cage Induction Motors – up to and Including 500 hp.

.7 NEMA:

.1 MG 1, Motors and Generators.

.2 MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.

.3 250, Enclosures for Electrical Equipment (1,000 V Maximum).

.8 Ontario Electrical Safety Code 23 edition, 2002. (OESC).

.9 ULc:

.1 1, Flexible Metal Conduit.

.2 674, Standard for Safety Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

.3 2111, Overheating Protection for Motors.

.10 EEMAC Standard M1-6, Motors and Generators.

.11 EEMAC Standard MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

1.3 Definitions

.1 CISD-TEFC: Chemical industry, severe-duty enclosure.

.2 EXP: Explosion-proof enclosure.

.3 ODP: Open drip-proof enclosure.

.4 TEFC: Totally enclosed, fan cooled enclosure.

.5 TENV: Totally enclosed, nonventilated enclosure.

.6 WPI: Open weather protected enclosure, Type I.

.7 WPII: Open weather protected enclosure, Type II.

.8 Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

.9 Inverter Duty Motor: Motor meeting all applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

1.4 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Descriptive information.

.2 Nameplate data in accordance with NEMA MG 1.

.3 Additional Rating Information:

.1 Service factor.

.2 Locked rotor current.

.3 No load current.

.4 Safe stall time for motors 300 hp and larger.

.5 Multi-speed load classification (e.g. variable torque).

.6 Variable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.

.7 Guaranteed minimum full load efficiency and power factor.

.4 Enclosure type and mounting (e.g. horizontal, vertical).

.5 Dimensions and total weight.

.6 Conduit box dimensions and usable volume as defined in NEMA MG 1 and OESC.

.7 Bearing type.

.8 Bearing lubrication.

.9 Bearing life.

.10 Space heater voltage and watts.

.11 Description, ratings, and wiring diagram of motor thermal protection.

.12 Motor sound power level in accordance with NEMA MG 1.

.13 Maximum brake horsepower required by the equipment driven by the motor.

.14 Description and rating of submersible motor moisture sensing system.

.2 Information Submittals:

.1 Factory test reports, certified for motors 300 hp and larger.

.2 O&M data.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 GE Canada.

.2 Leeson Canada.

.3 Reliance Electric.

.4 MagneTek.

.5 Siemens Energy and Automation, Inc., Motors and Drives Division.

.6 Baldor.

.7 U.S. Electrical Motors.

.8 TECO-Westinghouse Motor Co.

.9 Toshiba International Corp., Industrial Division.

2.2 General

.1 For multiple units of the same type of equipment, furnish identical motors and accessories of a single Manufacturer.

.2 In order to obtain single source responsibility, a drive motor, its driven equipment, and specified motor accessories shall be supplied as a Vendor Package.

.3 Meet requirements of NEMA MG 1.

.4 Frame assignments in accordance with NEMA MG 13.

.5 Provide motors for hazardous (classified) locations that conform to OESC and have an applied CSA listing mark.

.6 Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

.7 Lifting lugs on all motors weighing 45 kg or more.

.8 Operating Conditions:

.1 Maximum ambient temperature not greater than 40°C.

.2 Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.

.3 Overspeed in either direction in accordance with NEMA MG 1.

2.3 Horsepower Rating

.1 As designated in motor-driven equipment specifications.

.2 Constant Speed Applications: Brake horsepower of the driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

.3 Variable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

2.4 Service Factor

.1 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.5 Voltage and Frequency Rating

.1 System Frequency: 60-Hz.

.2 Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
0.37 kW and smaller	115	1
0.56 kW through 298 kW	575	3

.3 Suitable for full voltage starting.

.4 74.6 kW and larger also suitable for solid state reduced voltage starting.

.5 Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90% of motor rated voltage.

2.6 Efficiency and Power Factor

.1 For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

.1 Efficiency:

.1 Tested in accordance with CSA C390, paragraph 12.59.

.2 Guaranteed minimum at full load in accordance with NEMA MG 1 Table 1, Supplement, or as indicated in motor-driven equipment specifications.

.2 Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.7 Locked Rotor Ratings

.1 Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

.2 Safe stall time 12 seconds or greater.

2.8 Insulation Systems

.1 Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

.2 Motors Rated Over 600 V: Sealed windings in accordance with NEMA MG 1.

.3 Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP motors which must be Class B with Class B rise**.**

2.9 Enclosures

.1 Enclosures to conform to NEMA MG 1.

.2 TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

.3 EXP:

.1 TEFC listed to meet requirements for Class I, Zone 1 or 2 (as required in the application), Group C and D hazardous locations.

.2 Drain holes with drain and breather fittings.

.3 Integral thermostat opening on excessive motor temperature in accordance with OESC.

.4 Terminate thermostat leads in terminal box separate from main terminal box.

.4 Submersible: In accordance with Article Special Motors.

.5 CISD-TEFC: In accordance with Article Special Motors.

.6 All motors to be minimum TEFC.

2.10 Terminal (Conduit) Boxes

.1 Oversize main terminal boxes for all motors.

.2 Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

.3 Except ODP, Supply and Install gaskets between box halves and between box and motor frame.

.4 Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19:

Terminal Box Usable Values		
Voltage	**kW**	**Percentage**
Below 600	11.2 through 93	500
Below 600	111 through 224	275
Below 600	261 through 447	225
Above 600	All sizes	200

.5 Terminal for connection of equipment grounding wire in each terminal box.

2.11 Bearings and Lubrication

.1 Horizontal Motors:

.1 0.56 kW and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

.2 0.75 through 298 kW: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

.3 Above 298 kW: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.

.4 Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and 11.

.2 Vertical Motors:

.1 Thrust Bearings:

.1 Antifriction Plate type (Kingsbury) bearing.

.2 Manufacturer's standard lubrication 74.6 kW and smaller.

.3 Minimum 50,000 hours L-10 bearing life.

.2 Guide Bearings:

.1 Manufacturer's standard bearing type.

.2 Manufacturer's standard lubrication 149 kW and smaller.

.3 Minimum 100,000 hours L-10 bearing life.

.3 Regreasable Antifriction Bearings:

.1 Readily accessible, grease injection fittings.

.2 Readily accessible, removable grease relief plugs.

.4 Oil Lubrication Systems:

.1 Oil reservoirs with sight level gauge.

.2 Oil fill and drain openings with opening plugs.

.3 Provisions for necessary oil circulation and cooling.

.5 Bearing Isolation: Motors rated for inverter duty shall have electrically isolated bearings to prevent stray current damage.

2.12 Noise

.1 Measured in accordance with IEEE 85 and NEMA MG 1.

.2 Motors controlled by variable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 Balance and Vibration Control

.1 In accordance with NEMA MG 1, Part 7.

2.14 Equipment Finish

.1 Protect Motor for Service Conditions:

.1 ODP Enclosures: Indoor industrial atmospheres.

.2 Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure

.2 External Finish: Prime and finish coat Manufacturer's standard.

.3 Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 Special Features and Accessories

.1 Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1, and attached with stainless steel screws.

.2 Winding Thermal Protection:

.1 Provide thermostats, thermistors, and RTDs as indicated on the P&IDs and control drawings.

.3 Bearing Temperature Protection:

.1 As indicated in P&IDs.

.4 Vibration detection relay mounted in NEMA 250, Type 4X enclosure on side of motor, when indicated.

.5 Nameplates:

.1 Raised or stamped letters on stainless steel or aluminum.

.2 Display motor data required by NEMA MG 1, paragraphs 10.39 and 10.40 in addition to bearing numbers for both bearings.

.3 Premium efficiency motor nameplates to also display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

.6 Anchor Bolts: Supply and Install anchor bolts meeting Manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

2.16 Special Motors

.1 Requirements in this article take precedence over conflicting features specified elsewhere in this Section.

.2 CISD-TEFC:

.1 In accordance with IEEE 841.

.2 TEFC in accordance with NEMA MG 1.

.3 Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.

.4 Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.

.5 Ventilating Fan: Corrosion-resistant, nonsparking, external.

.6 Drain and Breather Fittings: Stainless steel.

.7 Nameplate: Stainless steel.

.8 Gaskets between terminal box halves and terminal box and motor frame.

.9 Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.

.10 Double shielded bearings.

.11 125,000 hours minimum L-10 bearing life for direct-connected loads.

.12 External Finish: Double-coated epoxy enamel.

.13 Coated rotor and stator air gap surfaces.

.14 Insulation System, Windings, and Connections:

.1 Class F insulation, Class B rise or better at 1.0 service factor.

.2 Multiple dips and bakes of nonhygroscopic polyester varnish.

.15 Service Factor:

.1 At 40°C Ambient: 1.15.

.2 At 65°C Ambient: 1.00.

.16 Safe Stall Time Without Injurious Heating: 20 seconds minimum.

.3 Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

.4 Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

.5 Inverter Duty Motor:

.1 Motor supplied power by adjustable voltage and variable frequency drives shall be inverter duty rated.

.2 Motor shall be suitable for operation over entire speed range indicated.

.3 Provide forced ventilation where speed ratio is greater than published range for motor being installed.

.4 Motor installed in Class I, Zone 1 or 2 hazardous (classified) locations shall be identified as acceptable for variable speed when used in a these hazardous locations.

.6 Submersible Pump Motor:

.1 As per Pump Manufacturers.

.2 At 100 Percent Load:

Submersible Pump Motors		
kW	**Guaranteed Minimum Efficiency**	**Guaranteed Minimum Power Factor**
3.7 through 7.4	80	82
7.5 through 37.3	85	82
37.4 through 74.6	87	82
Over 74.6	89	82

.3 Insulation System: Manufacturer’s standard Class B or Class F.

.4 Motor capable of running dry continuously.

.5 Enclosure:

.1 Hermetically sealed, watertight, for continuous submergence up to 20 m depth.

.2 Listed to meet OESC requirements for Class I, Zone 1 and 2 Group C and D hazardous atmosphere.

.3 Seals: Tandem mechanical.

.6 Bearing and Lubrication:

.1 Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.

.2 Minimum 15,000 hours L-10 bearing life.

.7 Inrush kVA/horsepower no greater than NEMA MG 1 and Code F rating.

.8 Winding Thermal Protection:

.1 Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.

.2 Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.

.3 Switch contacts rated at 5 amps, 120 VAC.

.9 Motor Seal Failure Moisture Detection:

.1 Probes or sensors to detect moisture beyond seals.

.2 Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120 VAC supply.

.3 Monitoring module with control power transformer, probe test switch and test light, and two independent 120 VAC contacts, one opening and one closing when the flux of moisture is detected.

.10 Bearing Overtemperature Protection for Motors Larger than 100 hp

.1 Sensor on lower bearing housing monitoring bearing temperature.

.2 Any monitoring relay necessary to provide 120 VAC contact opening on bearing overtemperature.

.11 Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120V ac contacts, one closing and one opening on malfunction.

.12 Connecting Cables:

.1 Two separate cables, one containing power and grounding conductors, and the other containing control and grounding conductors.

.2 Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.

.3 Length: 10 m minimum.

.4 CSA listed and sized in accordance with OESC.

.7 Inclined Motors:

.1 Motors suitable for operation only in horizontal position not acceptable.

.2 Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.

.3 Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 Factory Testing

.1 Tests:

.1 In accordance with CSA C390 for polyphase motors and for single-phase motors.

.2 Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.

.3 For energy efficient motors, test efficiency at 50, 75, and 100% of rated horsepower:

.1 In accordance with CSA C390 or IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.59 and 12.60.

.2 For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by CSA C390 or IEEE 112, Test Method F.

.4 Power Factor:

.1 Speed.

.2 Current at rated horsepower.

.3 kW input at rated horsepower.

.4 On motors 74.6 kW and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

.5 Vibration (balance).

.2 Test Report Forms:

.1 Routine Tests: IEEE 112, Form A-1.

3. EXECUTION

3.1 Installation

.1 In accordance with Manufacturer's instructions and recommendations.

.2 Align motor carefully and properly with driven equipment.

.3 Secure equipment to mounting surface with anchor bolts.

3.2 Field Quality Control

.1 Refer to Section 16030 – Electrical Testing.

END OF SECTION

DISINFECTION OF PIPING AND EQUIPMENT

1. GENERAL

1.1 Work Included

.1 Disinfection of piping and water conveying equipment.

1.2 Related Codes

.1 AWWA C651-99 Disinfecting Water Mains.

.2 City of Winnipeg Standard Construction Specifications, Division 2 – CW2125.

1.3 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

1.4 Schedule of Items to be Disinfected

.1 The Contractor shall disinfect all items affected by the Work which will be used for the conveyance or storage of potable water; these include but are not limited to the following structures and piping:

.1 All pipework conveying potable water, including but not necessarily limited to:

.1 Suction piping to the Branch 1 pumps and including the pumps.

.2 Discharge pipework from the Branch 1 pumps.

.3 Valves and instrumentation installed in the potable water piping.

.4 Cooling water supply and discharge piping.

.5 Cooling water supply pumps.

.6 Potable water supply piping to the main WTP within the DBPS.

2. MATERIALS

2.1 Water

.1 Water for disinfection shall be provided by the Contractor. The water shall be free from all suspended and deleterious material. The water can be obtained at no charge from the existing City supply under direction from the Contract Administrator/City.

DISINFECTION OF PIPING AND EQUIPMENT

.2 Disinfect piping intended to carry potable water before placing in service as follows:

.1 Meet the requirements of AWWA C651, unless otherwise specified.

.2 Disinfecting Mixture:

.1 A chlorine-water solution having a free chlorine residual of 40 mg/L to 50 mg/L.

.2 Prepare by injecting one of the following:

.1 Liquid chlorine gas-water mixture.

.2 Calcium or sodium hypochlorite and water mixture.

.3 Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution is of the specified strength.

.4 Apply liquid chlorine -water mixture by means of a chlorinating device.

.5 Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1% solution (10,000 mg/L chlorine).

.6 Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1% solution.

.7 The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite [1] (65 – 70% C1)	0.5 kg	28.5 Litres
Sodium Hypochlorite [2] (5.25% C1)	3.8 Litres	16 Litres

1. Comparable to commercial products known as HTH, Perchloron, and Pittchlor.
2. Known as liquid laundry bleach, Clorox, and Purex.

.3 Point of Application:

.1 Inject chlorine mixture into piping to be treated at the beginning of the line through a suitable tap in the piping.

.2 Control clean water from the existing system or another source so it flows slowly into newly installed piping during chlorine application.

.3 Manipulate valves so the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

.4 Retention Period:

.1 Retain treated water in pipeline for a minimum of 24 hours or long enough to destroy nonspore-forming bacteria.

.2 At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 mg/L of chlorine.

.3 Operate valves, hydrants, and other appurtenances during disinfection to assure disinfecting mixture is dispersed into all parts of the pipeline including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.

.4 Do not place concentrated quantities of commercial disinfectants in pipeline before filling with water.

.5 After chlorination, flush the water from the permanent source of supply until water through pipeline is equal chemically and bacteriologically to the permanent source of supply.

.6 Sample water and have bacteriological testing performed by an approved lab. Submit a report to the Contract Administrator.

.5 Disposal of Disinfecting Water:

.1 Dispose of disinfecting water in an acceptable manner that will protect the public and receiving waters from harmful or toxic concentrations of chlorine.

.2 Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level. Dechlorination may be required.

2.2 Calcium Hypochlorite

.1 Calcium hypochlorite shall comply with ANSI/AWWA B-300.

2.3 Sodium Hypochlorite

.1 Sodium hypochlorite shall comply with ANSI/AWWA B-300.

DISINFECTION OF PIPING AND EQUIPMENT

3. EXECUTION

3.1 Applicable Standards

.1 Except as otherwise specified, the work shall be undertaken in accordance with the following codes:

.1 AWWA C651-99 Disinfecting Water Mains.

.2 City of Winnipeg Standard Construction Specifications, Division 2 – CW2125

.3 If these codes conflict, the most stringent clause will apply.

3.2 Cleaning

.1 All pipework to be disinfected shall be thoroughly cleaned prior to disinfection.

.2 All construction material not part of the permanent structure shall be removed.

.3 Pipes shall be flushed to remove all dirt prior to disinfection. If necessary, the pipe shall be cleaned by swabbing or other mechanical means as directed by the Contract Administrator.

3.3 Disinfection of Piping

.1 The Contractor shall disinfect all potable water pipes that have been affected by the Work.

.2 All pipework shall be disinfected according to City of Winnipeg Standard Construction Specifications, Division 2 – CW2125, clause 3.3 Disinfection.

3.4 Disposal of Chlorinated Water

.1 After the disinfection process is complete, the heavily chlorinated water shall be drained and disposed of in an approved manner.

.2 Heavily chlorinated water shall not be discharged to local sewers or surface drains without first obtaining the permission of the Contract Administrator.

.3 If other disposal methods are impractical, dechlorinate the chlorinous water using methods outlined in AWWA C651-99.

3.5 Filling of Piping

.1 Immediately following the disposal of the heavily chlorinated water, the piping shall be filled with potable water.

.2 It is recommended that the potable water used for refilling of the piping be sampled to ensure that no bacteriological contamination exists in the fill water prior to placement in the pipes.

3.6 Bacteriological Testing

.1 Bacteriological testing shall follow the procedure specified in City of Winnipeg Standard Construction Specifications, Division 2 – CW2125, clause 3.4 Bacteriological Samples, except that after the chlorination procedure is complete and the piping has been refilled with potable water, two consecutive sets of samples will be taken 24 hours apart.

.2 Bacteriological testing is to be performed at the nearest available laboratory that is able to perform the tests.

3.7 Disinfection

.1 Disinfection will be acceptable when bacteriological test results from both samples show the total Coliform result is < 1 cfu/100 ml, the HPC does not exceed 500 cfu/ml, and the total chlorine residual does not exceed 2 mg/l after flushing.

.2 If the either of the initial disinfection tests fail, the pipes may be reflushed and resampled.

.3 If either of the check samples fail, then the pipes shall be redisinfected until satisfactory results are obtained.

.4 All costs associated with the redisinfection and testing shall be borne by the Contractor.

3.8 Placing into Service

.1 No piping that is required to be disinfected shall be placed into service until bacteriological samples pass.

3.9 Entry into Existing or Previously Disinfected Potable Watermains

.1 Where entry is required either into existing piping or into previously disinfected piping, the Contractor shall assure that the following measures are taken:

.1 All personnel shall wear clean, dirt free protective overalls and disinfected, clean rubber footwear. Such footwear shall be reserved solely for use within the affected areas and shall not be worn in undisinfected areas.

.2 All tools and equipment shall be clean, grease free and spray disinfected before use. Equipment, which shows evidence of fuel, oil or grease leakage, shall not be used.

.3 The immediate area surrounding the access point for the piping concerned shall be cleaned and spray disinfected prior to the start of work. All previously disinfected footwear, tools or equipment removed outside this area or the affected piping shall be redisinfected on return.

.4 Disinfection of footwear, tools, equipment, and access areas shall be by spraying with a 200 mg/l concentrated chlorine/water solution.

.5 Workmen who show signs of illness shall not work within the affected structures or surrounding access area.

END OF SECTION

FACTORY APPLIED PROTECTIVE COATINGS

1. GENERAL

1.1 Work Included

.1 Supply and application of all factory applied prime coats and factory applied finish coats, where specified, for equipment and products supplied by the Contractor.

1.2 Submissions

.1 With the equipment Shop Drawings, submit details of the coating systems to be applied.

1.3 Quality Assurance

.1 This Specification is intended to be a minimum reference standard. The Contractor may submit for review alternative coating systems for specific items of equipment which provide equal or better corrosion protection and maintenance service than those specified herein.

2. PRODUCTS

2.1 Surface Preparation

.1 Immersion Service: After degreasing, dry blast all ferrous components to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE No. 1 and obtain a 1.3 mm (50 µ) blast profile.

.2 Non-immersion Service: After degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanness in accordance with NACE No. 3 and obtain a 1.3 mm (50 µ) blast profile.

2.2 Coating

.1 Provide 3 coats of polyamide epoxy coating, NSF 61 approved potable grade, 0.08 mm (3 mils) minimum dry film thickness per coat.

2.3 Assembly

.1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.

.2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

.3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers, and rivets in a similar manner.

.4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts,

washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

3. EXECUTION

3.1 General

.1 Apply coatings in accordance with coating Manufacturer's instructions.

3.2 Inspection

.1 Notify the Contract Administrator two (2) weeks before commencing the protective coating to permit the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.3 Protection

.1 Protect all coated equipment adequately against damage, dust, moisture, and scratching during shipment, off-loading and storage on Site. If, in the opinion of the Contract Administrator, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return and re-coat the equipment at the Contractor's cost.

.2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

3.4 Application Conditions

.1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10 and 20°C, and a relative humidity should not exceed 80%.

END OF SECTION

IDENTIFICATION

1. GENERAL

1.1 Work Included

.1 Identification of equipment, motors, valves, ferrous and non-ferrous piping.

1.2 Related Work

.1 Section 11901 – Factory Applied Protective Coatings

2. PRODUCTS

2.1 Equipment Nameplates

.1 Provide metal nameplate on each piece of equipment, installed mechanically fastened with raised or recessed letters. Nameplates to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

.2 Submit list of plates for review prior to engraving.

2.2 Equipment and Project Identification

.1 Supply and install white laminated identification plates with 12 mm recessed black letters on all equipment installed under this Contract. The identification shall include the unit name and the project identification number, e.g. Pump.

.2 Submit list of plates for review prior to engraving.

2.3 Valves

.1 Provide all valves with a 32 mm diameter brass tag with 12 mm black engraved numbers complete with non-ferrous chains or "S" hooks.

.2 Consecutively number valves in distinct systems in accordance with the process schematic drawings.

.3 Furnish a directory consisting of a typewritten valve list showing the tag number, the location of the valve and its use. The directory may be made up in sections to suit the respective WTP area or system.

.4 Mount one copy of these lists in glazed frames as directed by the Contract Administrator. Provide lists in the operating and maintenance manual.

IDENTIFICATION

2.4 Piping

.1 All piping installed under this Contract shall be identified with pipe markers designating the pipe service and the direction of flow.

.2 Pipe markers shall be stencilled in contrasting colour.

.3 Direction arrows are to be 150 mm long x 50 mm wide for piping with an outer diameter 75 mm or larger, including insulation. Use 100 mm long x 20 mm wide for smaller diameters. Provide double headed arrows where appropriate.

.4 Block capital letters are to be used for names, 50 mm high for piping with an outer diameter 75 mm or larger, including insulation. Use 20 mm high for piping with outside diameter less than 75 mm. Use 12 mm high for piping with outside diameter less than 25 mm. Abbreviations for names of the pipe service are provided in this Section.

2.5 Colour Coding

.1 Colour coded system identification shall be carried out on the following items:

.1 Piping, valves, and other equipment supplied and installed under this Contract, shall match the existing colour of similar equipment in the station.

.2 All equipment supplied under other supply contracts are factory coated and finished. The Contractor for this Contract is only responsible for touch-up painting in case the painting is damaged during equipment delivery or installation.

.3 In case an existing colour is not identified for a particular item of equipment, the Contract Administrator shall advise the finished colour.

3. EXECUTION

3.1 Equipment Manufacturer's Nameplates

.1 Locate nameplates so that they are easily read. Do not paint over plates.

3.2 Equipment and Project Identification

.1 Plates shall be attached to the equipment with sheet metal screws or nuts and bolts (adhesive will not be accepted).

.2 Fasten plates in conspicuous locations. Where plates cannot be mounted on hot or cold surfaces, provide standoffs.

IDENTIFICATION

3.3 Valves

.1 Attach brass tags to all valves with supplied chains or S-hooks. Ensure tags are easily accessible and do not conflict with valve operation.

3.4 Piping

.1 On completion of protective coatings or finish painting, neatly stencil on background, direction flow arrows and the pipe surface.

.2 Provide pipe markers in readily visible locations. Piping shall be identified:

.1 At each valve

.2 On both sides of wall penetrations

.3 At floor and roof penetrations

.4 On each leg of branches

.5 Every 15 m along continuous runs

END OF SECTION