END

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 07 20 00: Insulation.

.2 Section 07 90 00: Joint Sealing.

1.2 REFERENCES

.1 CCMPA Canadian Concrete Masonry Producers Association Metric Technical Manual, September 2004.

.2 CAN/CSA-A3000-08, Cementitious Materials Compendium.

.3 CSA-A23.1-09/A23.2-09, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.

.4 CAN/CSA-A82-06 (R2011), Fired Masonry Brick Made from Clay or Shale.

.5 CAN/CSA-A165 Series-04(R2009) (CSA-A165.1 Concrete Masonry Units) (CSA-A165.2 Concrete Brick Units) (CSA-A165.3 Prefaced Concrete Masonry Units Units).

.6 CAN/CSA A179-04(R2009), Mortar and Grout for Unit Masonry.

.7 CAN/CSA-A370-04(R2009), Connectors for Masonry.

.8 CAN/CSA-A371-04(R2009), Masonry Construction for Buildings.

.9 CSA-G30.18-09, Carbon Steel Bars for Concrete Reinforcement.

.10 CSA-S304.1-04, Design of Masonry Structures.

.11 CAN/CGSB-37.4-M89, Fibrated, Cutback Asphalt, Lap Cement for Asphalt Roofing.

.12 ASTM A82/A82M-07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

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

1.3 SUBMITTALS

.1 Submit product data sheet for each item. Indicate VOC's mortar, grout, parging, colour additives and admixtures.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Brick: burned clay to CAN/CSA-A82.1, Type FBX, Grade SW. Include soldier, rowlock, and other shapes indicated. Submit samples for approval.

.2 Concrete block to CAN/CSA-A165.1: CCMPA Metric Sizes, as indicated on the drawings.
- .1 H/15/A/M, hollow, normal weight for exterior walls .
- .2 SSand SF/15/A/M, semi- and full solid, normal weight for top course of load bearing walls.
- .3 H/15/C/M, hollow, lightweight for interior partitions.
- .4 Special shapes: provide bullnosed and double bullnosed units for exposed corners. Provide purpose-made shapes for lintels and bond beams. Provide additional special shapes as indicated.

.3 Stone: Limestone, to C568, sound, hard, durable, well seasoned and of uniform strength, colour and texture, free of quarry sap, flaws, seams, sand holes, iron pyrites, harmful quantities of radiation, or other mineral or organic defects. Machine pitched split exposed face, random lengths, unit heights as indicated, 90 to 100 mm bed thickness.

.4 Mortar: to CSA A179, Proportion specification. Select type from table below.
- .1 Exterior above grade:
  - .1 Type S: loadbearing walls requiring high compressive strength.
  - .2 Type N: loadbearing walls requiring low compressive strength.
  - .3 Type N: Non-loadbearing walls, parapet walls.
- .2 Exterior at or below grade:
- .3 Interior:
  - .1 Type N: loadbearing walls and non-loadbearing partitions.
- .4 Fine grout to Table 3.
- .5 Parging: Match mortar used for masonry, or use Type N if type is not known.

2.1 MATERIALS (Cont'd)

.5 Admixtures for mortar colour: metallic oxide pigment.

.6 Cavity Wall Connectors: Engineered ties, properly sized, consisting of 1.6 mm thick stainless steel connector plate, 4.76 mm (0.19

.7 Horizontal Reinforcement for Single Wythe Masonry: Ladder design, 4.8 mm side rods and welded 3.66 mm cross wires, stainless steel. Width of reinforcing 50 mm less than the nominal thickness of the wall. Provide prefabricated corners and tees.

.8 Reinforcing bars: to CSA-G30.18, Grade 400R, deformed.

.9 SS bolts, nuts and washers: stainless steel to ASTM F593.

.10 Cell vent weep-hole ventilator: flexible U.V. resistant polypropylene co-polymer, sized to match masonry units, colours selected from manufacturer's standard range.

.11 Motar dropping control device: 25 mm wide x 250 mm high, insect resistant, recycled polyester or high density polyethylene woven mesh strips.

.12 Precast concrete sills:
- .1 Cement: to CAN/CSA-A3001, type GU.
- .2 Compressive strength: 30 MPa at 28 days.
- .3 Exposure class: F-1 to CSA-A23.1/A23.2.
- .4 Aggregate size: 10 mm maximum size to CSA-A23.1/A23.2.
- .5 Air content: 6%.
- .6 Water: potable.
- .7 Finish: acid washed.
- .8 Size: As indicated x length to suit opening.

PART 3 - EXECUTION

3.1 MIXING AND APPROVAL

.1 In accordance with CAN/CSA-A179.

.2 Do not commence masonry work until mortar is tested and approved by Departmental Representative.

3.2 PROTECTION

.1 Protect in accordance with CAN/CSA-A4371, except following requirements supplement Clause 6.7.2:

.1 Maintain temperature of mortar between 5°C and 50°C until used.

3.3 INSTALLATION AND WORKMANSHIP

.1 In accordance with CAN/CSA-A4371.

.2 Joints of uniform thickness. Tolerances suggested in notes to Clause 7.1 of CAN/CSA-A4371 apply.

.3 Align vertical joints.

.4 Lay maximum 1800 mm height of masonry per day.

.5 Cut masonry with power saw.

.6 Fill space between top of non-bearing partitions, underside of deck and underside of structural members with fibre firestopping compressed as recommended by Manufacturer and requirements of ULC tests. Neatly trim on each side of partitions.

.7 Install mineral fibre joint filler between:

.1 Exterior masonry walls and columns.

.2 Masonry and lintels.

.8 Do masonry reinforcing, tying and connecting in accordance with CAN/CSA-A370 and CAN/CSA-A371. If there is conflict in the requirements of these two standards, the more stringent requirement shall apply.

.9 Install insulation retaining wedges as work progresses taking care that mortar joint has achieved initial set before tamping wedges into place.

3.3 INSTALLATION AND WORKMANSHIP (Cont'd)

.10 Lightly wet set masonry surfaces before laying abutting masonry.

.11 Remove surplus mortar and mortar droppings as work progresses.

.12 Concave joints, strike flush behind resilient base to height of base.

.13 Build in items supplied by other sections.

.14 Fill built-in interior hollow metal frames with mortar.

.15 Control joints:
- .1 Provide continuous vertical control joints in block partitions in following locations:
  - .1 In partitions in indicated locations and not spaced farther than 7.5 m o.c.
  - .2 On each side of column.
- .2 Stop masonry reinforcement each side of control joint. Keep joint free of mortar.

.16 Reinforced masonry lintels:
- .1 Install reinforced block lintels at openings.
- .2 Provide minimum bearing of 200 mm at each side of opening.
- .3 Install reinforcing bars and fill with concrete.
- .4 Set block lintels in place using specified mortar.

.17 Install masonry flashing over foundation walls on which masonry units bear, over lintels built into masonry and above roof flashing where roof abutts masonry.

.18 Extend masonry flashing beyond exterior face and turn down 45° to form a drip, through outer wythe, up backing material minimum 200 mm and turn into joint at inner wythe. Lap joints 100 mm and apply adhesive.

.19 Wet clay brick, absorbing more than 12% water when tested to CAN/CSA-A82.2, before laying.

.20 Place reinforcing bars in cavities and fill cavity with concrete where indicated.

.21 Install cell vent weep-hole ventilator at 600 mm centres at bottom course and first course above lintels.

3.4 CLEANING

.1 Remove excess mortar and smears.

.2 Point or replace defective mortar.

.3 Scrub surfaces clean.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American National Standards Institute/National Particleboard Association/National Electrical Maufacturers Association (ANSI/NPA/NEMA):
- .1 ANSI/BHMA A156.9-2003, Cabinet Hardware.
- .2 ANSI/BHMA A156.11-2004, Cabinet Locks.
- .3 ANSI/BHMA A156.16-2002, Auxiliary Hardware.
- .4 ANSI/NPA A208.1-2009, Particleboard.
- .5 ANSI/NPA A208.2-2009, Medium Density Fiberboard (MDF) for Interior Applications.
- .6 ANSI/NEMA LD 3-2005, High-Pressure Decorative Laminates.

.2 ASTM International:
- .1 ASTM C919-08, Use of Sealants in Acoustical Applications.
- .2 ASTM C920-08, Elastomeric Joint Sealants.
- .3 ASTM D785-08, Rockwell Hardness of Plastics and Electrical Insulating Materials.

.3 Architectural Woodwork Manufacturers Association of Canada (AWMAC):
- .1 AWI/AWMAC/WI Architectural Woodwork Standards, AWS Edition 1-2009.

.4 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-71.20-M88, Adhesive, Contact, Brushable.

.5 Canadian Standards Association (CSA):
- .1 CAN/CSA-B651-04, Accessible Design for the Built Environment.

1.2 ACCESSIBILITY

.1 Comply with CAN/CSA-B651, Accessible Design for the Built Environment.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Exposed hardwood: Clean, seasoned, straight, square and true on all four sides. Grade-mark all wood materials. Kiln dry wood materials for interior use to a moisture content of 4% to 8%, and 7% to 10% for exterior use.

.2 Exposed softwood: S-DRY, graded and stamped to National Lumber Grades Authority, Standard Grading Rules for Canadian Lumber, March 1, 2007.

.3 Concealed blocking and framing: S-DRY, graded and stamped to National Lumber Grades Authority, Standard Grading Rules for Canadian Lumber, March 1, 2007, SPF, 121c. "STUD" and 101d. "D" FINISH.

.4 Exposed plywood: hardwood plywood to AWI/AWMAC/WI Architectural Woodwork Standards, Premium Grade, veneer core, quarter sliced, centre balance book match.

.5 Concealed plywood: douglas fir to CSA 0121, Good One Side, urea formaldehyde free adhesive.

.6 Laminated plastic: NEMA LD-3, high pressure paper base decorative laminates. Unless otherwise specified, use the following:

- .1 Horizontal Postform Work: Grade HGP, 1 mm thick.
- .2 Horizontal Flat Work: Grade HGS, 1.2 mm thick.
- .3 Vertical Postform Work: Grade VGP, 0.7 mm thick.
- .4 Vertical Flat Work: Grade VGS, 0.7 mm thick.
- .5 Backing Sheet: Grade BK, same thickness as facing sheets, sanded one face and manufactured by the same manufacturer as the facing sheet.

.7 Laminated plastic core: poplar plywood to CSA 0153, Standard Construction, Interior Bond, BB Grade, urea formaldehyde free, formaldehyde free MDF medium density fibreboard to ANSI/NPA A208.2, 769 kg/m3, minimum 20% recycle content, and particleboard to ANSI/NPA A208.1, Grade R, industrial, 720 kg/m3, minimum 20% recycled content.

2.1 MATERIALS (Cont'd)

.8 Laminated plastic adhesive: contact adhesive to CAN/CGSB-71.20, Ecologo certified.

.9 Melamine Board: Melamine resin impregnated paper, thermally fused to particle board or MDF core.
- .1 Finish edges with 0.508 mm thick matching edge banding laminate.

.10 Poured epoxy: apply 100% solid epoxy resin compound at rate which will produce finished thickness of not less than 1.25 mm thick, with surface ground to dull black, non-reflecting surface which is free of minute pin holes, air bubbles and pores. Use 0.25 mm thick coating for concealed and unfinished surfaces. Epoxy finished surfaces to conform to following minimum requirements:
- .1 Tensile strength: 20 to 30 MPa.
- .2 Flexural strength: 700 MPa.
- .3 Compressive strength: 100 MPa.
- .4 Impact strength: 4 J.
- .5 Hardness: 100 Rockwell.
- .6 Linear shrinkage on curing: 0.4%.
- .7 Water absorption: 0.1%
- .8 Good flexibility, hard abrasion, impact and thermal shock resistant.
- .9 Resist immersion in water, and heat up to 100 degrees.
- .10 Resistance against alkaline substances, detergents and coolants.
- .11 Resistance to acid fumes, acid solutions, greases and oils.
- .12 Resistance to wide range of corrosive chemicals and solvents.
- .13 Will not support mould or fungus growth.

.11 Sealant: 1 component, silicone base, to ASTM C919 and ASTM C920, primerless, Type S, Grade NS, Class 50, SWRI validated, Ecologo certified, mould and mildew resistant.

.12 Cord grommet: friction fit, PVC grommet and cap, 75 mm diameter.
- .1 Acceptable material: '00U07.03' distributed by Lee Valley Tools, 1-800-267-8767.

.13 Construction adhesive: to CSA O112 Series, cartridge loaded.
- .1 Maximum allowable VOC limit 140 g/L.

.14 Wood Veneer: AWS1 Grade AA, birch species, plain sliced, book match, equal width, uniform,

2.1 MATERIALS (Cont'd)

.14 Wood Veneer:(Cont'd)
clean, without open defects, patches, plastic repair, minimum 0.80 mm thick after sanding.

2.2 HARDWARE

.1 Piano hinge: to ANSI/BHMA-A156.9, type B81491, reversible.

.2 Magnetic catch: to ANSI/BHMA-A156.9, type B13171, heavy duty.

.3 Cabinet pull: to ANSI/BHMA-A156.9, type B32011, finish 628, satin aluminum, 76.2 mm centres, back mounted.

.4 Adjustable shelf standard: to ANSI/BHMA-A156.9, type B84061, surface application, open shelf rest type B84091.

.5 Vertical slotted shelf standard: to ANSI/BHMA-A156.9, type B04102, prefinished chrome with type B04112 shelf brackets, material and finish to match shelf standards.

.6 Drawer slide set: heavy duty to ANSI/BHMA-A156.9, type B05051, with zinc plate finish.
.1 68 kg rating, progressive full extension.
.2 45 kg rating, rolling steel balls and nylon rollers, full extension.
.3 34 kg rating, ball bearing nylon rollers.

.7 Coat hooks: to ANSI/BHMA-A156.16, type L13111.

.8 Closet bar: to ANSI/BHMA-A156.16, attached by surface screws, round type L03131.

.9 Draw bolts: type recommended by laminated plastic manufacturer.

.10 Elbow catch: 'Model 3675' manufactured by Amerock.

2.3 FABRICATION

.1 To AWI/AWMAC/WI Architectural Woodwork Standards, premium grade.

.2 Shop assemble units in size to allow passage to installed location.

.3 Apply 9 mm matching solid stock into exposed plywood edges.

2.3 FABRICATION (Cont'd)

.4 Match grain and colour of adjoining exposed natural finished wood.

.5 Laminated Plastic Work: Cover exposed faces and edges with matching laminated plastic.

.6 Shop apply laminated plastic with hairline joints, chamfer exposed edges.

.7 Apply bituminous paint to edge of cutouts in laminated plastic tops at sinks.

.8 Plywood shelves and shelf gables.

.9 Form rebates to receive glass.

.10 Seal all surfaces for site finishing.

2.4 STAINLESS STEEL COUNTERTOP

.1 Stainless Steel Sheet: ASTM A 167, Type 316, with No. 4 finish.

.2 Fabricate laboratory countertops and back splashes as indicated.

.3 Fabricate countertop and back splashes to longest practicable lengths.

.4 Cut holes for fittings, accessories, and equipment.

.5 Round or chamfer exposed edges and corners of cutouts.

.6 Form coutnertops and work surfaces of 1.6 mm thick stainless steel sheets with edges returned as indicated.

.7 Connect steel reinforced tops to cabinets with bolts.

.8 Apply metal tops to a water resistant particleboard or plywood core using contact adhesive.

.9 Cove internal corners of sheet metal to 12 mm radius. Coat underside with 3 mm thick sound deadener.

.10 Finish exposed edges and surfaces in same manner as specified for working surface of countertop material.

2.4 STAINLESS STEEL COUNTERTOP (Cont'd)

.11 Make allowances around periphery and where fixed objects pass through or project into countertop material to permit normal movement without restriction.

.12 Joints: field welded or mechanical watertight.

2.5 SOLID SURFACING

.1 Solid Surfacing: homogeneous filled acrylic sheets; not coated, laminated or of composite construction, superficial damage to a depth of 0.25 mm shall be repairable by sanding and polishing, semi-gloss finish with a gloss rating of 25-50.

.2 Joint Adhesive, Solid Surfacing: Manufacturer's standard two-part adhesive kit to create inconspicuous, non-porous joints, with a chemical bond.

.3 Panel Adhesive, Solid Surfacing: Manufacturer's standard neoprene-based panel adhesive.

.4 Sealant, Solid Surfacing: Manufacturer's standard mildew-resistant silicone sealant colour formulated to match sheets.

2.6 FABRICATION - WOOD VENEER WORK

.1 Check job dimensions and conditions. Do not proceed until unsatisfactory conditions are corrected.

.2 As far as practical, assemble work at the shop and deliver to the job ready for installation. Leave ample allowance for fitting and scribing on the job.

.3 Fabricate work square and to required lines. Recess and conceal fasteners and anchor heads.

.4 Parallel clip veneer pieces in equal widths and join by tapeless splicer and glue.

.5 Provide unexposed backs of panels with backing veneer having the same physical characteristics as the face veneer.

.6 Properly join panels with tight, hairline joints and hold rigidly in place with assembly bolts. Use glue blocks where necessary. Conceal joints and connections. Locate prominent joints where directed. Intermediate joints between

2.6 FABRICATION - WOOD VENEER WORK (Cont'd)

.6 (Cont'd) supports will not be permitted. Prevent opening-up of glue lines in the finished work.

.7 Comply with glue manufacturer's written recommendations for mositure content, glue shelf life, pot life, working life, mixing, spreading, assembly time, time under pressure and ambient temperature.

2.7 FABRICATION - SOLID SURFACING

.1 Shop fabricate work to greatest extent practical and to sizes and shapes indicated, in accordance with reviewed shop drawings and solid polymer manufactuer requirements.

.2 Form joints between work using manufacturer's joint adhesive. Make joints inconspicuous in appearance and without voids. Attach 50 mm wide reinforcing strip of solid polymer material under each joint or as recommended by the manufacturer.

.3 Cut holes and cutouts for items penetrating the work to templates. Reinforce holes and cutouts to manufacturer's requirements.

.4 Provide edge details indicated. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

PART 3 - EXECUTION

3.1 HARDWARE SCHEDULE

.1 Swinging doors:
- .1 1 pair cabinet hinges.
- .2 1 cabinet pull.
- .3 1 magnetic catch.
- .4 1 door lock.

.2 By-passing doors:
- .1 1 by-passing door hardware set.
- .2 1 recessed pull.
- .3 1 sliding door lock.

.3 Drawers:
- .1 1 drawer slide set.
- .2 1 cabinet pull.
- .3 1 drawer lock.

3.1 HARDWARE SCHEDULE (Cont'd)

.4 Adjustable shelves:
.1 4 shelf standards.
.2 4 rests per shelf.

3.2 INSTALLATION

.1 Set items in place, plumb, straight and level to a tolerance of 1:400 and rigidly secure in place.

.2 Completely factory assemble units.

.3 Join abutting laminated plastic tops with draw bolts.

.4 Apply sealant to junction of backsplash and adjacent wall finish.

.5 Adjust hardware after cabinets installed for smooth effortless operation.

.6 Install poured epoxy materials in accordance with manufacturer's written instructions and as indicated on drawings.

3.3 INSTALLATION - SOLID SURFACING

.1 Install work plumb and level, in accordance with reviewed shop drawings and product installation details.

.2 Adhere solid surfacing tops to support framing with panel adhesives or concealed fasteners.

.3 Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work. Keep components and hands clean when making joints.

.4 Apply sealant at joints to adjacent construction, in accordance with requirements of Section 07 90 00.

.5 Keep components and hands clean during installation. Remove adhesives, sealants and other stains.

END

PART 1 - GENERAL

1.1 SUBMITTALS

.1 Shop Drawings: Indicate each type of access doors, arrangement of hardware, operating mechanism and required clearances.

.2 Maintenance Data: Provide operation and maintenance data for incorporation into Maintenance Manual.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Aluminium Plates: 6061-T6 alloy, anodizing quality.

.2 Aluminium Extrusions: 6063 alloy, T5 temper, anodizing quality.

.3 Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304 or 316; with minimum sheet thickness indicated representing specified thickness in accordance with ASTM A480/A480M.

.4 Fasteners: Manufacturer's standard to suit intended use, non-corrosive and compatible with in-contact metals.

.5 Grout: Non shrink, non metallic, flowable, 24h, 15 MPa (2100 psi), pull out strength 7.9 MPa (1150 psi).

2.2 FLOOR DOORS

.1 Specified Product: Flush mount, aluminium, capable to support 1464 kg/sq.m. (300 psf) live load, drainable, all stainless steel hardware, odour resistant.
- .1 Single Leaf: J-AL-R Series by The Bilco Company.
- .2 Double Leaf: JD-AL-R Series by The Bilco Company.

.2 Cover and Frame: Mill finished, diamond pattern reinforced aluminium cover plate, 6 mm thick exclusive of raised pattern, and 6 mm extruded aluminium channel frame with bend down anchor tabs and continuous EPDM perimeter gasket.

2.2 FLOOR DOORS (Cont'd)

.3 Lifting Mechanisms: Compression spring operators, controlling cover operation throughout the entire arc of cover upward motion and acting as a check in retarding cover downward motion when closing.

.4 Turn and Lift Handle: Removable exterior turn/lift handle with a spring loaded ball detent and protected by a flush, gasketted, removable screw plug.

.5 Hinges: Heavy stainless steel duty hinges, each having a minimum 6.3 mm diameter Type 316 stainless steel pin, maintain cover does not protrude into the channel frame.

.6 Hold Open Arm: Equip cover with an hold open arm which automatically locks the cover in the open position.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verify dimensions and conditions of previously installed work, upon which this Section depends, and coordinate repairs, alterations, and rectification if necessary.

.2 Obtain Consultant's written approval prior to field cutting or altering of structural members.

3.2 INSTALLATION

.1 Install work level, true, square, straight, and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

.2 Perform drilling of concrete as required to fasten work of this Section.

.3 Grout work in concrete with non-shrink grout. Trowel surface smooth and flush with adjacent surfaces.

.4 Insulate metals where necessary to prevent corrosion due to contact between dissimilar metals and between metals and concrete. Use bituminous paint, butyl tape, building paper or other approved means.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM F1066, Vinyl Composition Floor Tile.

.2 ASTM F1861-08, Standard Specification for Resilient Wall Base.

1.2 WHIMS

.1 Submit WHMIS MSDS - Material Safety Data Sheets acceptable to Labour Canada and Health Canada for primer, cement and adhesive. Indicate VOC content.

.2 Submit WHMIS MSDS in accordance with Sections 01 33 00 and 01 78 00.

1.3 MAINTENANCE DATA

.1 Provide maintenance data for resilient flooring for incorporation into operation and maintenance manual specified in Section 01 78 00.

1.4 SUBMITALS

.1 Submit a list of 6 projects (with contact people and phone numbers) completed within the previous 12 months which use the same systems specified here in accordance with Sections 01 33 00 and 01 78 00.

.2 Submit copy of flooring manufacturer's installation procedures in accordance with Sections 01 33 00 and 01 78 00.

.3 Submit letter stating that the moisture content of concrete slab and the ph of the surface is within manufacturer's written guidelines for proposed flooring system.

.4 Do not proceed with flooring installation if the concrete slab moisture content is over 3.0 lbs/1000 S.F. Contact the manufacturer's representative and inform the Departmental Representative immediately.

1.5 SAMPLES

.1 Submit samples in accordance with Sections 01 33 00 and 01 78 00.

1.5 SAMPLES (Cont'd)

.2 Submit duplicate full size sample pieces of tile material, 300 mm long base and edge strips.

1.6 MAINTENANCE MATERIALS

.1 Provide ten lineal metres of resilient base of matching colour for each profile in addition to the resilient base required to complete the present installation.

.2 Deliver to job site in boxes clearly marked with information on contents and include address and date of installation.

.3 Unload and store within building where directed by Departmental Representative.

1.7 ENVIRONMENTAL CHOICE PROGRAM

.1 Provide adhesive products bearing certification of the Ecologo Program CCD-046.

.2 Submit one copy of the licensing criteria statements and the verification of compliance with CCD-046 to the Departmental Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Vinyl composition tile: to ASTM F1066, Class 2 through pattern tile, mottled, asbestos free, 305 x 305 x 3.17 mm.

.2 Slip Resistant Sheet Vinyl: To ASTM F1303, Type 2, Grade 1, 2.5 mm thick, smooth with embedded abrasives with intergrated anti-bacteria treatment, moisture resistant backing, static coefficient of slip resistance in excess of 0.6 when tested in accordance with ASTM D2047, standard colour. Welded seams.

.3 Vapor Emission Test kit: "Vapor emission Test for measurement of Concrete Moisture", manufactured by Vaprecision (800) 449-6194 and distributed by Durox Floor Accessories, (416) 630-4883.

.4 Resilient base: to ASTM F1861, Type I Rubber Base, 100 mm high, continuous, coved, preformed external corners.

2.1 MATERIALS (Cont'd)

.5 Primer, cement, and adhesive: type recommended by flooring and base manufacturer to suit substrate and installation, Ecologo certified.

.6 Sub-floor filler: premixed latex modified cement mixed with water to produce cementitious paste.

.7 Wax and sealer: type recommended by flooring manufacturer.

.8 Reducing strip: extruded vinyl, profile to suit application.

.9 Resilient Rubber Stair Treads: Lengths and depths to fit each stair tread in one piece or, for treads exceeding maximum lengths manufactured, in equal-length units, solid colour, raised round surface, visually impaired, with integral riser, square nosing.

PART 3 - EXECUTION

3.1 SUB-FLOOR TREATMENT

.1 Remove ridges and bumps.

.2 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:500, allow to cure.

.3 Remove dust, old adhesive, paint, dirt, wax, sealer and foreign matter from existing surfaces.

3.2 PREPARATION AND INSTALLATION

.1 Maintain room and material temperature at approximately 20°C for 3 days before laying, and minimum 2 days after laying.

.2 Test subfloor for moisture content in accordance with flooring manufacturer's written instructions using the Vaprecision vapour emission test.

.1 Perform moisture condition test in each major area. A minimum of 1 test per 1000 sq. ft., prior to installation. Moisture condition shall not exceed 3 pounds per 1000 sq. ft. per 24 hour day in accordance with the Rubber Manufacturers Association Test Method. Do not proceed with work until

3.2 PREPARATION AND INSTALLATION (Cont'd)

.2 (Cont'd)

.1 (Cont'd) results of moisture condition tests are acceptable.

.3 Do not proceed with work until results of moisture condition tests are acceptable.

.4 Prepare floor and install flooring in accordance with flooring manufacturer's written instructions.

.5 Base joints at maximum length available or at internal corners.

.6 Install reducing strip at exposed edges, centre under doors at doorways.

.7 Use filler to strengthen tread nosing and riser. Fill irregularities in substrates to conform to tread nosing and riser.

.8 Install resilient stair finishes one piece for full width of stair. Adhere over entire surface and fit accurately.

.9 For treads installed as separate, equal-length units, install to produce a flush joint between units.

3.3 CLEANING AND WAXING

.1 Clean, seal and wax work to manufacturer's written instructions.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 Architectural Painting Specification Manual, The Master Painters Institute (MPI), 2010 plus amendments.

.2 CAN/CGSB-85.100-93, Painting.

.3 CGSB-85-GP-15M-Apr-1978, Painting, Maintenance, Exterior Steel Exposed to Dry Weather.

1.2 WHMIS

.1 Submit MSDS - Material Safety Data Sheets for each material specified.

.2 Indicate VOC's in g/L.

1.3 MATERIAL LIST

.1 Submit in accordance with Sections 01 33 00 and 01 78 00, a list of proposed materials prepared by paint manufacturer, for review at least 30 days before materials required. List shall bear manufacturer's certification that materials listed are premium quality and conform to VOC guidelines and flash points listed.

1.4 ENVIRONMENTAL CHOICE PROGRAM

.1 Provide paint products bearing the 'Ecologo' of the Environmental Choice Program, CCD-47-2005: Architectural Surface Coatings and CCD-48-2006: Surface Coatings - Recycled Water-Borne.

.2 Submit written proof in the form of CSA Certification Reports of Certification under the Environmental Choice Program in accordance with Sections 01 33 00, 01 61 00 and 01 78 00 when requested. Alternatively, material in original containers bearing the 'Ecologo' will satisfy this requirement.

1.5 INTERIOR PAINT GLOSS TERMS

.1 Gloss terms: to ASTM D523-08 shall have following values:

Gloss Term	Gloss Value
Flat	0 to 10
Eggshell (Satin)	15 to 25
Semi-Gloss	45 to 55

1.5 INTERIOR PAINT GLOSS TERMS (Cont'd)

.1 Gloss terms:(Cont'd)

Gloss, medium	60 to 80
Gloss, high	80 to 90

1.6 FIRE LABELS

.1 Do not paint Fire Labels on doors or frames.

1.7 VENTILATION

.1 Ventilation:

.1 Provide continuous ventilation during and after application of paint. Run ventilation system during installation at 30% outside air; provide continuous ventilation for 7 days after completion of application of paint in accordance with Section 01 51 00.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Only materials listed in the latest edition of the APL are acceptable for use on this project. Provide material from a single manufacturer for each system used

.2 Use only materials having a minimum MPI Environmentally Friendly E3 rating based on VOC (EPA Method 24) content levels and meeting requirements of Canadian Environmental Protection Act Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulation.

2.2 INTERIOR MATERIAL AND SYSTEM

.1 Wood (plywood, , wood deck ceilings, cabinets, partitions, etc.):

.1 Int. 6-3T, Latex, semi-gloss finish, Premium.

.2 Int. 6.3Y, Polyurethane, clear, moisture cured, gloss, Premium.

.2 Plaster, gypsum board (beaverboard, composition board, gypsum, hardboard, pegboard, plasterboard, wallboard):

.1 Int. 9-2K, Latex, semi-gloss finish, Premium.

2.2 INTERIOR MATERIAL AND SYSTEM (Cont'd)

.3 Canvas and cotton insulation coverings (pipes, ductwork, boilers, etc.):
.1 Int. 10.1A, Latex, eggshell finish, Premium.

.4 Concrete block:
.1 Int. 4.2G, Tile-Like Epoxy Finish for Wet Surfaces, semi-gloss , Premium.

.5 Concrete floors:
.1 Int. 3.2C, Epoxy Finish (2 component waterborne), Premium.
.2 Int. 3.2F, Concrete floor sealer finish.

.6 Structural and misc. steel:
.1 Int. 5.1K, Epoxy Modified Latex, Premium.

.7 Galvanized metal (zinc coated steel), (ducts, pipes, doors, frames, steel deck ceilings):
.1 Int. 5.3J, Latex Finish, eggshell, Premium.

.8 Aluminum:
.1 Int. 5.4H, Latex Finish, semi-gloss, Premium.

.9 Copper:
.1 Int. 5.6H, Latex Finish, semi-gloss, Premium.

2.3 EXTERIOR MATERIAL AND SYSTEM

.1 Pavement marking:
.1 Ext. 2.1A, Latex Traffic and Zone Marking, follow manufacturer's recommendations, minimum thickness 0.127 mm (5 mil).

.2 Structural and misc. steel (factory-primed):
.1 Ext. 5.1L, Polyurethane Finish, High Performance, requires SP6 blast, semi-gloss, Premium.

.3 Galvanized metal (zinc coated steel) (downpipes, eavestroughs, flashing, roof and wall sheets, handrails, posts and misc.):
.1 Ext. 5.3H, Latex Finish, Semi-gloss, Premium.

.4 Aluminum (sash, sills and frames, flashings, misc. work, handrails, posts, rails, downpipes, etc.):
.1 Ext. 5.4C, Aluminum Finish (Exposed Aluminum), Premium.

PART 3 - EXECUTION

3.1 NEW SURFACES PREPARATION

.1 Perform work to MPI requirements

.2 Sand surfaces smooth.

3.2 APPLICATION

.1 Paint items as specified and/or indicated on drawings and schedules.

.2 Paint items in accordance with the requirements set out in the MPI Architectural Specification Manual.

.3 Brush or roll on finish to smooth, even, uniform surface.

.4 Sand lightly between coats.

.5 Paint mechanical and electrical work exposed in finished areas or on exterior. Where not noted on colour schedule paint items same colour as surfaces on which they occur.

.6 Paint visible portion of ducts behind registers, grilles and louvres with flat black paint.

.7 Paint electrical backboard prior to installation of electrical equipment.

.8 Finish doors, including edges after fitting.

.9 Paint graphics with straight edge and clear, sharp definition of colour change.

.10 Finish interior of valances white.

.11 Finish on inside surfaces of woodwork to match outside surfaces.

.12 Apply one additional finish coat to surfaces with deep, dark or accent colours called for on schedule.

.13 For patched walls, ceilings or other surfaces, paint the entire wall or area up to the next change in plane or direction as directed by Departmental Representative.

END

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

.1 Installer: Trained and approved by the manufacturer and having a minimum three years experience in the installation of the work described in this Section and can show evidence of satisfactory completion of projects of similar size, scope and type.

.2 Maintenance Seminars: Engage a factory authorized service representative to train Owner's maintenance personnel on proper maintenance procedures.

.3 Pre-Installation Meeting: Prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Consultant of the date and time of the meeting.

.4 Manufacturer's Site Inspection: Have the manufacturer's technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer's inspection reports and verification that the work of this Section is correctly installed.

.5 Testing of Substrates: Test substrates that have been cured for minimum 28 days, and after preparation for Product installation is complete and patching or levelling compound is fully cured. Conduct testing simultaneously on substrates free of sealer, curing compounds, oil, grease and other agents detrimental to the test and Product performance. Locate test sites to cover representative installation areas. Do not proceed with work when the test results do not conform to the specified allowable.

.1 Cohesive Strength: Minimum 1.45 MPa (210 psi) by tensile load as tested to CSA A23.2-6B. Do one test for every 9 sq.m. (1000 sq.ft.) or fraction thereof.

.2 Moisture Vapour Transmission, Slabs-om-Grade: ASTM D4263 plastic sheet method, no visible condensation or vapour allowed. Do one test for every 4.5 sq.m. (500 sq.ft.) or fraction thereof.

1.1 QUALITY ASSURANCE (Cont'd)

.5 Testing of Substrates:(Cont'd)

.3 Surface Moisture Content: Maximum 4%, tested by moisture meter. Do one test for every 4.5 sq.m. (500 sq.ft.) or fraction thereof.

.4 Surface Temperature: Minimum 3 degree C above the measured dew point.

1.2 SUBMITTALS

.1 Product Data: Submit manufacturer's technical data, installation instructions and general recommendations for each type of material required.

.2 Samples: Submit 300 mm x 300 mm sample for approval. Submit additional samples until approval is obtained. Make changes in aggregate mix as required to secure correct colour and texture. Label sample(s) with Project name and number, applicator, names of material and manufacturer, colour, gloss, texture and aggregate mix proportion.

.3 Maintenance Data: Provide specific instructions for maintenance, preservation and cleaning. Provide adequate warning of maintenance materials or practices which may be detrimental to the work.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials in original, unopened containers with manufacturers labels and seals intact.

.2 Handle and store materials in accordance with manufacturer's printed directions.

.3 Store flammable materials in safe, approved containers to eliminate fire hazards and remove from Site at end of each work shift.

.4 Do not use materials that has been stored for period of time exceeding maximum recommended shelf life of materials.

1.4 PROJECT CONDITIONS

.1 Maintain minimum air and surface temperatures at 16 deg C for 24 hours before, during, and for 48 hours following application, or until cured.

.2 Maintain well-lit and well-ventilated area.

1.4 PROJECT CONDITIONS (Cont'd)

.3 Comply with coating manufacturer's directions for maintenance of substrate temperatures, ventilation and other conditions required to execute and protect work.

1.5 PROTECTION

.1 Protect adjacent surfaces from damage resulting from work of this Section. If necessary, cover or mask adjacent surfaces to those receiving work including fixtures and equipment.

.2 Replace materials soiled during application, and from which soil cannot be completely removed, at no extra cost.

.3 Ensure that spark-proof electrical equipment is used in areas where inflammable materials are being applied. Prevent use of open flames or equipment that may cause sparks.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Vinyl Ester Coating: Chemical resistant, reinforced coating system, slip-resistant finish; standard colour, 1.6 mm dry film overall system thickness.
- .1 Primer: Penetrating two-component vinyl ester primer.
- .2 Reinforcing Fabric: Glass fiber mat or scrim.
- .3 Finish Coats: Mineral filled multiple component vinyl ester resin.

.2 Filler and Grout: Compatible to coating and as recommended by coating manufacturer.

.3 Joint Backing: Preformed, compressible strips of closed cell polyethylene or urethane foam, rubber tubing or non-migrating plasticized vinyl, oversized 25%, compatible with sealant, primer, epoxy surfacing and substrate.

.4 Joint Sealant: CAN/CGSB-19.24-M, Type 1, Class B, multi component modified urethane base chemical curing; material compatible with coating and as recommended by coating manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Clean substrates free of laitance, oil, grease, curing and sealing compounds, hardeners, chemical additives and other foreign matter detrimental to application.

.2 Prepare concrete substrates with shot blasting or other method recommended by manufacturer. Remove weak concrete, uneven joints, rough areas, foreign and projection off surfaces. Surface to be hard, and sound. Equip dry blasting machine with vacuum to minimize dust.

.3 Repair cracks, holes or other defects in accordance with manufacturer's recommendations. Level substrates with filler or grout.

.4 Prepare metal surfaces to manufacturer's requirements.

.5 Blow clean control joints, sawcuts and cracks with compressed air and grout with material compatible with coating materials.

.6 Ensure that masonry backing surfaces for cove bases are free of voids and irregularities. Fill recessed joints with recommended filler or grout.

.7 Provide 20 mm x 6 mm deep chase in substrate where work of this Section does not abut against a vertical surface. Fill chase with grout.

.8 Provide a 20 mm x 20 mm cove where work of this Section abut against a vertical surface. Form cove with grout.

3.2 INSTALLATION

.1 Mix and apply work in strict accordance manufacturer's printed directions in specified thickness, with integral cove bases, uninterrupted except at sawn joints or other types of joints required, free of laps, pin holes, voids, crawls, skips or other marks or irregularities are visible, and to provide uniform appearance.

.2 Work coating into corners and other restricted areas, up and over bases, and into recesses to ensure full coverage.

3.2 INSTALLATION (Cont'd)

.3 Make clean true junctions with no visible overlap between adjoining applications of coatings.

.4 Primer: Apply primer over prepared substrate, at manufacturer's recommended spreading rate with timing of application co-ordinated with subsequent application of materials to ensure optimum adhesion between coating and substrate.

.5 Reinforcing: Immediately embed reinforcing fabric, full coverage and saturated with primer. Apply extra coat of primer for full saturation of the reinforcing fabric.

.6 Finish Coats: Apply minimum of two finish coats at spreading rate recommended by manufacturer to achieve minimum total thickness of 0.9 mm DFT. Allow minimum recommended drying time between coats.

.1 First Coat: Apply first coat and immediately broadcast aggregates and back roll to obtain slip-resistant texture finish. Let dry.

.2 Top Coat: Apply second coat to dry first coat for consistent appearance.

3.3 ADJUSTMENT AND CLEANING

.1 Touch up and refinish minor defects in work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

.2 Remove promptly as work progresses spilled or splattered coating materials from adjacent surfaces. Do not mar surfaces while removing splatters.

.3 Protect completed work from traffic for at least one week to allow proper curing of floor finish. Protect work from any trades using area after completion of installation.

END

PART 1 - GENERAL

1.1 GENERAL

.1 This section covers the supply and installation of High Voltage Equipment and Devices, Cables and Overhead Connectors, and Pad Mounted Transformer as specified herein and as shown on the contract drawings.

1.2 RELATED SECTIONS

.1 Section 26 05 00: Common Work Requirements - Electrical.

.2 Section 26 05 43.01: Installation of Cables in Trenches and in Ducts.

.3 Section 26 41 00.01: Primary Lightning Arresters.

1.3 SCOPE OF WORK

.1 Provide 44kV poles and hardware.

.2 Provide 44kV primary cable feeders and protective equipment.

.3 Provide primary concrete encased ductbank.

.4 Provide pad-mounted 44KV-600V Primary transformer.

.5 Provide grounding system in accordance with OESC section 36 and report of grounding study.

.6 Provide all equipment, cable and connectors as detailed in this specification and as indicated on electrical drawings.

.7 Provide all required approvals from Electrical Safety Authority (E.S.A.) and Hydro One.

1.4 SHOP DRAWINGS

.1 Shop drawings for each of the following components of the high voltage system:
- .1 Master drawing index
- .2 Plan view, front elevation, and right side elevation.
- .3 Assembly ratings
- .4 Major components ratings
- .5 Transformer and concrete pad.
- .6 44 KV Cable connection at transformer.

1.4 SHOP DRAWINGS (Cont'd)

.1 (Cont'd)
.7 Busduct connections at transformers.
.8 Lightning arresters.
.9 Primary fuses: Selection of the fuses shall be in accordance with the final approved protection coordination study.
.10 Terminal pole assembly drawing, complete with installation details of all associated equipment.
.11 Primary high voltage cable and terminations.
.12 Grounding system components.

1.5 MATERIAL AND EQUIPMENT

.1 Concrete Work: Section 03 10 00.

.2 Excavation and Backfilling: Section 31 23 33.01.

1.6 OPERATION MANUAL AND TRAINING

.1 Prepare and submit operation and maintenance instruction manuals as specified in Section 26 05 00.

1.7 WARNING SIGNS

.1 Warning signs in accordance with Rule 36-006 of the Electrical Safety Bulletins shall be posted on the 46 kV equipment and devices including 46 kV fuses, panels and transformer. Warning signs shall indicate the voltage level. Warning signs are also required on all high voltage cables and conduits at points of access.

.2 Where luminaires are installed on poles, there shall be signs cautioning that high voltage is present and advising that lamp changing shall be done only by qualified persons.

.3 All poles carrying primary or secondary lines shall have the warning sign "Danger-Keep Off". If work on this pole or near wires is necessary, call a qualified person.

1.8 QUALIFICATIONS

.1 Approved High Voltage electrical sub-Contractors are:
.1 Hydro One.
.2 PBW High Voltage Ltd.
.3 B.G. High Voltage System.
.4 G.T.Woods.

1.8 QUALIFICATIONS (Cont'd)

.1 (Cont'd)

.5 K. Line.

PART 2 - PRODUCTS

2.1 OVERHEAD DISTRIBUTION EQUIPMENT AND CONDUCTORS

.1 All overhead distribution line poles, accessories and conductors are to be in accordance with requirements of the Ontario Electrical Safety Code - Section 75, and CSA Standards as applicable:

.1 CAN/CSA-O15-05(R2009), Wood Utility Poles and Reinforcing Stubs.

.2 CSA Standard 015.1, Specification for the Physical Properties and Preservative Treatment of Eastern White Cedar Poles.

.3 CSA Standard 015.2, The Physical Properties of Western Red Cedar Poles and Reinforcing Stubs.

.4 CSA Standard 015.3, Specification for the Physical Properties of Jack, Lodgepole, and Red Pine Poles, and Reinforcing Stubs.

.5 CSA Standard 015.4, The Physical Properties of Douglas Fir and Western Larch Poles and Reinforcing Stubs.

.6 CAN/CSA Standard O80 Series-08, Wood Preservation.

.7 CSA Standard O116-1969(R2008), Power and Communication Sawn Wood Crossarms.

.8 CSA Standard C83-96(R2011), Communication and Power Line Hardware.

.9 CSA Standard 0124, Specification for the Physical Properties of Power and Communication Wood Insulator Pins.

.10 CAN/CSA-G12-92(R2007), Zinc-Coated Steel Wire Strand.

.2 Unless otherwise specified, all ferrous metal components and hardware is to be hot-dipped galvanized.

.3 Pole(s): Wood pole(s), treated with preservative in accordance with requirements of CAN/CSA-O80 and the OESC, butt and side marked with identification, and of a species, Class and length in accordance with OESC requirements to suit the application.

.4 Insulators: Nedco (Canadian Porcelain) wet-process porcelain insulators of a type to suit the application, complete with proper pins and accessories.

2.1 OVERHEAD DISTRIBUTION EQUIPMENT AND CONDUCTORS (Cont'd)

.5 Guys and Anchors: Galvanized steel stranded guy wire, minimum 9 mm diameter, complete with all required Nedco or equal grips, clamps, bolts, anchors and rods, guards and accessories.

2.2 DIP POLE (POLE HP2-HP11)

.1 The poles shall be 15.5 m class "H3" wood pole complete with crossarms, etc. shall be shipped pre-assembled for easy erection on site. The structure shall consist of columns and interconnecting and supporting girders, all as shown on the electrical drawings. All structures to be supplied complete with anchoring bases, strain "U" bolts, tower eyes, insulators and clamps suitable for incoming conductors.

.2 The structure shall be designed and manufactured in accordance to NEMA SG6 Latest Revision and E.S.A. regulations for electrical structures. Design loads shall be in accordance with said specifications but shall not be less than the following:

.1 Incoming Lines: 455 kg per conductor with lines approaching at an angle of up to 30 degrees from the perpendicular.

.2 Dead Load: Self weight of structure plus 13 mm thickness of ice over all surfaces.

.3 Equipment Load: Actual weight of equipment plus 50% increase for ice coating.

.4 Wind Load: 123 kg per square metre on 1-1/2 x net exposed area of the structure.

.5 Stresses: The allowable stresses for structural members under static loads plus dead load shall be calculated and have a factor of safety in accordance with the minimum requirements of CSA and the Aluminum Association.

.6 Horizontal deflection of vertical members - Maximum 1/100th of the vertical height of the structure.

.7 Vertical deflection of horizontal members - Maximum 1/200 of the span.

.8 Horizontal deflection of horizontal - Maximum 1/200 of the span.

2.3 POLE HP1 and HP12

.1 Generally similar to pole HP2, but designed for slack span.

.2 Complete with following:
- .1 46KV, 600A vertically mounted, 3 pole, integer load break switch, S&C Cat # 320355.
- .2 46KV Fused doublebreak switches c/w ED 381R14-T206.
- .3 Twelve (12) SMD-2C fuse refills (6 for mounting, 6 spares), rating to be in accordance with the co-ordination study
- .4 48kV intermediate class metal oxide lightning arrestors.
- .5 48kV cold shrink type XLPE-CN cable terminations.
- .6 Alumaform 31-AP bracket.
- .7 Ground mat as indicated in Contract document.

2.4 GUYING

.1 Provide pole guying and anchors as required.

.2 The installation of guys to be in accordance with OESC 75-300 to 75-316.

2.5 RATINGS

.1 All 46 KV equipment including switches fuses, fuse holders, switch and 44 KV bus with respect to bus size and bus supports must be capable of withstanding a 1500 MVA fault for the duration of the total clearing time of the protective devices. Insulators, conductors, spacings, phased ground clearances etc shall also be suitable for 250 KV BIL rating.

2.6 HIGH VOLTAGE CABLE

.1 HV cables shall be single core, 46 kV rated, suitable for 44 kV nominal voltage system.

.2 The cables shall have stranded copper conductors with TR-XLPE or EPR insulation and extruded conductor with insulated semi-conducting shield. Provide 100% insulation for 44 kV cables with 33% concentric neutral (for 3PH, 4W system) and extruded jacket.

.3 The cables shall be suitable for installation in a duct bank or a conduit system. Design and test data shall be supplied.

2.7 CABLE TERMINATION

.1 High voltage cables shall be terminated using approved cable terminators with sealed compression connectors.

.2 The terminations, bending and splicing of high voltage cables must be made in accordance with the manufacturer's recommendations. Cable bends must be in accordance with Rule 36-102 and Table 15.

.3 The installation of all cables shall comply with OESC Sections 36, Section 12 & Appendix B where applicable and relevant ESA Bulletins and manufacturer's recommendations.

.4 Retain an approved independent test company to conduct tests on the high voltage cables. High voltage cables shall be meggered and hi-pot tested as recommended by the manufacturer. A record shall be made of all tests conducted and submitted to the Engineer for approval. Copies of the records shall also be included in the instruction manual.

.5 The concentric neutrals of the cable shall be grounded at both ends.

.6 The cable terminators shall be suitable for outdoor installation.

2.8 SURGE ARRESTORS

.1 Lightning arrestors on the 44 KV system shall be rated for 39 KV MCOV Intermediate Class having polymeric housing.

.2 Provide suitable brackets for mounting the lightning arrestors on the pole.

.3 Surge arrestors shall be installed in order to adequately protect the transformer and/or high voltage cable from over voltage surges due to lightning, switching or fault conditions. The surge arresters must be grounded in accordance with the Ontario Electrical Safety Code.

2.9 CABLE RUN & DUCT BANK

.1 A concrete encased duct bank shall run from the terminal pole base to the substation transformer Four - 103 mm PVC ducts shall run the entire length. Cable shall be 100% insulated 4/0 aluminum, 46KV shielded XLPE with grounded

2.9 CABLE RUN & DUCT BANK (Cont'd)

.1 (Cont'd)
concentric neutral and PVC jacket. Supply 46KV terminators and lugs for all cable ends.

2.10 CONCRETE WORK

.1 Provide concrete bases for equipment and structure with footings extending beyond the frost line and reinforced as required to suit soil conditions. All foundations to be constructed so as not to be affected by frost action.

2.11 GROUNDING

.1 Substation grounding, including ground grid, ground rods, gradient control mats, fence equipment and connections shall be supplied and installed in accordance with the following standards and codes. For estimating purposes, include price for ground rods and ground wire requirements as shown on contract drawings. Indicate separate unit prices for addition or deduction in accordance with the requirements of the grounding study. Grounding study is to be carried out under this division (see section 26 28 18).

.1 E.S.A. Inspection Bulletin: 36-10-16.
.2 Ontario Electrical Safety Codes: Rules 36-300 to 36-312, Table 51.
.3 IEEE Standard 80-2000.

2.12 TRANSFORMERS REFERENCES

.1 The equipment shall be designed, factory assembled and tested in accordance with the following:

.1 CAN/CSA-C88-M90(R2009), Power Transformers and Reactors.
.2 CAN/CSA-C88.1-96(R2011), Power Transformer and Reactor Bushings.
.3 Low Losses CAN/CSA-C802.3-01(R2012), Maximum Losses for Power Transformers.
.4 Tamper Resistant - All tamper resistant equipment must meet the requirements of Standard CAN/CSA-C88-M90(R2009).

2.13 TRANSFORMER - QUALITY ASSURANCE (QUALIFICATIONS)

.1 Manufacturer shall be specialized in the manufacturing and assembly of Stacked Core, Circular Coil type transformers for a minimum of 20 years.

2.14 TRANSFORMER - WARRANTY

.1 Manufacturer warrants equipment to be free from defects in materials and workmanship for one (1) year from date of installation.

2.15 TRANSFORMER REQUIREMENTS

.1 Power transformer shall be rated as follows: 2500 kVA or as indicated on electrical drawing, three phase, 60 Hz and neutral solidly grounded.

.2 Primary Voltage: 44000 volts, 250 kV BIL, Delta Connected.

.3 Secondary Voltage: 600 volts, 30 kV BIL, Wye Connected.

.4 The impedance of the transformer shall be: 5.75% ± 7.5%.

.5 The transformer shall be designed to meet the average sound level as listed in CSA C88.

.6 The temperature rise shall be 65°C.

.7 The transformer shall be suitable for outdoor service.

.8 The transformer shall be Tamper Resistant and shall meet the general principals of Standard CAN/CSA-C88-M90(R2009).

.9 The standard liquid insulating media shall be mineral oil, meeting the requirements of CSA C50, Class A.

.10 The transformer(s) shall be designed for operation at 1000 mm.

.11 The transformer(s) shall be designed and manufactured to operate in an ambient not exceeding +40°C and never below -50°C, with an average ambient of +30° C in any day.

.12 Provide a no load tap changer with 2 ± 2 ½% FCAN (full capacity above normal) & FCBN (full capacity below normal) located in the primary windings. The tap changer shall have an

2.15 TRANSFORMER REQUIREMENTS (Cont'd)

.12 (Cont'd)
externally operated handle, position indicator with provision for padlocking. The tap position shall be clearly marked on the tap changer dial plate. A warning notice shall be applied adjacent to the handle of the tap changer stating: "WARNING OFF CIRCUIT TAP SWITCH - OPERATE ONLY WHEN TRANSFORMER IS DE-ENERGIZED.

.13 The coils shall be circular wound with adequate bracing and blocking to minimize the effects of short circuit. Use of adhesive as a primary means for strength is not acceptable. Strong

.14 The conductor material shall be 99.9% high conductivity copper and/or aluminum as indicated.

.15 Copper windings shall be designed using a maximum current density of 1800 Amps/square inch and aluminum windings shall be designed using a maximum current density of 1200 Amps/square inch.

.16 Hi-Val pressboard with withstand voltage >60 kV @ 60 Hz, minimum dielectric constant of 3.5 K, high electrical strength, excellent aging characteristics, low shrinkage and good bending properties shall be used for high-low barriers and yoke and tank shields.

.17 5 mm duct strips with high compressive strength, low power factor at high temperatures and excellent transformer oil impregnation shall be allocated evenly throughout the winding to allow for uniform heat dissipation.

.18 Thermally upgraded plain insulation paper shall be used.

.19 The stacked and semi-mitered core shall be manufactured from a minimum of M4 grain oriented electrical grade silicone steel. The core shall be designed using a maximum of 1.7 Tesla, in-rush current of < 6 times rated current and excitation current of < 1% @ rated voltage. Wound shell type cores will not be accepted.

.20 Formed and welded core clamps, joined by tie rods from top to bottom suitably braced to stop movement, shall support the core. The core shall be painted to inhibit any rust development, to strengthen the core laminations and to reduce sound levels.

2.15 TRANSFORMER REQUIREMENTS (Cont'd)

.21 The core and coil assembly shall use wood or TX blocking between the coil and clamp to reduce the effects of short circuit. The blocking shall be grooved to allow easier circulation of oil flow within the core and coil assembly.

.22 The transformer core shall be grounded internally to the tank.

.23 The transformers shall be designed to meet the minimum short circuit requirements of CAN/CSA-C88.

2.16 TRANSFORMER MECHANICAL FEATURES

.1 The transformers shall be of sealed tank construction, with welded steel plate of thickness suitable to withstand without permanent deformation positive and negative pressures 25% greater than stated on rating plate.

.2 The tank wall stiffeners shall be made of formed steel to maximize strength in order to ensure field filling.

.3 The transformer exterior surfaces shall be sand or grit blasted clean, all oil and foreign materials shall be removed before painting. The exterior shall be coated with one coat of rust inhibiting primer followed by two coats of topcoat to a total minimum dry film thickness of 3 mils. The interior of the tank shall be washed clean to remove all metal scale and foreign materials. The interior shall be painted with an oil resistant paint to an area four inches below the normal oil level.

.4 All welding shall be in accordance with CSA W47.1 and CSA W59 standards.

.5 Lifting moving and jacking facilities capable of handling the total filled mass shall be supplied.

.6 A minimum of four (4) heavy duty lifting lugs complete with a hole suitable for securing the transformers for transportation shall be used. The lugs must be sized to ensure that repeated use will not result in any permanent deformation.

.7 The transformers shall have a structural steel I-beam base.

2.16 TRANSFORMER MECHANICAL FEATURES (Cont'd)

.8 A manhole or handhole suitably sized and located shall be provided.

2.17 TRANSFORMER ACCESSORIES

.1 A rating plate and connection diagram showing the serial number of the transformers and the data required in accordance with CAN/CSA C88 shall be attached to the transformers.

.2 Qualitrol 208-60U emergency pressure relief device with an operating pressure of 8 PSI, self re-sealing c/w hood for deflecting away from the controls.

.3 A magnetic liquid level gauge with low liquid level contacts for remote alarm

.4 A direct mount liquid temperature indicator c/w two (2) preset alarm contacts.

.5 A pressure-vacuum gauge.

.6 A 25 mm bronze globe liquid drain valve c/w 10 mm sampling valve installed with center of valve 28 mm from tank bottom.

.7 Two 25 mm pipe connections installed on the cover so that liquid may be filtered and recirculated in the transformer.

.8 Two (2) stainless steel ground pads c/w two (2) hole Nema drilling located on opposing sides and ends of the tank.

.9 Cable tap shall be provided on both the primary and secondary Transformer shall be equipped with weatherproof terminal connection box for overhead cable bus connectors.

2.18 TRANSFORMER CABINETS AND ENCLOSURES

.1 The HV, LV & Instrument enclosures shall be manufactured from 11-gauge steel and shall be bolted to the transformer to allow for interchange ability.

.2 The HV enclosure shall have a 50 mm gable sloped roof to ensure proper water run off.

2.18 TRANSFORMER CABINETS AND ENCLOSURES (Cont'd)

.3 Tamper Resistant:

.1 All gauges, valves, primary and secondary terminations, tap changers, oil pressure relief vents etc. shall be contained within the transformer enclosure.

.2 All enclosures shall be full height and shall restrict the entry of water (other than floor water) so as not to impair the operation of the transformer.

.3 The bottom of the enclosures shall have a minimum 50 mm return and shall provide for flush mounting on a flat, rigid mounting surface.

.4 Access to the compartment shall be provided by a door hinged with a minimum of 5 pin type hinges and shall have three (3) Pentahead bolts with at least one having provision for padlocking. The door shall be constructed of a minimum of 11 gauge steel. Normal entry shall be possible only with the use of proper access tools.

.5 All access doors shall hinged and be capable of being locked with a single lock.

.6 A permanent, legible warning sign carrying the wording "High Voltage, 44000 volts. Do not enter this compartment unless visibly isolated.", shall be applied to the door of the primary compartment.

.7 All access doors shall have no exposed bolts or nuts, and have a minimum of two penta bolts complete with sleeves as detailed in Clause 5.2.1.2 and Figure 7 of CAN/CSA-C227.4

.8 Pentahead bolts must be corrosion resistant and their design shall minimize the possibility of misalighnment and cross threading. The pentahead bolt shall be supplied with a non-rotating guard such that removal of the bolt is possible only by the proper tools.

.9 Equipment shall have no external means of operation of switching equipment nor shall it have an external glass viewing window.

.10 There shall be no exposed screws, bolts, or other fastening devices that are externally removable.

.11 There shall be no openings through which foreign objects such as sticks, rods, or wire may be inserted to contact live parts.

2.19 TRANSFORMER TESTS

.1 The transformer shall be subjected to standard production tests including but not limited to include the following:
- .1 Resistance measurements
- .2 Ratio tests
- .3 Polarity and phase relationship
- .4 Exciting current and losses on rated voltage and 110% of rated voltage
- .5 Impedance and load loss
- .6 Applied potential
- .7 Induced potential
- .8 Pressure test
- .9 Core insulation test
- .10 Insulation power factor test
- .11 Audible sound level

.2 In addition to the standard production tests the following shall also be provided:
- .1 The transformer shall be energized five (5) consecutive times at 110% of rated voltage.
- .2 Upon request, the manufacturer shall provide certification that the fully assembled transformer is suitable for full field vacuum filling.

.3 Rectangular designs shall confirm with test data that the impedance changes occurring during testing do not exceed the values required during testing of circular coil designs.

.4 A certified test report will be supplied prior to or at time of shipping.

2.20 FENCE

.1 The station fence shall be installed as detail to meet requirement of OESC 26-300 through 26-324.

.2 The station fence grounding shall be installed as detail to meet requirement of OESC 36-312.

PART 3 - EXECUTION

3.1 OVERHEAD DISTRIBUTION EQUIPMENT AND CONDUCTORS

.1 Install overhead conductors for and 44KV equipment in accordance with OESC Code.

.2 Provide pole foundation in accordance with pole manufacture's recommendation.

.3 The contractor has to verify the soil condition prior to installing any pole in the ground.

.4 Provide guys and anchors where it is deemed necessary in accordance with site condition.

.5 The installation is to be approved by ESA.

3.2 UNDERGROUND SERVICE

.1 Installation:

- .1 Install cables in ducts in accordance with Section 26 05 43.01.
- .2 Allow adequate conductor length for connection to supply by power supply authority.
- .3 Allow adequate conductor length for connection to service equipment.
- .4 Service conduit shall terminate in main panel with an approved grounding bushing. From the grounding bushing a #4/0 ground connection shall be made to the distribution centre ground bus.

.2 Ductbank Installation:

- .1 Provide reinforcing rods and band ties over entire length as detailed.
- .2 Ensure that concrete fills all voids around ducts.
- .3 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with minimum 75 mm thick concrete cover on all sides.
- .4 Slope ductbanks 150 mm per 30 m minimum to drainage point. Adjust final slopes on-site to coordinate with existing utilities.
- .5 Provide drain holes not less than 12 mm in diameter in each conduit and provide a fabricated 50 mm drain assembly with saddle

3.2 UNDERGROUND SERVICE (Cont'd)

.2 Ductbank Installation:(Cont'd)

.5 (Cont'd) cutouts for each conduit fitting over the drain line. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with 12 mm stainless steel straps to conduit assembly to prevent mechanical displacement.

.6 Install on undisturbed soil where possible. Backfill required to be compacted pit run gravel and sand, 200 mm lifts maximum.

.7 Clean and swab all ducts. Install galvanized iron pillories in spare ducts. Cap spare ducts.

.3 Service Installation:

.1 General routing to follow that indicated on drawings.

.2 Provide ductbank as indicated on drawings.

3.3 PADMOUNT TRANSFORMER

.1 Inspection:

.1 Check factory made connections of transformer unit for mechanical security and electrical continuity.

.2 Check transformer insulating liquid for correct quantity and specification according to manufacturer's written instructions.

.2 Installation:

.1 Ensure concrete pad is fully cured before transformer is installed.

.2 Set and secure transformer unit in place, rigid, plumb and square.

.3 Make connections.

.4 Connect transformer unit ground bus to system ground.

.5 Wire one set of contacts on liquid temperature thermometer, liquid level gauge, to sound alarm when unsafe condition reached.

.6 Ensure care is taken to prevent contamination of liquid and components when field filling transformers. Supply test results if required.

.7 Use only metal hose when field-filling transformer with oil: never, under any circumstances, use rubber hose.

.8 Set taps to produce rated secondary voltage at no-load.

3.3 PADMOUNT TRANSFORMER (Cont'd)

.3 Field Quality Control

.1 Perform tests in accordance with Section 26 05 00.

.2 Carry out following insulation tests using megger or other insulator tester with 20,000 megohm scale and resulting insulation resistance corrected to base of 20°C.

.1 High voltage to ground with secondary grounded for duration of test.

.2 Low voltage to ground with primary grounded for duration of test.

.3 High to low voltage.

.4 Inspect primary and secondary connections for tightness and for signs of overheating.

.5 Inspect and clean bushings and insulators.

.6 Check oil level and temperature indicators.

.7 Set transformer taps to rated voltage as specified.

.8 Inspect for oil leaks and excessive rusting.

.9 Inspect oil level.

.10 Check fuses for correctness of type and size.

.11 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

3.4 GROUNDING

.1 Install ground grid as indicated.

.2 Grounding system in accordance with OESC section 36 & as shown in drawings.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 This section provides for the construction of all earth subgrades. The work shall include excavating, hauling, handling and placing in embankments, shaping, compacting, trimming of earth material and excavated material. Suitable excavated earth shall be used in embankment construction and as specified in the Contract Documents.

1.2 RELATED SECTIONS

.1 Section 31 11 00: Clearing and Grubbing.

.2 Section 31 14 13: Soil Stripping and Stockpiling.

.3 Section 31 23 33.01: Excavating, Trenching and Backfilling.

1.3 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
- .1 OPSS 206 Construction Specification for Grading (Nov 2010).
- .2 OPSS 212 Construction Specification for Borrow (Nov 2008).
- .3 OPSS 501 Construction Specification for Compacting (Nov 2010).

.2 American Society for Testing and Materials (ASTM)
- .1 ASTM D698-12, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m^3).

.3 Greater Golden Horseshoe Area Conservation Authorities (GGHCA):
- .1 Erosion and Sediment Control Guideline for Urban Construction, December 2006.

1.4 EXISTING CONDITIONS

.1 The extent of existing utilities cannot be guaranteed. Additional utilities may exist. Contractor to obtain actual locates prior to commencement of construction.

1.5 PROTECTION

.1 Protect existing natural features, pavement, surface or underground utility lines which are to remain as directed by Departmental Representative. If damaged, restore to original or better condition unless directed otherwise.

.2 Maintain access roads to prevent accumulation of construction related debris on roads.

1.6 QUALITY CONTROL

.1 Minimum testing requirements for Contractor:
- .1 Proff roll road subgrade in the presence of the Departmental Representative.
- .2 Provide quality control for compaction of various materials in accordance with OPSS 501 Table 1 with the following modificatioin:
  - .1 Part 1 (I) lot size to be every lift 9 max. 0.6m), 30 m maximum length in a 'Z' pattern.
- .3 Minimum compaction requirements for road subgrade 98% MDD.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Fill material: Type clean, native, compactable in accordance with OPSS 212 or SSM to OPSS 1010 table 2.

.2 Excavated or graded material existing on site may be suitable to use as fill for grading work if approved by Departmental Representative.

.3 Excavated materials for future re-use may be temporarily stockpiled as directed by the Departmental Representative. It shall also include installation of silt fence barriers to prevent materials from washing into existing ditches or watercourses. No extra payment will be made for the silt fences and subsequent site restoration in kind to original contours.

.4 Surplus excavated materials are to be stockpiled on the LTWMF site in areas designated by the Departmental Representative.

PART 3 - EXECUTION

3.1 STRIPPING OF TOPSOIL

.1 Refer to Section 31 14 13.

.2 Stripping shall be in accordance with OPSS 206.07.03.07.

3.2 GRADING

.1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

.2 Rough grade to depths below finish grades, as indicated by Contract documents.

.3 Grade ditches to depths indicated.

.4 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.5 Compact filled and disturbed areas to maximum dry density to ASTM D698, as noted by Contract documents.

.6 Do not disturb soil within branch spread of trees or shrubs to remain.

.7 No granular materials shall be placed on the sub-grade until the sub-grade has been compacted to 95% Standard Proctor Density, and approved by the Departmental Representative.

3.3 TESTING

.1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid by Departmental Representative. Refer to PWGSC SACC Manual.

3.4 SURPLUS MATERIAL

.1 Remove surplus material and material unsuitable for fill, grading or landscaping as directed by Departmental Representative.

.2 Surplus materials shall be stockpiled on site where designated by the Departmental Representative.

END

PART 1 - GENERAL

1.1 GENERAL

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

.2 This Section should be read in conjunction with the provided process and instrumentation drawings and general arrangement drawings.

.3 The WWTP will comprise of a variety of process valve applications depending on the provided process vender packages. It is the responsibility of the contractor to assess and evaluate information provided, including specifications, drawings, design rationale and process control description, and pilot trial report to appropriately select, supply, and install the process valves. Together with shop drawing submittal, the contractor shall provide appropriate justification (i.e. process calculation) for the selection/configuration basis.

1.2 DEFINITIONS AND INTERPRETATIONS

.1 Valve Identification

.1 Valves are identified in the Drawings by valve symbols.

.2 Actuators:

.1 Refer to Section 40 05 25 for actuator specification and electrical requirements.

.3 Valve supplier to provide a complete working package for the valve and the actuator, as specified.

1.3 SUBMITTALS

.1 Shop Drawings: Submit the following information in accordance with Section 01 33 00:

.1 Catalogue cuts and/or shop Drawings for each type of valve indicating the valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

.2 Operating and Maintenance data for incorporation in Operation and Maintenance Manual, as specified in Section 01 33 00. Include complete description of operation

1.3 SUBMITTALS (Cont'd)

.2 (Cont'd) together with detailed Drawings, a complete list of replacement and repair parts, and parts Manufacturer's identifying numbers.

.3 Affidavits and registration numbers described below in Quality Assurance.

1.4 QUALITY ASSURANCE

.1 For butterfly valves to be installed below ground, provide affidavits of compliance with AWWA C504.

.2 Valves are to be marked in accordance with MSS SP-25.

1.5 SHIPMENT, PROTECTION AND STORAGE

.1 Deliver valves to site and using loading methods which do not damage casings or coatings.

.2 Clearly tag valves stating size, type, coatings and mating parts.

.3 Store on-site until ready for incorporation in the Works using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Provide valves of the same type, size range and service from a single manufacturer.

.2 Provide new, unused valves for the Works.

.3 Valve materials to be free from defects or flaws, with true alignment and bores.

.4 Unless otherwise indicated on the Process and Instrumentation Drawings or specified in Division 40, valves shall be the same size as the pipe run in which they are to be installed.

.5 Clearly mark valve bodies in raised lettering to indicate the valve type, rating, and where applicable, the direction of flow. Conform to MSS SP25.

2.1 GENERAL (Cont'd)

.6 Provide padlockable lockout feature on all sizes of the following valve types.
- .1 Automated Control Valves (electric and pneumatic); FCV, LCV, and PCV only. Refer to the Drawings for abbreviation definitions.
- .2 Specialty Valves; FV and PRV only. Refer to the Drawings for abbreviation definitions.
- .3 Manual Isolation and Shut-off Valves; BUV, BAV, BFP, CHV, DBV, SOL, and PRV only.

.7 Specific requirements for the materials, ratings and service conditions for each valve are listed in Section 40 05 23.

.8 Valves to open counter-clockwise.

2.2 DRAWINGS

.1 The process drawings indicate major process valves required for the process to operate as intended.

.2 The detailed vender shop drawings, process Drawings, and may include other valves required for process and isolation.

.3 Provide drain, air vent, and flushing connections in accordance with this Division.

.4 Where a valve may be required for the process to function correctly or is required to satisfy fire and safety codes but it is not shown in the Drawings, inform the Departmental Representative and provide details and suggestions for remedial action. Do not commence piping in the related pipe run until obtaining the Departmental Representative's approval.

2.3 VALVE ENDS

.1 In pipe runs less than 75 mm diameter provide valves with female threaded ends, unless indicated otherwise. Threads to conform to ANSI B1.20.1.

.2 Valves in pipe runs equal to or greater than 75 mm diameter to be flanged unless indicated otherwise.

.3 For cast iron body valves, drill flanges to Class 125 pattern conforming to ANSI B16.1. For steel body valves, flanges to be Class 150

2.3 VALVE ENDS (Cont'd)

.3 (Cont'd) pattern or Class 300 pattern conforming to ANSI B16.5.

.4 Do not use grooved joint valve ends.

.5 Use flanged joints for buried and exterior valves. The flanges are to be compatible with the pipe and jointing technique used.

.6 Use flanged joints for buried butterfly valves.

.7 Lug style wafer body valves shall have tapped holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.8 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.9 Use wafer body butterfly valves only for control applications, and only if other valve(s) are provided for blocking and isolation. Use lug style or flanged wafer body butterfly valves if the function is blocking and isolation, including control valves where separate block and isolation valves are not provided.

.10 For gate valves, end flanges shall be integral with the gate valve body and be faced and drilled in accordance with ANSI B16.1, Class 125 flanges.

2.4 MANUAL OPERATORS

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

.2 Hand wheel diameter to conform to the following:

Nominal Valve Diameter (mm)	Minimum Hand Wheel Diameter (mm)
12	50
20	50
25	60
38	75
50	85
65	105
75	200
100	250
150	300
200	350
250	400

2.4 MANUAL OPERATORS (Cont'd)

.2 (Cont'd)

300	450
350	450
400	550
450	600
500	600
600 and up	600

.3 The maximum rim pull on a hand wheel not to exceed 300 N 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 than this force to operate, provide a gear operator. Unless different operators are scheduled or shown in the Drawings, conform to the following minimum requirements:

.1 Globe and Needle Valves: less than 200 mm, hand wheel; equal to or greater than 200 mm, gear operator.

.4 Match existing operating nuts. Provide 2/8 point operating wrenches.

.5 Supply stem extensions and valve boxes for buried valves and stem extensions for submerged valves as specified in the Drawings.

.6 Provide operating tees as required.

.7 Lever operators to conform to the following dimensions:

Nominal Valve Diameter (mm)	Minimum Length of Lever (mm)
6	80
12	80
20	100
38	150
50	150
65	150
75	175
100	225
150	250
200	300
250	450
300	450

2.4 MANUAL OPERATORS (Cont'd)

.8 Quarter turn lever operators to be perpendicular to the pipe run when the valve is closed.

.9 Lever operators on ball valves to be two position. Provide butterfly valves with ten (10) position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.

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

.1 Ball Valves: less than 150 mm, lever operator; greater than or equal to 150 mm, gear operator.

.2 Butterfly Valves: less than 250 mm, lever operator; greater than or equal to 250 mm, gear operator.

.11 Gear operator to be worm gear type, equipped with a hand wheel and a visual indicator of the valve position. Equip 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. Gear operators shall be grease lubricated.

.12 Operators for exposed service shall be gasketed for weatherproof service. Place gear boxes above ground and liquid surfaces.

.13 For manual valves on lines 75 mm and greater, mounted over 2.0 m above the operating floor, provide chain wheel gear operators. Design the operator so that a force of 150 N is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. The chain pulley to mesh positively with the chain. Extend the chain from the valve operator to operating height 1.2 m above the floor or as directed by the Departmental Representative. The exact dimensions shall be field determined. Provide

2.4 MANUAL OPERATORS (Cont'd)

.13 (Cont'd) approved chain hooks where required to prevent chain from hanging within traffic paths.

2.5 STEM AND COUPLINGS

.1 Provide operating stems and couplings of stainless steel.

.2 Provide the stem with a slenderness ratio (L/R) less than 200.

.3 Hollow stems are acceptable but they must be provided with stem guides (mounting brackets) and thrust bearings designed to carry the weight of the stem extension, eliminate load on the stem, and prevent buckling.

.4 Machine cut the threaded portion of the stem.

.5 For stems in more than one piece and with a diameter of 44.5 mm and larger, join the different sections together by threaded and bolted connections.

.6 Groove and key the couplings. The couplings are to be of greater strength than the stem.

.7 Provide stem guides of stainless steel, type 304 and UHMWPE bushed.

2.6 VALVE STEM EXTENSIONS

.1 Provide valve stem extensions where additional clearance is required for pipe insulation, for all submerged valves and other locations where valve operation without the extension is difficult.

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

.3 For all valves equal to or greater than 150 mm requiring stem extensions, provide pedestal mounted operators as shown on the process mechanical Drawings and standard details.

2.7 PRESSURE (SELF) REGULATING VALVES

.1 Pressure (self) regulation (PRV) valves shall be supplied, installed and calibrated under this Division.

2.8 AUTOMATIC AIR/AIR VACUUM RELIEF VALVES

.1 Air relief or vacuum safety (ARV) valves shall be supplied, installed and calibrated under this Division.

.2 Provide connection to the pipe.

.3 Valve discharge to be piped to within 50 mm of the floor.

2.9 PROTECTIVE COATINGS

.1 Unless otherwise specified, provide valves coated in accordance with Division 09.

2.10 SPARE PARTS

.1 Provide one 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 Departmental Representative's request, provide a price for these parts.

PART 3 - EXECUTION

3.1 PREPARATION

.1 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 provides suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Departmental Representative and initiate the necessary piping modifications at no cost to the Owner.

3.2 VALVE INSTALLATION

.1 Install valves in conjunction with the piping described in this Division and with control valves and their appurtenances described in Division 40.

.2 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.

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

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

.5 When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

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

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

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

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

.10 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 Departmental Representative.

.11 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.

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

3.2 VALVE INSTALLATION (Cont'd)

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

.14 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.

3.3 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 real 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.

END

PART 1 - GENERAL

1.1 GENERAL

.1 The specific design of the Waste Water Treatment Plant (WWTP) will be performed by the Contractor's Process Design Team. This includes items such as selection of specific Vendor Packages, specific pipe material/size/routing. Coordinate with the Contractor's Process Design Team to determine calibrated ranges of instruments, pipe size/material, actual I/O lists from the specific Vendor Packages which are selected, and suitable instrument installation details based on proposed process equipment and piping design. Confirm with Departmental Representative.

.2 All vendor packages shall be fully automatic with all status, alarm and operator control provided by the OIT, including manual control of individual pieces of equipment. Analog instrument readings, general and critical alarms, and key equipment status from the Vendor Packages are monitored in SCADA. The I/O shown on the P&IDs is for reference. Additional I/O may be required for proper treatment and integration with the Master Control Panel PLC. Allow for two additional discrete inputs, one additional discrete output, and one additional analog input for each Vendor Package, to be connected to the Master Control Panel PLC.

.3 The instruments shall be compatible with the expected waste water composition, and shall suit the functionality as defined in the Design Rationale and Process Control Description (Appendix S) and Pilot Trial Report (Appendix R) which are part of this Bid package.

1.2 REFERENCES

.1 Have the material, equipment, installation and workmanship meet the latest edition and requirements of the following:

- .1 Ontario Electrical Safety Code (OESC).
- .2 Canadian Standards Association (CSA) C22.2.
- .3 Canadian Electrical Manufacturers Association (CEMA).
- .4 National Electrical Manufacturers Association (NEMA): ICS 1-2000 (R2005, R2008), Industrial Control Systems General Requirements, 2008 Edition.

1.2 REFERENCES (Cont'd)

.1 (Cont'd)

.5 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.6 Instrumentation, Systems, and Automation Society (Formerly the Instrument Society of America, ISA).

.7 Electronic Industries Association / Telecommunications Industries Association (EIA/TIA 606).

.8 National Fire Code, National Fire Protection Association (NFPA): NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2012 Edition.

.9 Underwriters Laboratory, Inc. (UL): 508, Standards for Safety, Industrial Control Equipment.

.10 American Petroleum Institute (API): API RP 551, Process Measurement Instrumentation, February 2007 edition.

1.3 DEFINITIONS

.1 The following terms are used to describe the scope of work associated with various devices. The terms shall have the following definitions in the context.

.1 Installation & Wiring: Take custody and storage of third party delivered new item (device/assembly), include work for providing existing system with proper receptacles to receive the new item (e.g. cutting/flanging of existing pipe) and power and control wiring/conduit to the indicated destinations. Provide installation of all skid mounted equipment and loose items including Instrument Control Panel (ICP). Provide wiring from all devices to Instrument Control Panel (ICP) as shown in Process and Instrumentation (P&ID) drawings. Provide I/O wiring from local panels to PLC panel in accordance with contract drawings. Provide tags. Provide wire numbers in accordance with Instrumentation Wire Numbering Standard Detail in the contract drawings.

.2 Loop check: A complete loop check shall verify from a field device to a channel in PLC Input module or from a channel in PLC Output module to a field device. A PLC Engineering Workstation shall be used for loop test to show signal flowing through loop correctly. On-site loop check shall

1.3 DEFINITIONS (Cont'd)

.1 (Cont'd)

.2 Loop check:(Cont'd)
test the entire loop, stroking motorized or actuated field equipment, monitoring and operate through PLC Engineering Workstation.

.3 New: Provide new item (device/assembly), include work for receiving new items (e.g. cutting/flanging of existing pipe) and control wiring/conduit to the indicated destinations. Provide all I/O wiring in accordance with contract documents. Provide 120 V AC power circuit from the respective ICP for all non two-wire instruments. Provide tags. Provide wire numbers in accordance with Instrumentation Wire Numbering Standard Detail in the contract drawings.

.4 Product Data Sheet - listing of products as shown in "Product Data Sheets" table of Attachments to this section.

.5 Provide: Supply, install, setup/calibrate, test and place into successful operation. Submit site configuration/setup sheet for all instruments where site configuration/setup is required. Submit factory calibration sheet for all instruments. Submit site verification report, approved and signed by Departmental Representative, for all instruments.

.6 Vendor Package/Pre-Purchased System: Equipment/Devices identified as "Vendor Package" in the contract documents shall be provided by the general contractor. No product data sheet is available for instruments/components shown within the package.

1.4 ABBREVIATIONS

.1 The following abbreviations are used in the specifications and drawings. The abbreviations shall have the following definitions in the context.

.1 AMS: Asset Management System.

.2 CP: Control Panel.

.3 CS: Computer Subsystem.

.4 ESA Electrical Safety Authority.

.5 FAT/FDT: Factory Acceptance Test / Factory Demonstration Test.

.6 FOCS: Fibre Optic Communication Subsystem.

.7 HMI: Human Machine Interface, alias for Operator Interface Terminal.

1.4 ABBREVIATIONS (Cont'd)

.1 (Cont'd)

.8 HVAC: Heating, Ventilating, and Air Conditioning.
.9 I&C: Instrumentation and Control.
.10 I/O or IO: Input and Output.
.11 ICP: Instrument Control Panel.
.12 IPS: Instrument and Panel Subsystem.
.13 LCP: Local Control Panel.
.14 MCC: Motor Control Center.
.15 O&M: Operation and Maintenance.
.16 OIT Operator Interface Terminal.
.17 ORT: Operational Readiness Test.
.18 PAT: Performance Acceptance Test.
.19 PC: Personal Computer.
.20 PCS: Process Control System comprising PLCs, and OIs, communications systems and related hardware and software.
.21 P&ID: Process and Instrument Diagram.
.22 PLC: Programmable Logic Controller.
.23 PMCS: Process Monitoring and Control Software.
.24 RTU: Remote Terminal Unit.
.25 SAT/SDT: Site Acceptance Test/Site Demonstration Test.
.26 SCADA: Supervisory Control and Data Acquisition.
.27 SLDC: Single Loop Digital Controller.
.28 SSDT: Staging Site Demonstration Test.
.29 TS: Telemetry Subsystem.
.30 UPS: Uninterruptible Power Supply.

1.5 SCOPE OF WORK

.1 The Work in this Section generally consists of the supply of all labour, wiring, services, supply and installation of all products required, for a complete, integrated, operational instrumentation and control system to suit the process design requirements in accordance with the Contract Specification and Drawings.

.2 Provide Control Panels, Programmable Controllers and control system hardware including all peripheral devices as specified in the drawings and documents.

.3 Provide plant instrumentation including primary elements, transmitters, control devices.

.4 Provide analog and discrete I/O points to the respective Control Panels in accordance with the drawings and documents.

1.5 SCOPE OF WORK (Cont'd)

.5 Provide networking hardware required for communicating between Control Panels and to the plant SCADA system as shown on the drawings and documents.

.6 Provide programming and commissioning of control system, including PLCs and SCADA.

1.6 GENERAL REQUIREMENTS

.1 Provide all devices, components and accessory items necessary for the successful implementation and operation of the instrumentation and control systems.

.2 Complete detailed design of system drawings and selection of system components and accessories.

.3 Design as shown and specified includes:
- .1 Functional requirements.
- .2 Generalized component specifications.
- .3 Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring and panel power.

.4 The Contractor is responsible for gaining a comprehensive understanding of the process equipment and the control equipment. The Contractor shall coordinate all aspects of instrumentation and control wiring and hardware to be compatible with the process itself, and associated equipment (after optimum tuning and adjusting of mechanical, electrical, and instrumentation equipment).

.5 General Design Requirements for Control Logic, Control Panels and Wiring Diagrams:
- .1 Complete designs for control panels shown on Control Panel Schedule to perform the functions shown in the contract drawings and documents.
- .2 Complete wiring diagrams are not shown. Determine signal requirements from P&IDs, Wiring Detail Drawings, and other contract drawings and documents, and design the detailed wiring circuits. Conform to the requirements shown on the contract drawings.
- .3 Comply with the manufacturer's written instructions.

.6 Provide consistent functions throughout the entire system whether implemented in hardware or

1.6 GENERAL REQUIREMENTS (Cont'd)

.6 (Cont'd)
software. For example, but not limited to, provide all functions in control logic, sequence controls, and display layouts in same or similar manner.

1.7 CONTROL SYSTEM PROGRAMMING

.1 Provide programming and commissioning of the control system application software, including PLC and SCADA application software, and integration with Vendor Package Control Panels. Coordinate closely with the Departmental Representative when carrying out all work to demonstrate overall system integrity, allowing adequate time for the application software to be installed and tested.

.2 The Contractor shall provide a Process Control Narrative (PCN) description of the process control strategy for approval prior to the start of programming. The Process Control Description provided as part of the contract documents shall be used as a basis for the Contractor's PCN. The Contractor shall expand upon this document with additional details as required. It is the Contractor's responsibility to review the control system details from the Vendor Package suppliers, and to integrate those details such as specific alarms, process interlocks, and key equipment status in the PCN. The alarm dialer alarm groupings shall be defined in the PCN by the contractor, after consultation with the Departmental Representative.

.3 The Process Control Description provided as part of the contract documents describes the process control for the entire site as a whole, including the Pump Stations and other equipment which are provided under a separate contract (Contract C LTWMF). Each contractor is responsible for the portions applicable to the scope of their contract. Coordinate with the programmer of Contract C LTWMF and the Departmental Representative for all integration points, including but not limited to process alarms, interlocks, communication alarms, and alarm dialer points. The same PLC programming and SCADA standards as developed under this contract for the WWTP shall be used by the programmer of Contract C LTWMF. Coordinate with the programmer of Contract C LTWMF and the Departmental Representative for integration of SCADA screens and tags related to Contract C

1.7 CONTROL SYSTEM PROGRAMMING (Cont'd)

.3 (Cont'd) LTWMF into the SCADA application developed for the WWTP.

.4 Allow for a minimum of five days for meetings with the programmer of Contract C LTWMF and the Departmental Representative. As a result of the meetings, propose standards that demonstrate programming compatibility with the Contract C LTWMF, subject to approval by the Departmental Representative before the programming is implemented.

.5 Follow the requirements in the Programming Requirements attachment to this section.

.6 The commissioning of the control systems for the Vendor Package Control Panels will be completed by the Vendor Package suppliers under this contract. Coordinate closely with the Vendor Package suppliers and the Departmental Representative when carrying out all work to demonstrate overall system integrity and integration, allowing adequate time for the application software to be installed and tested.

.7 Coordinate closely with the Vendor Package suppliers and Departmental Representative when carrying out all work such as cross system/panel wiring, FAT, SAT etc.. Demonstrate overall system integrity including Control Panels programmed and commissioned by others. Refer to the Vendor Package shop drawings for carrying out all work.

.8 Provide testing and commissioning services including those associated with installing and testing software prepared by others as determined by the Departmental Representative. Assign qualified staff whenever it is required by the Departmental Representative during PLC and SCADA software testing. Allow in the Contract Price, for any additional time deemed necessary to meet the testing and commissioning requirements.

.9 Provide FATs to demonstrate the operational functionality of PLC and SCADA hardware and application software. Notify the Departmental Representative ten working days in advance of the FAT such that this test may be witnessed by the Departmental Representative. The FAT shall take place at the panel manufacturer's factory.

1.8 SYSTEM SUPPLIERS

.1 The supply and installation of instruments, ICPs and control system hardware, and control system application programming, including testing, calibration, commissioning shall be performed as a complete package by an experienced, Instrumentation and Control contractor (I&C contractor).

.1 The I&C contractor shall be required to have full in-house capability to engineer, design, fabricate, test all equipment and systems, as well as have the capability to commission the equipment in the field.

.2 Submit for review and acceptance by the Departmental Representative the qualifications of the proposed I&C contractor prior to the Preconstruction Meeting. Only the related shop drawings submitted by such an accepted I&C contractor shall be considered for the required work. Delay in submitting the I&C contractor qualifications or by submitting shop drawings from other than an I&C Subcontractor that is not qualified shall not be grounds for requesting an extension of time.

.3 The I&C contractor shall have procedures in place for standard project methodology for developing an automation plan, system functional specifications, implementation methods, test plans, integration, testing, staging, installation and startup.

.4 Submit the name and qualifications of the I&C Subcontractor for this section of the specification.

.5 Provide list of staff that will be working on the project. Provide staff qualifications.

.2 Include for service technicians qualified by the manufacturers. Unless otherwise specified, only the manufacturer's technicians are acceptable where analyzers, gas detection system, or flow meters are concerned. This includes subcontracting main suppliers and their services as necessary, and especially if called for in the Specification.

.3 All on site control and instrumentation work shall be performed under the direct supervision of a qualified and experienced supervisor employed by the Instrumentation and Control Contractor.

1.8 SYSTEM SUPPLIERS (Cont'd)

.4 All equipment shall be designed and installed in full conformity with the drawings, specifications, engineering data, written instructions and recommendations of the manufacturer.

.5 The Instrumentation and Control Contractor shall identify the specific staff members, including system engineers, maintenance engineers that will be responsible for the control system works specified herein.

1.9 SUBMITTALS

.1 Submittals shall be made in accordance with Section 01 33 00.

.2 Where a CD-ROM or other electronic media is submitted, insert it in a carrier pouch in a 3 ring binder.

.3 Product Data Sheets:

.1 Product Data Sheets specifying instruments and equipment are included in the Attachments to this section. Complete these sheets with the information noted below and any other data pertinent to the equipment and the application.

.2 Initial submission for review to accompany Shop Drawings:

.1 The product manufacturer and the supplier or representative.

.2 The complete model or catalogue number(s) including any special options.

.3 The available adjustment range(s) and the operating range(s).

.3 Second Submission during pre-commissioning, testing and calibration period:

.1 Serial numbers, part numbers, dates of installation and calibration.

.2 Any special procedures required to duplicate calibration.

.3 This submission is for signature by the Contractor and the Departmental Representative following acceptance of the operation of each instrument.

.4 Final Submission of signed-off Product Data Sheets included with Operating and Maintenance Instruction Manuals:

.1 All of the above information.

1.9 SUBMITTALS (Cont'd)

.3 Product Data Sheets:(Cont'd)

.3 (Cont'd)

.2 Phone and fax numbers of contact person for product support/service.

.4 Where there is any discrepancy, the description provided on the Product Data Sheet takes precedence over the model number given in the data sheet.

.4 Shop Drawings:

.1 Bill of material, catalogue information, descriptive literature, wiring diagrams, and Shop Drawings for components of the control system.

.2 Catalogue information on electrical devices furnished with the system.

.3 Shop Drawings, catalogue material, and dimensional layout drawings for control panels and enclosures.

.4 List of expendable materials and quantities.

.5 List of Instrument, Equipment and Panel Identification Nameplates.

.6 Submit, as a minimum, the following Shop Drawings:

.1 Scaled, referenced, front of panel layouts, and general arrangement drawings.

.2 Scaled, referenced, internal panel layouts (may be combined with the above).

.3 Equipment and/or panel block wiring diagrams showing termination identification at each item of equipment, inter-wiring and cable numbering, all peripheral equipment, any PLC module DIP switch settings, pin assignments for D-shell connectors, plugs and jacks, and instrument/equipment tag numbers.

.4 Where issued, loop drawings are typical for guidance only. Submit itemized instrument wiring arm drawings for all analog process loops and discrete connections, generally in accordance with ISA S5.4 format and as a minimum incorporating the following details: PLC terminal numbers, Control Cabinet terminal numbers, field terminal numbers, wire numbers, contact orientation, power source identifications and equipment numbers.

1.9 SUBMITTALS (Cont'd)

.4 Shop Drawings:(Cont'd)

.6 (Cont'd)

The AutoCAD files for these drawings shall be edited with "Record Drawing" detail and provided to the Departmental Representative.

.7 Panel elementary diagrams of prewired panels. Include, in diagrams, control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters. The diagrams shall be fully comprehensive so that every circuit loop can be followed completely. Indicate the types of loads, switches, transducers and power supplies such as motors, relays, lights, indicators, float switches, hand switches, isolators, signal selectors, dedicated 24 V DC power supplies, etc. Number and identify each component circuit and terminal. Also show wiring, terminals and devices which are external to the panel including items supplied by Other Contractors. Identify all wires/cables, enclosures, terminals, and devices. Show Tag Numbers.

.8 Detailed loop diagrams on a single 297 mm x 432 mm (11 inch x 17 inch) sheet for each monitoring or control loop (Analog and Digital loops). The loop diagram shall show all components of the loop internal and external to control panel(s), both analog, digital and discrete including all relays, switches, dropping resistors, etc. which are being provided for proper operation. The format shall be the Instrument Society of America, Standard for Instrument Loop Diagrams, ISA-S5.4 plus the following:

.1 Utilize AutoCAD for all instrumentation and control wiring drawings. Conform to the style, format, nomenclature symbols and other attributes as shown in the attached sample. Do not use external references or customized file extensions. Provide fully portable electronic file copies of all drawings.

.2 Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. Show all components and panel terminal board identification numbers and all wire numbers. Include all intermediate terminations between

1.9 SUBMITTALS (Cont'd)

.4 Shop Drawings:(Cont'd)

.8 (Cont'd)

field elements and panels (e.g. terminal junction boxes). Wire numbering and tagging in accordance with Section 26 05 21 - Wires and Cables (0 - 1000 V).

.3 Indicate location of all devices.

.4 Provide instrument description showing type, manufacturer, model number, range, setpoints and operation (e.g. fail open, open on energization, normally closed, etc) as applicable.

.5 Show all instrument loop power or instrument air requirements back to termination on terminal block or bulkhead, fuse block (including fuse size), etc., as applicable.

.6 Show all grounding points within cabinets and panels and identify the connection point of individual components.

.9 Calculations showing actual UPS load.

.10 Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.

.11 Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

.12 Configuration/parameter sheets including switch settings, parameter settings, and addresses. Show factory default settings and proposed settings.

.13 Diagrams showing dip switches complete with proposed settings.

.14 Make submissions on reproducible material such as mylar, vellum or legal-size paper, complete with a title block. Provide tabular columns to record the original submission date, a revision number, date and reason for subsequent revisions, and signature of authorized issuing staff member.

.5 Shop Drawings for Programmable Equipment:

.1 Bill of Materials to show documentation, software, hardware including communications gear and tools as follows:

.1 For software items include: Publisher, title, version, part number, serial number, media type and size, and information contained on label.

1.9 SUBMITTALS (Cont'd)

.5 (Cont'd)

.1 (Cont'd)

.2 For documentation include: Title and publisher for each item.

.3 For tools include: Documentation and appropriate hardware and software items.

.2 For Hardware:

.1 Physical, electrical and environmental requirements.

.2 Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.

.3 Show addresses for each hardware component including channel number, IP address.

.4 Network Communications wiring diagram showing all devices, ports, and cables. Identify locations of devices. Identify protocols utilized by each node/firmware & software applications including PLC modules.

.5 I/O list including the following fields for each input/output point:

.1 I/O type (DI, DO, AI, AO).

.2 Internal point numbers. Format shall be similar to instrument tag number.

.3 A description of the I/O point (eg. Raw Sludge Pump 1).

.4 I/O point address including processor number, rack number, I/O module, slot, address, field interface terminal strip number and terminals.

.5 Field wire number.

.3 Graphics Standard Confirmation: Prior to procurement of hardware and development of custom graphics, contact the Departmental Representative via shop drawing submittal, to confirm the manufacturer of standard SCADA/OIT software to be used as required.

.4 Graphics: For OIT, SCADA, and/or computer application software submit a design document containing:

.1 Layouts of graphics and/or displays.

.2 Alarm priorities.

.3 Lists of monitored points and controlled points.

.4 Listings of templates; configuration listings, tables and descriptions.

.5 Set of user manuals.

1.9 SUBMITTALS (Cont'd)

.5 (Cont'd)

.5 For Application Software:

.1 English language machine functional description or control narrative. Describe in general and in detail all aspects of the devices controlled, the operations or actions performed by the controlled devices, the devices monitored, the sensors, and the logic performed. Include any assumptions made in developing the program.

.2 Initialization Considerations - A description of the impact of power fail or system failover type restarts upon the subsystem shall be described.

.3 Describe failure contingencies in detail.

.4 Listing of operator inputs/selections to the control strategy shall be illustrated.

.5 For PLCs with present or future connection / communications to plant PLC or plant SCADA:

.6 Submit Memory Maps that define PLC register locations for each analog and discrete data transferred between the PLC and the plant host system. Memory map submittal shall include memory address, description of what information is in the register and register format for all registers. For analog values, the memory map submittal shall also include the register units/span. For discrete values, the memory map submittal shall also define what each register state represents. The PLC registers location shall not be changed once the Memory Map document has been reviewed and approved.

.6 For networks:

.1 Submit all network testing requirements to the Departmental Representative within 4 weeks following receipt of the order defining required network testing of the network cabling. These tests will be performed by Contractor's network installer demonstrating satisfactory communications connectivity.

.7 Allowable PLC Programming Software:

.1 Submit a request for confirmation of make/version of PLC programming software to be used by the Supplier.

1.9 SUBMITTALS (Cont'd)

.5 (Cont'd)

.7 (Cont'd)

Confirm with the Departmental Representative before starting software development.

.6 Device Shop Drawings:

.1 Submit Shop Drawings for all field and panel mounted devices. Manufacturers' documentation will be accepted only if the following information is clearly indicated and highlighted for the equipment proposed. Submit the following:

.1 A quotation from the proposed instrument or equipment vendor (prices removed), including tag numbers, quantities, options being provided and a full description and performance data.

.2 Installation details depicting mounting assemblies, physical dimensions.

.3 Termination details clearly indicating the type and lengths of external wiring required and electrical connections.

.4 Power supply rating, input and output signal ranges, maximum measured process range and calibrated scale, physical, electrical and environmental requirements.

.5 Exact catalogue model numbers for each piece of equipment and its accessory options, and clearly referenced by the respective instrument or equipment tag name given in this document (improperly tagged items shall be rejected).

.6 A separate sheet with manufacturers' recommended list of spare parts including individual pricing with the shop drawings.

.2 Note compliance and variance in writing or the specification shall have precedence over approved shop drawings. Stamp the shop drawings submitted as either "COMPLIES EXACTLY WITH SPECIFICATION" or "DEVIATES FROM SPECIFICATION" as appropriate. In the latter case, describe deviations exactly and indicate how they impact the specified duty of the component. The Departmental Representative will assess acceptability of submission.

1.9 SUBMITTALS (Cont'd)

.7 Record Copies of Shop Drawings, & Electronic Files:
.1 Submit six white print "as-built" copies of each Shop Drawing and document specified above, as well as electronic copies (on CD or comparable media). Under certain circumstances during the course of the contract, instead of paper, drawing and document files may be exchanged with the Departmental Representative to streamline coordination.

1.10 SUBMITTAL PACKAGES

.1 General:
.1 Submit all documentation required as described in this section.

.2 Submission Format:
.1 A complete set of Shop Drawings and the initial submission of the Product Data Sheets shall be bound into one volume and issued for approval before the commencement of work.

.3 Review Submittals:
.1 Submit all documentation in accordance with Package A, B, and C submittals as set out below.
.2 Bill of Materials: List of required equipment (part of Package A).

.4 Group equipment items by enclosure and field, and within an enclosure, as follows:
.1 IPS Components: By component identification code.
.2 Other Equipment: By equipment type.

.5 Data Included:
.1 Equipment tag number.
.2 Description.
.3 Manufacturer, complete model number and all options not defined by model number.
.4 Quantity supplied.
.5 Component identification code where applicable.

.6 Catalogue Cuts: components, electrical devices, and mechanical devices (part of Package A):
.1 Catalogue information.
.2 Descriptive literature.
.3 External power and signal connections.

1.10 SUBMITTAL PACKAGES (Cont'd)

.6 Catalogue Cuts:(Cont'd)
.4 Scaled drawings showing exterior dimensions and locations of all electrical and mechanical interfaces.

.7 Component Data Sheets: Data sheets for all components (part of Package A):
.1 Format and Level of Detail: In accordance with ISA S20.
.2 Include the component type identification code on the data sheet.
.3 Specific features and configuration data for each component:
.4 Location or service.
.5 Manufacturer and complete model number.
.6 Materials of construction.
.7 Options included.
.8 Size and scale range.
.9 Set points.
.10 List of configurable parameters c/w factory default settings, as shipped values, and a blank for field adjusted values.
.11 Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

.8 Sizing and Selection Calculations (part of Package A):
.1 Primary Elements: Complete calculations plus process data used. Example for flow elements: Minimum and maximum values, permanent head loss, and assumptions made.
.2 Controller, computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.

.9 Network Wiring Diagram (part of Package A):
.1 Complete configuration drawing showing cable types, jacks, jack types, jack numbers, PLCs, racks, computers, communications devices, terminals, plugs, patch panels, cable management racks, control panels, etc.
.2 Show location for each device and pull box.
.3 Show any existing as well as new; up to the plant property line.
.4 Include fibre optic cables as well as copper and wireless components.

.10 Spares, Expendables, and Test Equipment (Part of Package A).

1.10 SUBMITTAL PACKAGES (Cont'd)

.11 Package A is a Prerequisite to the submission of Package B.

.12 Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings (part of Package B):
- .1 Scale Drawings: Show dimensions and location of front of panel devices.
- .2 Panel Legend: List front of panel devices by tag number, and including nameplate inscriptions, service legends, and annunciator inscriptions.

.13 Panel Construction Drawings (part of Package B):
- .1 Scale Drawings: Show dimensions and locations of panel mounted devices, doors, louvers, subpanels, internal and external.
- .2 Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
- .3 Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
- .4 Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.

.14 Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labelling scheme.

.15 Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize (part of Package B):
- .1 Required voltages, currents, and phases(s).
- .2 Maximum heat dissipations (Joules per hour).
- .3 All calculations.
- .4 Steady State Temperature Calculations: For non-ventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 38 degrees Celsius.

.16 Package B is a prerequiste to the submission of Package C.

1.10 SUBMITTAL PACKAGES (Cont'd)

.17 Panel Control Diagrams: For discrete control and power circuits (part of Package C):

.1 Diagram Type: Ladder diagrams. Include devices, related to discrete functions that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.

.2 Show the connections at each device, terminals, and wiring or cabling between devices. The diagrams shall be fully comprehensive so that every circuit can be followed completely. Indicate types of loads, switches, and power supplies such as motors, relays, lights, indicators, float switches, hand switches, etc.

.3 If a loop connects to panels or devices not provided under this Section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:

.1 Show the first component connected to within the panel or device that is not provided under this section.

.2 Identify the component by tag and description.

.3 Identify panel and component terminal numbers.

.4 Product schematics, diagrams and drawings using Autocad or Microstation.

.5 Item Identification: Identify each item with attributes listed.

.6 Wires: Wire number and colour. Cable number if part of multiconductor cable.

.7 Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

.4 Discrete Components:

.1 Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

.2 Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (e.g. Sump Level High).

.3 I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.

1.10 SUBMITTAL PACKAGES (Cont'd)

.17 Panel Control Diagrams:(Cont'd)

.5 Relay Coils:

.1 Tag number and its function.

.2 On the right side of the run where coil is located, list the contact location by ladder number and sheet number. Underline normally closed contacts.

.3 Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

.4 Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.

.6 Ground wires, surge protectors, and connections.

.7 Circuit Names: Show names corresponding to Electrical Drawings.

.8 Panel Plumbing Diagrams: (part of Package C):

.1 For each panel containing piping and tubing. Show type and size for:

.2 Pipes and Tubes: Thickness, pressure rating, and materials.

.3 Components: Valves, regulators, and filters.

.4 Connections to panel mounted devices.

.5 Panel interface connections.

.9 Loop Diagrams: Individual wiring diagram for each analog, discrete or pulse frequency loop (part of Package C):

.1 Conform to the minimum requirements of ISA S5.4.

.2 The diagrams shall be fully comprehensive so that every circuit can be followed completely. Indicate types of loads, switches, transducers and power supplies such as motors, relays, lights, indicators, float switches, hand switches, isolators, signal selectors, dedicated 24 V DC power supplies, etc.

.3 If a loop connects to panels or devices not provided under this Section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:

.1 Show the first component connected to within the panel or device that is not provided under this Section.

1.10 SUBMITTAL PACKAGES (Cont'd)

.17 Panel Control Diagrams:(Cont'd)

.9 Loop Diagrams:(Cont'd)

.3 (Cont'd)

.2 Identify the component by tag and description.

.3 Identify panel and component terminal numbers.

.4 Product schematics, diagrams and drawings using AutoCAD.

.5 Under paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs two and six.

.6 Drawing Size: Individual 297 mm x 432 mm (11 inch x 17 inch) sheet for two PLC I/O modules where applicable, or one loop.

.7 Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.

.8 One Drawing Per Loop: Show each loop individually. No "typical" loop diagrams will be allowed. For PLCs: Show a maximum of two I/O modules per sheet. Use additional sheets where necessary for clarity.

.9 Show:

.1 Terminals, terminal numbers, location of DC power supply, and location of common dropping resistors.

.2 Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

.10 Tabular summary on each diagram:

.1 Transmitting Instruments: Output capability.

.2 Receiving Instruments: Input impedance.

.3 Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.

.4 Total loop impedance.

.5 Reserve output capacity.

.6 Schedule of Circuit and Raceway names.

.10 Interconnecting Wiring Diagrams (part of Package C):

.1 Diagrams, device designations, and symbols in accordance with NEMA ICS

1.10 SUBMITTAL PACKAGES (Cont'd)

.17 Panel Control Diagrams:(Cont'd)

.10 (Cont'd)

.2 Diagrams shall bear the electrical SubContractor's mark showing that they have been coordinated.

.3 Show:

.1 Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.

.2 Component and panel terminal board identification numbers, and external wire and cable numbers.

.3 Circuit names matching the Circuit and Raceway Schedule submitted as part of above.

.4 Intermediate terminations between field elements and panels for, but not limited to, terminal junction boxes.

.5 Pull boxes.

.6 Installation Details: Include all modifications or further details required and adequately define installation of IPS components.

.7 Applications Software Documentation for devices configured or programmed under this Section:

.8 Complete configuration documentation for microprocessor based configurational devices.

.4 For each device, include a block diagram showing:

.1 Functional blocks or modules used.

.2 Configuration, calibration, and tuning parameters.

.3 Descriptive annotations.

.11 Shop Drawings for PLC I/O List:

.1 Managed by Vendor/Contractor:

.2 During construction, maintain a PLC I/O List and provide copies to the Departmental Representative.

.3 Assign PLC I/O points to specific chassis, slot, and point addresses.

.4 PLC I/O List Changes: Changes to the PLC I/O List reflecting actual equipment and instrumentation provided by the Contractor/Vendor.

.5 Submit latest PLC I/O List revisions.

.6 Submit changes at approximately 30-Day intervals.

1.10 SUBMITTAL PACKAGES (Cont'd)

.17 Panel Control Diagrams:(Cont'd)

.11 Shop Drawings for PLC I/O List:(Cont'd)

.7 Shop Drawings for Changes Impacting PLC and SLDC Programming:

.8 Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.

.9 Submit changes at approximately 30-Day intervals.

.10 Samples: Provide a colour schedule with colour samples for control panels.

.18 Informational Submittals:

.1 Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PCS design.

.2 Legends and Abbreviation Lists:

.1 As part of first Submittal for each Subsystem.

.2 Include complete definition of symbols and abbreviations used on this Contract. (Example: Engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, OIT/HMI displays, alarm/status logs, and reports.

.3 Use identical abbreviations for Subsystems.

.4 Submit updated versions as they occur.

.3 Refer to subsection Submittals for the following items:

.1 Bill of materials.

.2 Catalogue cuts.

.3 Component data sheets.

.4 Panel wiring diagrams, one reproducible copy.

.5 Panel plumbing diagrams, one reproducible copy.

.6 Loop diagrams, one reproducible copy.

.7 Interconnecting wiring diagrams, one reproducible copy.

.8 Applications software documentation.

.4 Provide the Manufacturer's Certificate of Proper Installation and the Manufacturer's Certification Form where specified in Subsystems.

1.10 SUBMITTAL PACKAGES (Cont'd)

.18 Informational Submittals:(Cont'd)
- .5 Operation and Maintenance Data:
  - .1 Operations procedures.
  - .2 Installation requirements and procedures.
  - .3 Maintenance requirements and procedures.
  - .4 Troubleshooting procedures.
  - .5 Calibration procedures.
  - .6 Internal schematic and wiring diagrams.
  - .7 Component and I/O Module Calibration Sheets.
  - .8 Outline of O&M data.
  - .9 Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each component.
  - .10 Final versions of Legend and Abbreviation Lists.
  - .11 Extra Materials:
    - .1 List of proposed spares, expendables, and test equipment. Separate Submittals for each Subsystem.
    - .2 Recommended Spare Parts: List of, and descriptive literature for, additional spares, expendables, and recommended test equipment. Include quantities, unit prices, and total costs.

.19 Testing Related Submittals:
- .1 General: Complete testing related submittals
- .2 Unwitnessed Factory Test: No Submittals required.
- .3 Factory Acceptance Test:
  - .1 Preliminary Test Procedures:
    - .1 Outline of proposed tests, forms, and checklists.
  - .2 Final Test Procedures:
    - .1 Proposed test procedures, forms, and checklists.
    - .2 Capacity, Timing, and Simulation: Describe in test procedures simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements. Cover capacity and timing requirements to support equipment provided under the Contract

1.10 SUBMITTAL PACKAGES (Cont'd)

.19 Testing Related Submittals:(Cont'd)
.3 Factory Acceptance Test:(Cont'd)
.2 Final Test Procedures:(Cont'd)

Documents and designated future components. Include calculations to support these proposed test procedures.

.3 Test Documentation: Copy of signed off test results when tests are completed.

.4 Site Acceptance Test:
.1 Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
.2 Final Test Procedures: Proposed test procedures, forms, and checklists.
.3 Test Documentation: Copy of signed off test results when tests are completed.

.5 Functional Test:
.1 Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
.2 Final Test Procedures: Proposed test procedures, forms, and checklists.
.3 Test Documentation:
.4 Copy of signed off test results when tests are completed.
.5 Completed component calibration sheets.

.6 Performance Test:
.1 Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
.2 Final Test Procedures: Proposed test procedures, forms, and checklists.
.3 Test Documentation: Copy of signed off test results when tests are completed.

.7 Reliability Test:
.1 Test Procedures: Example forms and instructions for reporting failures.
.2 Test Documentation: Completed forms.

.20 Training Plan.

.21 Maintenance Service Agreement: Prior to Substantial Performance of the Work, submit

1.10 SUBMITTAL PACKAGES (Cont'd)

.21 Maintenance Service Agreement:(Cont'd) service agreements signed by the Departmental Representative and the maintenance provider for the Work.

1.11 OPERATIONS AND MAINTENANCE INSTRUCTION MANUALS

.1 Submit Operating and Maintenance Manuals.

.2 In addition to general requirements for operating and maintenance instruction manuals, include the following:

- .1 Manufacturer's hardware and distribution software manuals.
- .2 Special instructions or procedures, including package systems, software and instrument trouble-shooting techniques.
- .3 Systematic procedures for operations personnel to start up, shut-down, manually override and locally operate all related equipment in accordingly titled manual sections.
- .4 Recommendations on equipment maintenance and suggested spare parts.
- .5 Final Shop Drawings and signed-off Product Data Sheets as defined in this Specification.
- .6 Copies of Record drawings of all Shop Drawings.
- .7 Name(s), address(s) and telephone number(s) for local qualified system and/or product service representatives.
- .8 Calibration certificates from the manufacturers for each calibrated instrument.
- .9 Certified network test reports.

.3 Provide operating and maintenance instruction manual for Instrumentation & Controls in a separate indexed and tabbed manual, or separate indexed and tabbed section of the overall manual binder. Arrange sections in a logical, concise manner, and provide a cross-reference to enable all equipment/instruments to be located from its correct device tag.

.4 Prior to submission of final operating and maintenance instruction manuals, and at least thirty days prior to instrumentation and control system testing and commissioning commencing, submit to and review with the Departmental Representative, two copies of the proposed data for the instrumentation and control work section

1.11 OPERATIONS AND MAINTENANCE INSTRUCTION MANUALS (Cont'd)

.4 (Cont'd) of the operating and maintenance instruction manuals.

.5 The delivery of manuals shall be complete prior to application for a Certificate of Substantial Performance of the Work.

PART 2 - PRODUCTS

2.1 GENERAL

.1 In the event of any conflict between the applicable standards, rules, regulations, and the Contract Documents, apply the most stringent requirement.

.2 PLC and IO block diagrams shown on the contract drawings are diagrammatic and supplement performance requirements. Provide a complete system working seamlessly with other equipment not specified in this Section.

.3 Furnish all materials, equipment, and software (including package software and custom applications software programming), whether indicated in the Contract Documents or not, necessary to effect required instrumentation and control system, subsystem and loop performance.

.4 Generalized specifications for each type of IPS component are located in the Attachments to this Section.

.5 Supply any spare part required to commission instruments. Include five spare fuses of each type in the Instrument Panel.

.6 Purchase all equipment via official distribution channels that are authorized to sell, service, and support the equipment and have the responsibility to warranty its performance. Equipment that bypasses the manufacturer's authorized distribution channels is not acceptable. The Contractor is responsible for any costs associated with return, repair and/or replacement of equipment later discovered to be obtained in such a way.

.7 Supplied equipment shall be new and of best quality. No used or reconditioned equipment will be accepted.

.8 In addition to the insurance coverage required in the General Conditions, provide insurance

2.1 GENERAL (Cont'd)

.8 (Cont'd) coverage against theft or damage for any equipment turned over to the Departmental Representative during transit to and from the place of delivery and for the period when the equipment remains on the premises. Maintain coverage until equipment returned to Contractor or installed.

.9 Replacement electronics, sensors and transmitters to be stocked locally.

.10 Non-stock hardware shall be available no longer than three days.

.11 On-site technical support shall be available within 24 hours.

.12 All hardware remains the responsibility of the Contractor to provide a fully functional control system.

2.2 INSTRUMENT GENERAL REQUIREMENTS

.1 Supply field-mounted and panel mounted indicators calibrated in engineering units.

.2 Unless otherwise noted in the Contract Documents, supply instruments having linear 4-20 mA isolated output signals capable of driving a maximum load of 750 ohms.

.3 Unless otherwise noted in the Contract Documents, supply field-mounted instruments with NEMA 4X housings.

.4 Unless otherwise shown or specified, enclosures for all instruments located indoors in dry non-hazardous areas shall be as a minimum NEMA 12.

.5 Unless otherwise shown or specified, instruments located outdoors shall be suitable for the surrounding climate and appropriately installed with:

.1 A NEMA 4X enclosure including gasketed windows for displays, containing a thermostatically controlled heater and disconnect switch.

.2 A combined rain/ice/snow protection shield and sun shade for all electronic instruments which are already provided with sturdy, heated NEMA 4X enclosures by the manufacturer. Supply tip-up type hoods for

2.2 INSTRUMENT GENERAL REQUIREMENTS (Cont'd)

.5 (Cont'd)

.2 (Cont'd) access for routine calibration and maintenance.

.3 Drawing submissions shall clearly show the enclosures proposed for each instrument.

.6 Electrically heat traced sensing lines for instruments with sensing lines liable to freezing.

.7 Unless otherwise shown or specified, provide instruments located in hazardous areas with Canadian Electrical Code ratings for class, group, and division as shown.

.8 Unless otherwise shown or specified, provide instruments located in areas subject to flooding with submergence rated enclosures.

.9 All line voltage powered instruments shall be suitable for a 120 V AC power supply. Any line voltage AC powered instrument not CSA certified shall bear an Ontario Hydro Special Approvals Branch label.

.10 Provide all the necessary mounting hardware, electrical connections, transducer junction boxes, power supplies, and all accessory items or options required to satisfy each application.

.11 Provide equipment made of appropriate materials for the service indicated on each Instrument Specification Sheet, and for the process fluids present, which all exposed equipment and materials shall withstand.

.12 Provide corrosion resistant stainless steel screws, bolts, fasteners, etc. in all applications.

.13 Provide all special instrumentation communication cables, transducer cables, power cables, process sensing/sampling lines and capillary tubing in field measured lengths without joins as required by manufacturer. Allow adequate cable/capillary etc., to allow removal of instrument/transducer from process. Confirm instrument-mounting locations with Departmental Representative to ensure accurate field measurements.

2.2 INSTRUMENT GENERAL REQUIREMENTS (Cont'd)

.14 Provide mechanical protection for capillaries and transducer cables and adequately secure to eliminate sagging.

.15 Provide suitable shields, stilling wells or mounting plates to protect transducers.

.16 Instruments on liquid service shall be mounted below sensing lines, with process tapping points taken from the side of the process line.

.17 Instruments on gas service shall be mounted above the sensing lines, with process tapping points taken from the top of the process line.

.18 All instruments shall be provided with process devices. Valves shall be utilized on all instrument lines for easy removal without disruption to the process.

.19 Local indicators shall be provided for all transmitters. Local indicators shall read as follows:

.1 Temperature - Direct reading in degrees C.
.2 Level - Direct reading in m and 0 - 100 as a percent of calibrated range.
.3 Flow - Direct reading in L/sec.
.4 Pressure - Direct reading in kPa.

.20 Where manual operation of valves is required, based on a transmitter signal value, the indicator shall be located adjacent to the valve or equipment local control panel.

.21 Supplied instruments shall be of current design. Obsolete equipment, or equipment that has been identified for withdrawal from the market by the manufacturer before date of Substantial Performance of the Work shall not be accepted.

2.3 INSTRUMENTS

.1 Provide instruments as specified in the Attachments to this Section and listed in the Product Data Sheets of those Attachments.

2.4 CONTROL PANELS

.1 Provide the Instrument Control Panel(s) (ICP) with Programmable Logic Controller(s) (PLC) as specified and listed in the Attachments to this Section.

2.5 COMPUTERS AND SOFTWARE

.1 Provide computers and related hardware and software as specified and listed in the Attachments to this Section.

2.6 MOUNTING SYSTEMS GENERAL

.1 Mount electrical and electronic devices on DIN rail except where otherwise noted in the Contract Documents.
  .1 Exceptions:
    .1 UPSs.
    .2 Devices mounted on 483 mm (19 inch) racks.

.2 For devices mounted on 483 mm (19 inch) racks, provide:
  .1 Enclosure with NEMA rating to suit the area environment.
  .2 Doors on front and rear.
  .3 Locking handle with three point latch for each door.
  .4 Front and rear door hinges on the same side of the enclosure; hinges on the side closest to the nearest wall in the vicinity.
  .5 Piano type door hinges.
  .6 Wire management system; spare, troughs, hooks to wrap excess length of cables.

.3 For devices mounted on a shelf:
  .1 Do not stack; provide separate shelf for each device.
  .2 Provide front and rear access to the device complete with a hinged shelf and slack dressed cable or an easily accessible rear door on the enclosure.

2.7 PANEL FABRICATION

.1 General:
  .1 Meet all panel specific requirements set out in the Product Data Sheets.
  .2 Panel Construction and Interior Wiring to be in accordance with Canada Electrical Code (CEC), provincial and local codes, and applicable sections of EEMAC, NEMA, ANSI, CSA, and ICECA.
  .3 All panels shall bear CSA listing mark stating "LISTED ENCLOSED INDUSTRIAL CONTROL PANELS."
  .4 Use only panel shops that are CSA certified and ISO 9002 registered. Panels shall carry a CSA label or provide a label by the Electrical Safety Authority (ESA,

2.7 PANEL FABRICATION (Cont'd)

.1 General:(Cont'd)

.4 (Cont'd)
Ontario) based on the model code SPE 1000 for the field evaluation of electrical equipment.

.5 Conform to NEMA ratings as specified in the individual equipment sections.

.6 Minimum Panel Dimensions: As shown on the Drawings.

.7 Instrument Arrangements: As shown on the contract Drawings.

.8 Do not mount equipment on the bottom 400 mm of sub panel space

.9 Provide recessed type door handles, lockable with key numbers coordinated by area to reduce the quantity of keys.

.10 Provide all screws, blots, fasteners and accessories in corrosion resistant stainless steel.

.11 All cut-outs shall be cut, punched or drilled and finished smoothly with rounded edges.

.12 Provide all wall-mounted panels with 50 mm stainless steel spacers and incoming field cables

.13 Factory Finishing:

.1 Stainless Steel and Aluminum: Not painted.

.2 Non-metallic Panels: Not painted.

.3 Steel Panels:

.1 Sand the panel and remove all mill scale, rust, grease, and oil.

.2 Fill all imperfections and sand smooth.

.3 Paint the panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.

.4 Sand surfaces lightly between coats.

.5 Dry Film Thickness: 3 mm, minimum.

.4 Where Instrument Control Panels (ICPs) are freestanding cabinets in electrical rooms in proximity to Motor Control Centers (MCC's), provide ICPs that match the MCC enclosures in height, depth, finish, where possible and with a minimum NEMA 12 rating unless otherwise specified.

.5 Provide all other NEMA 12 panels fabricated of high grade cold rolled

2.7 PANEL FABRICATION (Cont'd)

.1 General:(Cont'd)

.13 Factory Finishing:(Cont'd)

.5 (Cont'd)
steel, 1.98 mm thick (14 gauge) minimum, phosphatized, primed and painted with two coats of ASA 61 gray baked enamel inside and out except on stainless steel. Sub panels to be 2.78 mm thick (12 gauge) CRS finished with white baked on enamel.

.6 Provide all NEMA 4X panels and field junction boxes in 1.98 mm thick (14 gauge) stainless steel, with a brushed or matte finish.

.14 Provide all panels and cabinets with interior back and side sub panels for mounting equipment, a 300 mm (minimum) print pocket, a cable base, modem/LAN switch pans, and a drip shield across the top of the panel.

.15 Provide self regenerating desiccant with vapour corrosion inhibitors for moisture and corrosion protection suitable for two years operation. Mark the date of installation on the package.

.16 Provide horizontal wireways at bottom and top inside the back plate of the panel. Identify field side and internal analog and digital wireways.

.17 Place knockouts for the wiring at the bottom or sides of the panel. Seal all conduits and gaps to maintain appropriate NEMA rating.

.18 Do not allow panel floor mounted equipment (i.e. UPS) to block access to the panel back plane mounted equipment.

.19 Provide panels with:

.1 20 percent spare I/O.

.2 20 percent spare terminal blocks, but not less than 10 of each type.

.20 Size panels to allow for:

.1 20 percent future terminal blocks.

.2 20 percent spare terminal blocks.

.3 One spare PLC/RPU chassis and adequate terminals space on the back of the panel.

.2 Front-of-Panel:

.1 General:

.1 Provide all door mounted equipment designed for flush mounting and properly sealed to maintain the panels NEMA rating.

2.7 PANEL FABRICATION (Cont'd)

.2 Front-of-Panel:(Cont'd)
.1 General:(Cont'd)
.2 Arrange front of panel such that devices are higher than 800 mm and lower than 2000 mm above the floor once the panel is in its mounting location.
.3 Indicating Lights:
.1 Provide Cluster LED type, extra bright, push to test pilot lights, and push buttons.
.2 Push to test (PTT) feature except where noted. May provide a single LAMP TEST push button and a set of lamp test relays for the set of lamps at a single location in lieu of individual PTT lights.
.3 Provide a fused Push to Test circuit to test each indicating light.
.4 Operator Interface Terminals (OITs)
.1 Installation of local operator interface terminals (non-SCADA) shall comply with all hardware, software and installation requirements.
.2 Minimum hardware requirements:
.1 Colour Display.
.2 264 mm (10.4 inch), with display area 211 mm x 157 mm (8.3 inch x 6.2 inch) or larger.
.3 640x 480, 18-bit resolution.
.4 64 MB RAM/ 64 MB Flash.
.5 Two USB communication ports.
.5 Windows:
.1 Provide clear polycarbonate windows sized for viewing complete PLCs and I/O modules without opening the panel door. Coordinate with panel mounted OITs for proper viewing heights.
.6 Provide a door mounted folding shelf suitable for use as a laptop workstation.

2.7 PANEL FABRICATION (Cont'd)

.2 Front-of-Panel:(Cont'd)

.2 Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

.1 Potentiometer Units:

.1 Three-terminal, oil-tight construction, resolution of 1 percent and linearity of plus or minus 5 percent.

.2 Single-hole, panel mounting accommodating panel thicknesses between 3.2 and 6.35 mm.

.3 Include legend plates with service markings.

.2 Indicating Lights:

.1 Heavy-duty, push-to-test type, oil-tight, industrial type with integral transformer for 120 V AC applications.

.2 Screwed on prismatic glass lenses in colours noted and factory engraved legend plates for service legend.

.3 Pushbutton, Momentary:

.1 Heavy-duty, oil-tight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120 V AC.

.2 Standard size legend plates with black field and white markings for service legend.

.4 Selector Switch:

.1 Heavy-duty, oil-tight, industrial type with contacts rated for 120 V AC service at 10 amperes continuous.

.2 Standard size, black field, legend plates with white markings, for service legend.

.3 Operators: Black knob type.

.4 Single-hole mounting, accommodating panel thicknesses from 1.6 to 6.35 mm.

.3 Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

.1 Potentiometer, Watertight:

.1 Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of One percent and linearity of plus or minus Five percent.

.2 Single-hole, panel mounting accommodating panel thicknesses between 3.2 and 6.35 mm.

2.7 PANEL FABRICATION (Cont'd)

.2 Front-of-Panel:(Cont'd)
.3 (Cont'd)
.1 Potentiometer, Watertight:(Cont'd)
.3 Include engraved legend plates with service markings.
.2 Indicating Lights, Watertight:
.1 Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120 V AC applications and corrosion-resistant service.
.2 Screwed on prismatic lenses and factory engraved legend plates for service legend.
.3 Pushbutton, Momentary, Watertight:
.1 Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120 V AC service at 10 amperes continuous and corrosion resistant service.
.2 Standard size, black field, legend plates with white markings for service legend.
.4 Selector Switch, Watertight:
.1 Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120 V AC service at 10 amperes continuous and corrosion-resistant service.
.2 Standard size, black field, legend plates with white markings, for service legend.
.5 Operators: Black knob type.
.1 Single-hole mounting, accommodating panel thicknesses from 1.6 to 6.35 mm.

.3 Temperature Control:
.1 Freestanding Panels:
.1 Non-ventilated Panels: Design to adequately dissipate heat from equipment mounted inside panel or on panel. Alternatively furnish refrigeration cooling system.
.2 Ventilated Panels:
.1 Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.

2.7 PANEL FABRICATION (Cont'd)

.3 Temperature Control:(Cont'd)
.1 Freestanding Panels:(Cont'd)
.2 Ventilated Panels:(Cont'd)
.2 For panels with backs against wall, furnish louvers on top and bottom of panel sides.
.3 For panels without backs against wall, furnish louvers on top and bottom of panel back.
.4 Louver Construction: Stamped sheet metal.
.3 Ventilation Fans:
.1 Furnish where required to provide adequate cooling.
.2 Create positive internal pressure within panel.
.3 Fan Motor Power: 120 V AC, 60 Hz, thermostatically controlled.
.4 Air Filters: Washable aluminum.
.4 Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
.2 Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
.3 Space Heaters:
.1 Thermostatically controlled to maintain internal panel temperatures above dew point.
.2 Refer to the Control Panel Schedule (ICP List) in the Attachments to this Section.

.4 Freestanding Panel Construction:
.1 Materials:
.1 Sheet steel unless otherwise noted in the Contract Documents.
.2 Minimum thickness of 3.6 mm, unless otherwise noted in the Contract Documents.
.2 Panel Fronts:
.1 Fabricated from a single piece of sheet steel, unless otherwise noted in the Contract Documents.
.2 No seams or bolt heads visible when viewed from front.
.3 Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

2.7 PANEL FABRICATION (Cont'd)

.4 Freestanding Panel Construction:(Cont'd)
- .3 Internal Framework:
  - .1 Structural steel for instrument support and panel bracing.
  - .2 Permit panel lifting without racking or distortion.
- .4 Lifting rings to allow simple, safe rigging and lifting of panel during installation.
- .5 Adjacent Panels: Securely bolted together so front faces are parallel.
- .6 Doors:
  - .1 Full height, fully gasketed access doors where shown on the Drawings.
  - .2 Latches: Three-point
    - .1 Acceptable material: `Type 44' by Southco Inc., 610-459-4000, www.southco,com.
  - .3 Handles: Keylock handle.
  - .4 Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
  - .5 Rear Access Doors: Extend no further than 610 mm beyond the panel when opened to a 90 degree position.
  - .6 Front and Side Access Doors: As shown on the Drawings.

.5 Non-freestanding Panel Construction:
- .1 Based on environmental design requirements, provide the following unless otherwise noted in Control Panel Schedule (ICP List) in the Attachments to this Section:
  - .1 For panels listed as inside, air conditioned:
  - .2 Enclosure Type: NEMA 12.
  - .3 Materials: Steel unless otherwise noted in the Contract Documents.
  - .4 For all other panels:
  - .5 Enclosure Type: NEMA 4X.
  - .6 Provide butterfly clamp for easy opening/closing of enclosure.
  - .7 Materials: Type 316 stainless steel unless otherwise noted in the Contract Documents.
- .2 Metal Thickness: 2 mm, minimum.
- .3 Doors:
  - .1 Rubber-gasketed with continuous hinge.
  - .2 Stainless steel lockable quick-release clamps.

2.7 PANEL FABRICATION (Cont'd)

.6 Control Panel Electrical:

.1 General:

.1 Supply power to instruments from the ICP. Protect each instrument power circuit with a panel mounted terminal block type circuit breaker sized to suit.

.2 Interlock main circuit breaker with panel door.

.3 Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.

.4 Mount operator controls and indications on front access door.

.2 Wiring:

.1 All panel wiring shall be neatly dressed and run in plastic duct with AC and DC conductors in separate ducts. Allow for duct of sufficient width/depth to accommodate all incoming field wiring.

.2 Hook and Loop cable ties shall be used for bundling and securing all wiring not enclosed in duct.

.1 Acceptable material: `Tak-Ty' by Panduit, 888-506-5400, www.panduit.com.

.3 Separate analog and other DC circuits at least 150 mm from any AC power and control wiring.

.3 Grounding:

.1 Furnish isolated copper grounding bus for signal and shield ground connections.

.2 Ground this ground bus at a common signal ground point in accordance with Canadian Standards Association (CSA) C22.2 and the Electrical Safety Code requirements.

.3 Supply two separate grounds, one for instrument grounding (ie 4-20 mA cable shieldsetc.) and one for control circuit grounding (ie. case grounds, control circuits, etc.). Install grounding so as to keep two grounds isolated (separate). Ground conductors shall be #6 AWG, coloured green, with white stripes used for instrument grounds and dark green for control circuit grounds.

.4 Ground conductors shall be Number Six AWG, coloured green, with white stripes used for instrument grounds

2.7 PANEL FABRICATION (Cont'd)

.6 Control Panel Electrical:(Cont'd)
.3 Grounding:(Cont'd)
.4 (Cont'd)
and dark green for control circuit grounds.
.5 Single Point Ground for Each Analog Loop:
.1 Locate at DC power supply for loop.
.2 Use to ground wire shields for loop.
.6 Group and connect shields in following locations:
.1 Control panel containing power source for loop.
.2 Ground terminal block rails to ground bus.
.3 Utilize Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.
.4 Control Panels with supply voltages greater than 120 V AC:
.1 Separation:
.1 Furnish a solid metal barrier, approximately 90 percent of height and 90 percent of width of interior, to separate VFD from PLC components.
.2 Furnish interior circulation fans to aid overall heat dissipation.
.2 Power Control Transformer:
.1 Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
.2 Limit voltage variation to 15 percent during contact pickup.
.3 Fuse one side of secondary winding and ground the other.
.4 Furnish primary winding fuses in ungrounded conductors.
.3 Power Monitoring Relay:
.1 Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
.2 Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
.4 Power Distribution Blocks: Furnish to parallel feed tap on branch circuit

2.7 PANEL FABRICATION (Cont'd)

.6 Control Panel Electrical:(Cont'd)
.4 (Cont'd)
.4 Power Distribution Blocks:(Cont'd) protective devices. Do not "leap frog" power conductors.
.5 Terminations for Power Conductors: Suitable for use with 75 degrees Celsius wire at full CSA, 75 degrees Celsius ampacity.
.5 Internal Panel Lights for Freestanding Panels:
.1 Type: Switched, fluorescent back-of-panel lights.
.2 Quantity: One light for every 1.2 m of panel width.
.3 Mounting: Inside and in the top of back-of-panel area.
.4 Protective metal shield for lights.
.5 Internal Panel Lights and Service Outlets for Smaller Panels:
.6 Internal Panel Light: Switched fluorescent light.
.7 Service Outlet: Breaker protected 120 V AC, 15 amp, duplex receptacle:
.8 Required for panels. Refer to the Control Panel Schedule (ICP List) in the Attachments to this Section.
.9 Service Outlets for Freestanding Panels:
.10 Type: Three-wire, 120 V AC, 15 ampere, duplex receptacles.
.11 Quantity:
.1 Panels 1.2 m Wide and Smaller: One.
.2 Panels Wider than 1.2 m: One for every 1.2 m of panel width, a minimum of two per panel.
.12 Mounting: Evenly spaced along back-of-panel area.

2.8 ELECTRICAL REQUIREMENTS

.1 General Electrical Requirements:
.1 I&C and electrical components, terminals, wires, and enclosures shall be CSA approved.
.2 All wire and cable shall be sized and installed in accordance with the O.E.S.C. Safety Code Requirements.
.3 No control wire smaller than Number 14 gauge shall be used except where so indicated on the drawings or as specified in other Sections.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.1 (Cont'd)
.4 Available main power will be at a nominal 120 V AC.
.5 Cables/wiring shall be in conduits except where otherwise indicated in the Contract Documents
.6 Electrical Raceways: As specified in Section 26 05 34.

.2 Signal Characteristics:
.1 Analog Signals:
.1 4 to 20 mA DC, in accordance with compatibility requirements of ISA S50.1.
.2 Unless otherwise specified or shown in the Contract Documents, use Type 2, two-wire circuits.
.3 Transmitters: Load resistance capability conforming to Class L.
.4 Fully isolate input and output signals of transmitters and receivers.
.5 Provide 250 Ohm precision resistors at terminal blocks where required.
.2 Pulse Frequency Signals: DC pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid state switches.
.1 Power source: Less than 30 V DC.
.3 Discrete Signals:
.1 Two-state logic signals.
.2 Utilize 120 V AC sources for control and alarm signals.
.3 Unless otherwise specified in the contract documents, all alarm signals shall be wired for fail-safe operation. Use isolated relay contacts rated for five amperes at 120 V AC and two ampere at 30 V DC.

.3 Wiring External to PCS Subsystems Equipment:
.1 Special Control and Communications Cable: Provided by Instrumentation and Control Subcontractor.
.2 Other Wiring and Cable: As specified in Section 26 05 21.
.3 Supply shielded cables in conduit as follows:
.1 Supply single pair shielded cables with 600 Volt insulation; Number 16 AWG twisted stranded copper.
.1 Acceptable Material: `1118A' manufactured by Belden, 905-372-8713, www.belden.com.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.3 (Cont'd)

.3 (Cont'd)

.2 Supply multi-paired shielded cables individually shielded, complete with overall shield, Number 18 AWG, 600 Volt insulation.

.1 Acceptable Material: `1051' manufactured by Belden, 905-372-8713, www.belden.com.

.3 Supply RS 485 two pair low capacitance shielded cables with 300 Volt insulation; Number 22 AWG twisted stranded copper conductors.

.1 Acceptable Material: `3107A' manufactured by Belden, 905-372-8713, www.belden.com.

.4 Supply communication cables as specified by PLC vendor.

.5 Provide Teck armoured equivalents of the above cables for cable tray applications.

.4 Provide all concrete coring between floors as required.

.4 Wires within Enclosures:

.1 AC Circuits:

.1 Type: 600 volt, Type TEW stranded copper.

.2 Size: For current to be carried, but not less than Number 12 AWG.

.2 Analog Signal Circuits:

.1 Type: 300 volt stranded copper, twisted shielded pairs.

.2 Size: Number 16 AWG, minimum.

.3 Other DC Circuits.

.1 Type: 300 volt, Type TEW stranded copper.

.2 Size: For current carried, but not less than Number 18 AWG.

.4 Special Signal Circuits: Use manufacturer's standard cables.

.5 Wiring Identification:

.1 All instrumentation and control wiring shall be identified with markers as specified. The identification is to consist of the coding as detailed on the drawings and as specified herein.

.2 Tag field wires with the field device tag and terminal information:

.1 For devices connected to control panels or RPU, show field source and destination information.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.5 Wiring Identification:(Cont'd)

.2 (Cont'd)

.2 For devices connected to other panels (e.g. MCC) show field source information.

.3 Wire number shall not change unless there is a function change in the wire run i.e. a fuse, a relay, etc. Wires passing through a junction box without a change in function would retain the same wire number.

.3 Field source information consists of the following:

.1 In most cases, the device type and loop number make up the device tag information needed on the labels.

.2 Add a number or character (+,-) to each wire from the field device to make the field information unique for each wire.

.3 In a few cases, the process code (three characters) may be needed to make the wire tag unique.

.4 The destination information consists of the following:

.1 Use the rack, slot and point information for RPUs and termination strip and terminal number for control panels.

.2 Inside an RPU panel, the wires and terminals are numbered by rack, slot and point/terminal.

.5 Cable Numbers:

.1 Field cables shall be tagged with the field device tag information at both ends.

.2 Where cables carry wires from multiple field devices, the cable tag shall use the device tag of the junction box.

.3 For cables tags, use P or C or I added to the device tag for Power, Control and Instrument respectively as some devices such as valves have all three cables.

.4 Cable numbering shall show the Junction Box relevant numbers in that a cable runs to a JB, but the wiring itself would not have such designation.

.5 For example, in the case of a Cable from a Junction Box to an RPU, assign a unique "loop/device number" to the Junction Box and treat it as a Device.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.5 Wiring Identification:(Cont'd)

.6 Wire Markers:

.1 Wire markers available from Brady amongst others allow more than one line of characters if required but one line shall be used if possible.

.2 Wire markers shall be kept to a minimum for ease of installation and readability. A single line of text shall be used, minimizing the characters as much as possible.

.6 Terminal Blocks for Enclosures:

.1 Quantity:

.1 Accommodate present and spare indicated needs.

.2 Wire spare PLC I/O points to terminal blocks.

.3 One wire per terminal for field wires entering enclosures.

.4 Maximum of two wires per terminal for Number 18 AWG wire for internal enclosure wiring.

.5 Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.

.2 General:

.1 All terminals shall be easily accessible with ample room for termination of field and panel wiring.

.2 Common connection of wires at terminal blocks to be by jumper bar unless otherwise specified.

.3 Use European style DIN rail mount terminal blocks only

.4 Connection Type: Screw compression clamp.

.5 Compression Clamp:

.1 Complies with DIN VDE 0611.

.2 Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.

.3 Guides strands of wire into terminal.

.4 Screws: Hardened steel, captive, and self-locking.

.6 Current Bar: Copper or treated brass.

.7 Insulation:

.1 Thermoplastic rated for minus 55 to plus 110 degrees Celsius.

.2 Two funneled shaped inputs to facilitate wire entry.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.6 Terminal Blocks for Enclosures:(Cont'd)

.2 General:(Cont'd)

.8 Mounting:

.1 Standard DIN rail.

.2 Terminal block can be extracted from an assembly without displacing adjacent blocks.

.9 End Stops: Minimum of one at each end of rail.

.10 Wire Preparation: Stripping only permitted.

.11 Jumpers: Allow jumper installation without loss of space on terminal or rail.

.12 Marking System:

.1 Terminal number shown on both sides of terminal block.

.2 Allow use of preprinted and field marked tags.

.3 Terminal strip numbers shown on end stops.

.4 Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.

.5 Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

.13 Test Plugs: Soldered connections for 18 AWG wire.

.14 Pin Diameter: 2 mm.

.3 Terminal Block, General Purpose:

.1 Rated Voltage: 600 V AC.

.2 Rated Current: 30 amp.

.3 Wire Size: 24 to 10 AWG.

.4 Rated Wire Size: 10 AWG.

.5 Color: Gray body.

.6 Spacing: 6.35 mm, maximum.

.7 Test Sockets: One screw test socket 2 mm - diameter.

.4 Terminal Block, Ground:

.1 Wire Size: 24 to 12 AWG.

.2 Rated Wire Size: 10 AWG.

.3 Color: Green and yellow body.

.4 Spacing: 6.35 mm, maximum.

.5 Grounding: Electrically grounded to mounting rail.

.5 Terminal Block, Fused, 24V DC:

.1 Use: Provide for each analog input, located on feed to instrument.

.2 Rated Voltage: 600 V DC.

.3 Rated Current: 25 amp.

.4 Wire Size: 22 to 10 AWG.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.6 Terminal Blocks for Enclosures:(Cont'd)

.5 Terminal Block, Fused, 24V DC:(Cont'd)

.5 Rated Wire Size: 10 AWG.
.6 Color: Gray body.
.7 Fuse: 6.35 mm by 32 mm.
.8 Indication: LED diode 24 V DC.
.9 Spacing: 13 mm, maximum.

.6 Terminal Block, Fused, 120 V AC:

.1 Use: Provide on each discrete input and output point.
.2 Rated Voltage: 600 V AC.
.3 Rated Current: 25 amp.
.4 Wire Size: 22 to 10 AWG.
.5 Rated Wire Size: 10 AWG.
.6 Color: Gray body.
.7 Fuse: 6.35 mm by 32 mm.
.8 Indication: Neon lamp, 120 V AC.
.9 Leakage Current: 1.8 mA, maximum.
.10 Spacing: 13 mm, maximum.

.7 Terminal Block, Blade Disconnect Switch:

.1 Use: Provide one for each input and output field interface wire. May be omitted where a fuse or circuit breaker is used.
.2 Rated Voltage: 600 V AC.
.3 Rated Current: 10 amp.
.4 Wire Size: 22 to 10 AWG.
.5 Rated Wire Size: 10 AWG.
.6 Color: Gray body, orange switch.
.7 Spacing: 6.35 mm, maximum.

.8 Terminal Block, Fused, 120 V AC, High Current:

.1 Use: Power circuit
.2 Rated Voltage: 600 V AC.
.3 Rated Current: 35 amps.
.4 Wire Size: 18 to 8 AWG.
.5 Rated Wire Size: 8 AWG.
.6 Color: Gray.
.7 Fuse: 6.35 mm by 32 mm.
.8 Spacing: 24.13 mm, maximum.

.7 Intrinsic Safety Barriers (Galvanically isolated):

.1 Use safety barriers as required based on the classification of the equipment installation areas.
.2 Monitor discrete signals that originate in hazardous area and are used in a safe area.
.3 Interface analog signals as they pass from hazardous area to safe area.

.8 Analog Signal Isolators:

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.8 Analog Signal Isolators:(Cont'd)
- .1 Provide signal isolation for analog signals that are sent from one enclosure to another.
- .2 Do not wire instruments on different panels, cabinets, or enclosures in series.

.9 Electrical Transient Protection:
- .1 General:
  - .1 Function: Protect elements of PCS against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
  - .2 Surge suppressers are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in the installation details in the Drawings.
  - .3 Construction: First-stage high energy metal oxide varistor and second stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
  - .4 Response: Five nanoseconds maximum.
  - .5 Recovery: Automatic.
  - .6 Temperature Range: Minus 20 degrees Celsus to plus 85 degrees Celsius.
- .2 Suppressors on 120 V AC Power Supply Connections:
  - .1 Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
  - .2 First-Stage Clamping Voltage: 350 volts or less.
  - .3 Second-Stage Clamping Voltage: 210 volts or less.
  - .4 Continuous Operation: Power supplies for one four-wire transmitter or receiver: Five amps minimum at 130 V AC. All other applications: 30 amps minimum at 130 V AC.
- .3 Suppressors on Analog Signal Lines:
  - .1 Test Waveform: Linear Eight microsecond rise in current from Zero amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
  - .2 Surge Rating: Tested and rated for 50 occurrences of 2,000 amp peak test waveform.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.9 Electrical Transient Protection:(Cont'd)

.3 (Cont'd)

.3 DC Clamping Voltage: 20 to 40 percent above operating voltage for circuit.

.4 DC Clamping Voltage Tolerance: Less than plus or minus Ten percent.

.5 Maximum Loop Resistance: 18 ohms per conductor.

.6 Physical Characteristics:

.1 Mounted in Enclosures: Encapsulated inflame retardant epoxy.

.2 Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples.

.3 Field Mounted at Four-Wire Instruments: With 120 V AC outlet, AC circuit breaker, and Ten ohm resistors on signal lines, all in enclosure.

.4 NEMA 4X fibreglass or Type 316 stainless steel with door.

.5 Maximum Size: 300 by 300 by 200 mm deep.

.10 Uninterruptible Power Supply (UPS):

.1 All control panels having a PLC, I/O rack, HMI, OIT, and/or data communications equipment shall be equipped with a UPS. This includes control panels supplied with packaged systems.

.2 The UPS shall provide uninterrupted power to, at minimum, the PLC/RTU, its I/O, field instruments.

.3 The UPS shall be sized to ensure the control panel continues to perform communications, data manipulation, calculations, monitoring and process data archiving for a minimum of 60 minutes following the loss of supply power.

.4 When sizing the UPS, all critical loads shall be identified and power calculations shall be provided. Provide additional battery cabinets to allow for load/time requirements if necessary.

.5 Where possible, install the UPS in a control panel. The UPS shall not block access to any panel mounted equipment.

.6 Enclose any unit not mounted in a control panel within a vented enclosure with a NEMA rating suitable for its mounting location.

.7 Installation shall include a maintenance bypass.

2.8 ELECTRICAL REQUIREMENTS (Cont'd)

.10 Uninterruptible Power Supply (UPS):(Cont'd)
.8 Provide a "Power On" light on the enclosure door.

2.9 CONTROL PROCESSORS

.1 General:
.1 All Control related equipment shall be housed in NEMA enclosures suitable for the application and environment, and as a minimum shall be NEMA 12, as described in previous subsections.
.2 Provide all software associated with the new PLCs licensed to Departmental Representative, on original storage media in original storage packaging.
.3 Provide all cables, line extenders and connection devices required for the connection of the system and for connection of any associated programming or operator interface devices. Provide double insulated cables unless otherwise specified. Select and provide connectors with electrical contact surfaces gold-plated, and D-shell connectors with metal or metalized plastic (shielded type) hoods.
.4 Provide components rated for continuous service under the following conditions:
.1 Temperature: 0 to 50°C
.2 Relative Humidity: 5 to 95 percent
.3 Vibration: 0.25G from 5 to 100 Hertz
.4 MTBF/MTTR: > 100,000 hours/3 hours
.5 Provide a written confirmation from the manufacturer of each product stating that it is a current product and that it will be supported (spare parts, software drivers, service, etc.) for a period of not less than Five years from the date of purchase. Submit confirmation with Shop Drawings.
.6 Provide FAT to demonstrate the operational functionality of PLC and SCADA hardware, application software and communications.
.7 For all motor Start/Stop commands and actuator Open/Close commands use only individually isolated relay output modules.
.8 Always use signal isolators for VFD analog signals in the ICP (Speed indication and speed setpoints).

.2 Communications:
.1 All communications to other Plant PLCs and SCADA to be via Ethernet.
.2 Data Exchanges between subsystems and Plant SCADA System.

2.9 CONTROL PROCESSORS (Cont'd)

.3 Data Exchange with Plant SCADA System:

.1 The PLC shall be configured to allow remote monitoring from the plant main SCADA system via Ethernet.

.2 Provide compatible media converters, protocols, work and equipment necessary so the Control Panel may be connected as a working node on the plant real time process control network. This includes providing Ethernet ports in the Control Panel for connecting to plant SCADA system.

2.10 EXPENDABLE MEDIA

.1 For any instrument or system peripheral which uses expendable media such as recorder chart paper, printer paper, CDs, DVDs, analyzer reagents & membranes, filters, etc., supply media sufficient for one year of operation from the date of Substantial Performance of the Work and deliver the media to the Departmental Representative prior to application for the Certificate of Substantial Performance.

PART 3 - EXECUTION

3.1 COORDINATION

.1 Carefully examine and monitor for compatibility, any instrumentation and control work provided as part of the work of Sections of the Specification, other than the Sections governed by this Section, and ensure that all trades involved are aware of any coordination problems or details.

.2 Incompatible work, such as instrument process connections, mounting of equipment, analog, discrete or communication wiring, voltages, or inconsistencies resulting from insufficient coordination of other related work, shall be satisfactorily resolved in the opinion of the Departmental Representative at no additional cost to the Contract.

.3 When scheduling site inspection, FAT, commissioning, or SAT with the Departmental Representative, allow at least ten working days advance written notice.

3.2 QUALITY CONTROL

.1 General:
- .1 The Departmental Representative may actively participate in any of the tests.
- .2 The Departmental Representative reserves right to test or retest all specified functions.
- .3 The Departmental Representatives decision will be final regarding acceptability and completeness of all testing.
- .4 Procedures, Forms, and Checklists:
  - .1 Except for Unwitnessed Factory Test, conduct all tests in accordance with, and documented on, Departmental Representative accepted procedures, forms, and checklists.
  - .2 Describe each test item to be performed.
  - .3 Provide space after each test item description for sign off by appropriate party after satisfactory completion.
- .5 Required Test Documentation: Test procedures, forms, and checklists, signed by the Departmental Representative and the Contractor.
- .6 Hardware Delivery: Completed when hardware has been delivered to the Site and inventoried by the Departmental Representative.

.2 Conducting Tests:
- .1 Provide special testing materials and equipment.
- .2 Where possible, perform tests using actual process variables, equipment, and data.
- .3 If not practical to test with actual process variables, equipment, and data, provide a suitable means of simulation.
- .4 Define simulation techniques in test procedures.
- .5 Test Format: Cause and effect.
  - .1 Person conducting test initiates an input (cause).
  - .2 Specific test requirement is satisfied if correct result (effect), occurs.

.3 Unwitnessed Factory Test:
- .1 Scope: Inspect and test system to ensure it is operational, ready for FAT.
- .2 Location: Instrumentation and Control Subcontractor's factory.

3.2 QUALITY CONTROL (Cont'd)

.3 Unwitnessed Factory Test:(Cont'd)

.3 Integrated Test:

.1 Interconnect and test system, except for primary elements and smaller IPS panels.

.2 Exercise and test all functions.

.3 Provide stand alone testing of smaller IPS panels.

.4 Simulate inputs and outputs for primary elements, final control elements, and IPS panels excluded from test.

.5 Submit internal QA/QC reports to the Departmental Representative for approval.

.4 Panel Inspection & Factory Acceptance Testing (FAT):

.1 Make arrangements with equipment supplier(s) for panel inspection and FAT prior to delivery.

.2 Install and verify all free issued equipment to be located in the respective control panels prior to the FAT.

.3 Schedule the FAT session(s) with the Departmental Representative a minimum of 20 working days in advance. Allow sufficient time for thorough testing and corrections to take place.

.4 All Pre-FAT submittals shall be submitted at the time of scheduling. Acceptance of the test date is contingent upon the acceptance of the FAT documentation.

.5 Panel inspection and FAT shall be performed in the presence and to the satisfaction of the Departmental Representative, and shall include all devices necessary to simulate actual operating conditions.

.6 Make the following documentation available to Departmental Representative at the test site both before and during FAT:

.1 Drawings, Specifications, Addenda, and Change Orders.

.2 Master copy of FAT procedures.

.3 List of equipment to be tested including make, model, and serial number.

.4 Approved hardware Shop Drawings for equipment being tested.

.5 Approved preliminary software documentation Submittal.

3.2 QUALITY CONTROL (Cont'd)

.4 (Cont'd)

.7 Daily Schedule for FAT:

.1 Begin each day with a meeting to review the day's test schedule.

.2 End each day with a meeting to review the day's test results and to review or revise next day's test schedule.

.8 Scope:

.1 Test the entire system, with the exception of primary elements, final control elements, and certain smaller IPS panels, to demonstrate that it is operational.

.2 FAT is required for all panels.

.9 Location:

.1 Packaged Systems: Vendor's factory.

.2 All Others: Instrumentation and Control Subcontractor's factory.

.10 Scheduling:

.1 For the ICPs, FATs shall be completed no later than 40 working days prior to the scheduled SAT date.

.11 Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:

.1 One of each type function; e.g., if there is sequence control for several identical units, demonstrate control for one unit.

.2 One of each type of function in each IPS panel; for example, but not limited to, annunciator operation, controller operation, and recorder operation.

.3 All required and shown functions for 100 percent of all loops.

.12 Non-loop Specific Functions:

.1 Non-loop Specific Functions:

.1 Capacity: Demonstrate that Subsystems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.

.2 Timing: Include tests for timing requirements.

.3 Diagnostics: Demonstrate online and offline diagnostic tests and procedures.

.13 Deficiencies:

.1 Make the necessary corrections as indicated by the tests, or as directed by the Departmental Representative. Shipment of equipment to site is

3.2 QUALITY CONTROL (Cont'd)

.4 (Cont'd)

.13 Deficiencies:(Cont'd)

.1 (Cont'd) contingent on the Departmental Representative's approval.

.14 Failed Tests:

.1 Repeat and have witnessed by the Departmental Representative.

.2 With the approval of the Departmental Representative, certain tests may be conducted and witnessed by the Departmental Representative as part of the Site Acceptance Test.

.5 Site Acceptance Test (SAT):

.1 When initial site inspections and commissioning of the instrumentation and the control system is satisfactorily complete, schedule with the Departmental Representative to demonstrate the entire system is ready to start control application program commissioning.

.2 Include for the presence of qualified instrument technicians and equipment manufacturers' representatives to supervise the test if requested by the Departmental Representative. Testing is to demonstrate the proper operation of all field physical input and output signals of the PLC system under actual operating conditions to the satisfaction of the Departmental Representative. This includes proper operations and communications between PLCs, and all peripheral devices. Supply all labour, instruments and materials to perform the testing.

.3 SAT test plan shall be developed and submitted to the Departmental Representative for approval no later than 20 working days prior to the scheduled start of SAT.

.1 Roles and responsibilities of SAT team participants.

.2 SAT schedule.

.3 Any safety or process-related considerations.

.4 Procedure for performing tests.

.4 Demonstrate that specified equipment and standard software has been properly installed at the staging site and is fully functional.

.5 Verify all data communications required for plant SCADA operation.

3.2 QUALITY CONTROL (Cont'd)

.5 Site Acceptance Test (SAT):(Cont'd)

.6 Demonstrate that specified subsystem equipment and standard software has been properly installed at the staging site and is ready for application software development by the Departmental Representative.

.7 No later than five working days after the completion of SAT, a SAT test report shall be submitted to the Departmental Representative. At minimum the SAT test report shall include:

.1 Description of any deviation from the SAT test plan.

.2 Summarize test results.

.3 Explain any deficiencies and plans for corrective action.

.8 Deliver all testing software, panel keys etc. to the Departmental Representative.

.9 SAT Deficiencies shall be corrected and successfully retested prior to applying for a Certificate of Substantial Performance.

3.3 GENERAL INSTALLATION REQUIREMENTS

.1 Unless otherwise specified, install and calibrate instrumentation and control system hardware in strict accordance with the manufacturer's written instructions and/or recommendations.

.2 Advise the Departmental Representative of any perceived problems regarding implementation of installation details or standard practices for the particular application in sufficient time to avoid delays to the Contract.

.3 If any requirements of this Specification, or a drawing detail, contradicts the equipment manufacturer's written instructions or recommendations in a manner which could be detrimental to its operation, including the possibility of inducing adverse side effects elsewhere to the system, immediately notify the Departmental Representative in writing and refrain from installing until the problem is resolved.

.4 Confirm the correct locations for equipment with the Departmental Representative prior to installation and/or roughing-in.

.5 Supply any materials and/or test facilities necessary for commissioning.

3.3 GENERAL INSTALLATION REQUIREMENTS (Cont'd)

.6 Prior to the shutdown of any operating equipment, provide a written notice 48 hours in advance to the Departmental Representative. Shut down of equipment is limited to a length of time determined by the Departmental Representative. Make all arrangements to minimize down time.

3.4 INSTRUMENT INSTALLATION

.1 Provide, install, wire, test, calibrate and commission instruments and all peripheral devices necessary in accordance with this Specification, drawings for construction and any special details where they apply. Where installation details are not indicated, conform to the manufacturer's written instructions and/or API RP 551 recommendations.

.2 For all instruments, submit completed Calibration forms and Instrument Installation Checklist forms in accordance with Section 01 91 33.

.3 Unless otherwise shown or specified, all required mounting hardware, enclosures, terminations, junction boxes, etc., shall be provided. Refer to the bid drawings and the manufacturer's documentation to confirm the necessary hardware and construction for specific mounting assemblies where such details are not specified herein.

.4 Use field junction boxes suitable for the area classification to "marshal" groups of signals of the same type in an area and cable back to buildings and local control panel with multicore cables.

.5 Junction boxes may be FRP (fibreglass reinforced plastic) or similar material suitable for the area and rust and weather resistant. Terminals inside field junction boxes shall be DIN rail mounted.

.6 Provide the necessary mechanical shields, mounting plates to properly secure and protect transducers. Provide stilling wells wherever turbulence can adversely affect measurement.

.7 Instrument support brackets may not be welded to process piping or equipment, but shall generally be pedestal or wall mounted.

.8 Provide isolation valves for all instruments.

3.4 INSTRUMENT INSTALLATION (Cont'd)

.9 For location, power, mounting and other related details, refer to the manufacturer's installation details and to the instrument and electrical drawings issued for construction.

.10 Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that induces vibration.

.11 Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.

.12 Position instruments so that they do not block or obstruct walkways or access points and provide adequate space around installation for removal of covers, etc.

.13 Locate instruments and their associated sensors, local isolation valves, isolation switches and other related accessories so that they are readily accessible for operation, maintenance or removal. Ensure that instrument displays are properly oriented so as to be easily viewed. Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments. Any instrument that is not easily accessible for operation or maintenance, or any indicator that is not easily and readily visible shall be relocated as directed by the Departmental Representative at no charge to the Contract.

.14 When drilling or installing conduit entry points in instruments, protect internally mounted equipment from vibration, shock and metal filings. Conduit entries shall maintain the equipment or panel NEMA rating.

.15 Install process sample piping and sensing lines to avoid accumulation of vapour or gas (in liquid service) and of liquid or condensate (on vapour or gas service) as appropriate.

.16 Sensing and sample lines shall be run in half inch stainless steel tubing with compression type fittings.

.17 Standard instrument process connections of half inch NPT female shall be provided (Pressure gauges normally half inch NPT male).

3.4 INSTRUMENT INSTALLATION (Cont'd)

.18 Locate all drain plugs below the lowest tube fitting, union or valve. Slope horizontal tubing toward drain plug by minimum 1 cm per meter. Provide drain plugs on all tubed instrument systems.

.19 Field measure lengths for transducer cables, and similar items prior to ordering. Mechanically protect cables and adequately secure in place without sagging.

.20 Protect all instruments with capillaries throughout their length without sagging, by using painted/galvanized angle iron and clips. Avoid sharp bends in capillary and coil any excess close to the sensor end. Protect the coiled capillary by clipping to a steel plate or other safe method.

.21 Electrically heat trace all instrument sensing and sample lines liable to freezing.

.22 Run field cables for analog signals in separate conduit from 120 V AC / 24 V DC control or 120 V AC power supply cables.

.23 All instrument transmitters connected to the PLC shall be powered by UPS.

.24 Once an instrument has been inspected by the Departmental Representative and initially calibrated, it is to remain powered up at all times unless servicing the instrument itself. Immediately install keepers on all panel circuit breakers powering instruments.

.25 Instrument calibration, setpoints and other programmable parameters shall be confirmed with the Departmental Representative during on-site inspection as soon as site conditions are sufficiently ready. Final calibration values may and will be different than nominal values specified in the Product Data Sheets at no extra cost to the Contract.

.26 Provide, install, coordinate, and inspect grounding of surge suppressors at:

.1 Connection of AC power to PCS equipment including panels, consoles assembles, and field mounted analog transmitters and receivers.

.2 At the field and panel, console, or assembly connection of signal circuits that

3.4 INSTRUMENT INSTALLATION (Cont'd)

.26 (Cont'd)
.2 (Cont'd)
have portions of the circuit extending outside of a protective building.

.27 Instrument Nametags: Provide and install component identification for field Instruments.
.1 Materials: 76 mm x 32 mm x 1.6 mm, White Phenolic with black core.
.2 Mounting: Affix to component with 1.0 mm or 1.3 mm stainless steel wire or stainless steel screws.
.3 Inscription: As shown below:
.1 Line 1: Device Tag, 6.5 mm Block Letters.
.2 Line 2: Name of Instrument, 4 mm.
.3 Line 3: Calibrated Range, 4 mm.
.4 Line 4: Power Source, 4 mm.

.28 Equipment Nametags: Provide and install component identification for field Equipment.
.1 Materials: 76 mm x 32 mm x 1.6 mm, White Phenolic with black core.
.2 Mounting: Affix to component with 1.0 mm or 1.3 mm stainless steel wire or stainless steel screws.
.3 Inscription: As shown below:
.1 Line 1: Device Tag, 12.5 mm Block Letters.
.2 Line 2: Name of equipment or device, 6.5 mm.
.3 Line 3: Power Source, 6.5 mm.

3.5 CONTROL PANELS

.1 Provide, install, test and commission the control panels listed as shown on the design documents and drawings.

.2 Coordinate with Vendor Package suppliers to install, test and commission Control Panels as shown on the design documents and drawings.

3.6 INSTALLING CONTROL EQUIPMENT

.1 Install, test, and commission controllers in accordance with requirements of this specification, drawings for construction, and any special details as they apply. Where installation details are not indicated, conform to the manufacturer's written instructions and/or API RP 551 recommendations.

3.6 INSTALLING CONTROL EQUIPMENT (Cont'd)

.2 Install PLC and other related peripherals in NEMA panels as indicated on the drawings. Mount freestanding panels on a 100 mm (4 inches) concrete pad if stand-alone, at the same height as other panels if part of an existing suite or MCC installation, unless otherwise indicated. Provide spacing of 50 mm minimum between rear of panels and external walls, to avoid effects of possible condensation. Freestanding panels shall have stainless steel spacers between panel and wall.

.3 Locate and install controllers and panels so as to be easily accessible for maintenance and readability of displays.

.4 Displays and keyboards are to be protected during the construction and commissioning period, but remain readily accessible on the panel's exterior.

.5 When drilling conduit entry points in panels, protect internally mounted equipment from vibration, shock or metal filings. Panels and conduit installations made to them shall maintain their appropriate NEMA rating. Confirm panel location with Departmental Representative prior to fixing.

.6 Following Site Acceptance, provide to the Departmental Representative a minimum of six identified control panel keys for each panel.

.7 Organize I/O points in racks so that I/O from two or more pieces of equipment with the same process function are divided among at least two groups of I/O cards in a rack. Organize the I/O points so that if one I/O card fails, at least one piece of equipment from the group that has the same process function will be fully operational.

.8 Wire all spare I/O to terminal strips and terminate according to the Manufacturer's written recommendations.

.9 If single ended analog signal modules are used, group signals in such a way that signals of the same power supply are connected to one card. Otherwise, use signal isolators.

.10 Follow the Manufacturer's written recommendations for loading resistors on digital

3.6 INSTALLING CONTROL EQUIPMENT (Cont'd)

.10 (Cont'd) outputs to limit the affect of leakage currents through triac and relay outputs.

.11 Follow the Manufacturer's written recommendations for surge suppression on inductive loads.

.12 Once ICPs are installed and sufficient field wiring is in place to power up the PLCs, immediately install keepers on any lighting panel or MCC circuit breaker feeding the ICP. Unless otherwise authorized by the Departmental Representative, the ICP and PLC are to remain powered up at all times.

.13 Once PLCs are installed at site and sufficient field wiring is in place to begin commissioning software, take the necessary steps to prevent hardware failure or unauthorized tampering with running control programs. Ensure ICPs and PLCs are not inadvertently switched off or crashed by unsanctioned activity.

.14 Take the necessary precautions to ensure computers installed at site are not inadvertently switched off, crashed by unsanctioned activity or tampered with in any way. Do not alter settings or interrupt programs that are operating. Take steps necessary to minimize this risk and prevent disruption to plant operation.

3.7 SYSTEM WIRING REQUIREMENTS

.1 Provide all required system wiring. All wiring shall conform to the latest revision of the O.E.S.C and to the Electrical Area Classification for Hazardous Locations where applicable.

.2 Where specific wiring types are not specified (except AC power wiring) provide wiring types as recommended in writing by the system component manufacturers.

.3 Provide conduit for all system wiring, except for power cords with integral plugs, and except where duct, tray or similar raceway are indicated.

.4 Unless otherwise specified, install analog signal cabling, including transducer cables and network cables in separate dedicated R.S.

3.7 SYSTEM WIRING REQUIREMENTS (Cont'd)

.4 (Cont'd) conduits away from AC power and other EMF sources. Ultrasonic sensor cabling shall be installed strictly in accordance with manufacturer's written instructions.

.5 Seal all conduit terminations to prevent moisture penetration.

.6 Communication and analog signal conductor shields shall be isolated and taped back at one end and terminated at a single ground point at the other as shown on the loop drawings. If the correct grounding information is unclear, confirm exact shield termination and isolation details with the equipment manufacturer and the Departmental Representative.

.7 Install lightning and surge protection on all analog signal cabling entering or exiting buildings. Provide two spare units.

.8 Install signal isolators (24 VDC externally powered if not loop-powered devices) on all analog loops with signal cabling running outside buildings, speed control signals into variable frequency drives, and any situation where potential EMF could damage electronic equipment. Provide two spare isolators.

.9 Unless specifically shown otherwise, wire all digital alarm contacts "normally open", "close to trip".

.10 Use only manufacturer molded cable assemblies between computer and peripherals, such as printers, RS-232, Ethernet, etc. Unless otherwise approved by the Departmental Representative, do not supply custom-made cables. Where custom cables are allowed, connectors shall be complete with proper shells and able to withstand physical bending and twisting.

.11 Provide adequate slack on cable harnesses to permit easy removal of I/O and other printed circuit cards and/or modules and instruments during service or repair.

.12 All feeders shall be run in continuous lengths between power supply point and the load with no splices.

3.7 SYSTEM WIRING REQUIREMENTS (Cont'd)

.13 Unless specifically required, wiring of devices (e.g. switches) in series to a single relay is not permitted.

.14 Wires entering or leaving enclosures, terminate and identify as follows:
- .1 Analog and discrete signal, terminate at numbered terminal blocks.
- .2 Special signals terminated using manufacturer's standard connectors.

.15 Signal Distribution:
- .1 Within Panels: 4 to 20 mA DC signals may be distributed as 1 to 5 V DC.
- .2 Outside Panels: Isolated 4 to 20 mA DC only.
- .3 All signal wiring shall be twisted shielded pairs.

.16 Signal Switching:
- .1 Use dry circuit type relays or switches.
- .2 No interruption of 4 to 20 mA loops during switching.
- .3 Switching Transients in Associated Signal Circuit:
  - .1 4 to 20 mA DC Signals: 0.2 mA, maximum.
  - .2 1 to 5 V DC Signals: 0.05 V, maximum.

.17 Wiring Interface:
- .1 For analog and discrete signal: Terminate at numbered terminal blocks.
- .2 Power (240 volts or greater): Terminate at manufacturer's standard connectors.
- .3 For panel: Terminate at equipment on/with which it is mounted.
- .4 Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

3.8 INSTRUMENTATION AND CONTROLS PRE-COMMISSIONING

.1 Comply with the requirement of Section 01 91 13.

.2 All field testing, calibration procedures, commissioning procedures, calibration schedule, calibration form etc. shall be submitted and be approved by the Departmental Representative.

.3 Supply all materials, equipment and labour necessary for testing, calibration,

3.8 INSTRUMENTATION AND CONTROLS PRE-COMMISSIONING (Cont'd)

.3 (Cont'd) commissioning and repair and be prepared to present proof of recent calibration on testing equipments.

.4 For Control Loop Checkout/Verification, arrange for the Contractor, electrical, instrumentation and control sub-contractors to test loop wiring between PLC and field devices, advise the Departmental Representative to be present for the procedure.

.5 When testing instrumentation loops, perform the testing of each loop in sequence and in groups. The testing of instrument loops will be graded on a pass/fail basis. If more than two instrument loops within a group fail the loop checkout, the entire group of loops will be deemed to have failed the checkout. When the failed loops have been repaired, the entire group shall be retested.

.6 Prepare Instrument Calibration Forms for every field instrument and Loop Check Sheets for every control loop.

.7 Prior to installation of application programs for automatic control by others, all installations shall be proved correct and fully operational as outlined below.

.8 After the instrumentation and control system has been initially visually inspected for proper installation, including any specified vendor inspection, but prior to any introduction of process fluids/materials to the facility (if retrofit on existing process, submit proposed testing method), energize the system loop by loop and:

.1 Check and test the operation of each and every system component, and adjust or repair as necessary.

.2 Confirm all instrument calibration parameters, i.e. 4-20 mA span and displayed ranges, with the Departmental Representative.

.3 Check the calibration of each instrument, and where necessary, re-calibrate in accordance with the manufacturer's written instructions.

.4 Ensure that calibration and commissioning work is carried out by qualified technicians, and have the work performed by

3.8 INSTRUMENTATION AND CONTROLS PRE-COMMISSIONING (Cont'd)

.8 (Cont'd)

.4 (Cont'd) the manufacturer's service representatives if so specified.

.5 Prepare typewritten record on each Instrument Calibration Form of the calibration, repair or replacement work performed and submit to the Departmental Representative. Enter the calibration information and any other relevant details about each instrument on the Product Data Sheets.

.6 Loop check all field signal wiring for continuity and correct contact polarity. Ringing wires from terminal strips is insufficient. Check each loop by interrogating the controller I/O via on-line utilities and exercising field equipment to confirm correct field operation. Field actions include power-up instruments, set-up calibration, energize MCC starters (disabling power feeds as appropriate) testing Hand-Off-Auto switches, tripping field pressure, float and level switches etc.

.7 Do not perform insulation tests or "megger" tests on any instrument wiring connected to field or panel equipment.

.8 When the inspection, testing, and calibration is complete, submit Instrument Calibration Forms, Loop Check Sheets and Product Data Sheets and advise the Departmental Representative in writing that all equipment has been checked and is ready for introduction of process fluids or material.

.9 Once process fluid or material have been introduced to the facility, or part of process:

.1 Repeat the above checks to confirm that the equipment operates correctly when actuated by actual process fluid or material: e.g. that high level alarm float switches are actuated at the correct height by a rising fluid, and low level switches operate correctly on a falling fluid level.

.2 Forward to the Departmental Representative a report certifying that the instrumentation and control system is complete, operational, and ready for site acceptance, and ready to load control program.

3.8 INSTRUMENTATION AND CONTROLS PRE-COMMISSIONING (Cont'd)

.10 Each and every Instrument calibration, Final Loop Check and equipment operation checks will be witnessed by the Departmental Representative. Upon satisfactory demonstration of instrument and/or loop operation, the Departmental Representative will sign off the Product Data Sheets, Calibration Forms and Control Loop Check Sheets. The instrumentation and control system will then be considered ready for testing control software, and finally Site Acceptance Testing.

.11 Instruments, loops and equipment which are found to be inoperable or improperly calibrated, will immediately be rejected. The associated equipment shall be rectified, re-calibrated and sheets revised and resubmitted as soon as the problem is resolved.

.12 If three or more such instances occur, the Contractor will be requested to repeat all pre-commissioning checks.

.13 When all equipment, instruments and systems have been demonstrated and Product Data Sheets, Instrument Calibration Forms and Loop Check Sheets have all been signed off, forward a complete set of the signed sheets to the Departmental Representative.

3.9 COMMISSIONING

.1 Provide the services of qualified manufacturers' service representatives for installation, setup, calibration, testing, and commissioning of instruments.

.2 Provide configuration and programming for all microprocessor based equipments including single loop or multi-loop controller, analyzer, gas detection systems and other intelligent instruments.

.3 Before requesting witnessed loop checks, carry out Contractor's own field and loop check tests to verify that the equipment operates as intended. Correct any problems or deficiencies prior to requesting witnessed checks. Provide letter to Departmental Representative stating that Contractor's own field and loop check tests are complete, prior to requesting witnessed checks.

3.9 COMMISSIONING (Cont'd)

.4 Demonstrate instrument calibration and loop checks. Each loop check shall be witnessed by, and successfully demonstrated to the Departmental Representative for sign-off approval.

.5 Provide Site Acceptance Testing (SAT) to demonstrate the correct operational functionality of the PCS.

.6 As certain areas of the process are brought on-line, ensure all related equipment and services remain powered up and in working order. Ensure other ongoing activities, in close proximity or otherwise, do not disturb or interrupt the operation of the existing systems or the work already commissioned or placed into operation. Should any such activity pose a risk to this work or to the system operation, advise the Departmental Representative immediately.

3.10 MANUFACTURER SERVICES AND CERTIFICATION OF INSTALLATION

.1 Allow in the bid for all the necessary services and expenses of a trained, qualified manufacturer's representative for each device as specified in the specification sheet, to ensure correctness of installation, testing, start-up, commissioning and training. The qualified representative is to:

.1 Provide on-site supervision of installation for the initial and critical stages of the work as agreed to with the manufacturer/supplier and as required by the Departmental Representative.

.2 Supervise testing of equipment. Supervise retesting of equipment at no additional cost to the Contract.

.3 Provide written certification stating that the work has been completed satisfactorily.

.4 Provide a complete Installation, Start-up Checklist and sign off on the start-up work completed.

.5 Provide operation and maintenance instruction to the plant operation personnel.

.2 Provide supervision of installation as required by the manufacturers for all equipment in this section. The Departmental Representative may order additional supervision at no additional cost to the Contract if, in their opinion, installation procedures are compromised.

3.10 MANUFACTURER SERVICES AND CERTIFICATION OF INSTALLATION (Cont'd)

.3 Provide all materials, labour and equipment to make any adjustments to the installation as required by the manufacturer or the Departmental Representative to effect performance.

.4 On completion of installation and testing, obtain certification from the manufacturers that the equipment is installed correctly, is in full operating condition, and is operating in accordance with its design rating. Submit the original certificate to the Departmental Representative.

.5 Include the service of the trained personnel to inspect and commission the equipment when ready for starting and to instruct the operation personnel in the operation and maintenance of the equipment. Time spent on site by the trained personnel shall be witnessed by the Departmental Representative.

.6 Include above services for all equipment specified in relation to this Section and as a minimum provide commissioning and training as follows:

.1 Major process equipment - See the list below. Split the specified time into three stages: inspection during installation, start up and commissioning, plant operation personnel training.

.2 Two (Eight hours) days for all other process instrument, where not specially mentioned, of which four hours minimum are dedicated to training.

.7 As a minimum requirement, allow for in the Bid Price the following days for the service of a manufacturer's representative. Not all days will necessarily be concurrent. If additional days are required to complete the work, include these additional days and trips in the Bid Price.

Nitrate Analyzers	Three Days
Ammonium Analyzers	Three Days
Ultrasonic Level Transmitters	Two Days
Magnetic Flow Meters	Two Days
Turbidity Analyzers	Two Days
Dissolved Oxygen Analyzers	Two Days
pH Analyzers	Two Days
Gas Monitors	Two Days
Level Switches	One Day
Capacitive Moisture Sensors	One Day
Capacitive Level Switches	One Day
Uninterruptible Power Supplies	One Day

3.11 TRAINING

.1 In accordance with Section 01 91 41.

.2 Supply a site training program for the plant operation personnel consisting of:
- .1 Maintenance Training (40 hours) in two groups of 20 hours each by Instrument Supplier and/or appropriate equipment manufacturer's representatives.
- .2 Operations training (40 hours) in two groups of 20 hours each by Instrument Supplier.

.3 Dates and personnel receiving training will be coordinated by the Departmental Representative.

.4 The training program is to include operation, care, control and routine maintenance of the equipment, as well as troubleshooting of the system and its components.

.5 A training manual shall be provided for each trainee.

.6 The training program shall be conducted by qualified instrument technicians and competent manufacturer's personnel experienced both with the product and with instruction, using system operation and maintenance manual data as the basis for demonstrations and instructions.

.7 Training shall take place at the site or at the equipment itself. Operation and maintenance manuals shall be submitted to the Departmental Representative a minimum of thirty (30) days prior to the training occurring for use in the training course.

.8 The site training program shall be complete prior to application for a Certificate of Substantial Performance of the Work.

.9 Pay all cost associated with the training program, with the sole exception of salaries associated with the plant operation personnel being trained.

.10 Submit a course outline to the Departmental Representative for approval thirty days prior to the start of the course. The Departmental Representative reserves the right to modify the course content.

END

PART 1 - GENERAL

1.1 SCOPE OF WORK

.1 Supply, installation, testing, and Performance Verification of skid-mounted, pre piped, pre wired and pressure tested chemical feeding equipment shown and specified, complete with metering pumps, control panels, piping, valves, calibration columns, frames and accessories to feed chemicals, complete and operable, in accordance with the requirements of the Specifications.

1.2 REFERENCES

.1 The following is a list of standards which may be referenced in this Section:
- .1 ABMA
- .2 NEMA: MG 1, Motors and Generators.

1.3 DEFINITIONS

.1 Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.4 CONTRACTOR SUBMITTALS

.1 Shop Drawings:
- .1 Make, model, weight, horsepower, and cross sectional details and colour brochures of each equipment assembly.
- .2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.
- .3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
- .4 Detailed Drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
- .5 Power and control wiring diagrams.
- .6 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.

1.4 CONTRACTOR SUBMITTALS (Cont'd)

.1 Shop Drawings:(Cont'd)
- .7 Factory finish system.
- .8 Size, length and spacing of anchor bolts or attachment to the foundations or supports.
- .9 External utility requirements air, water, power, etc for each component.
- .10 Control Panel external face layout and inter layout drawings and electrical wiring diagrams.

.2 Quality Control Submittals:
- .1 Factory Functional and Performance Test Reports.
- .2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.
- .3 Special shipping, storage and protection, and handling instructions.
- .4 Manufacturer's printed installation instructions.
- .5 Suggested spare parts list to maintain the equipment in service for a period of five (5) years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- .6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- .7 O&M manual.

1.5 SHIPMENT, PROTECTION AND STORAGE

.1 Ship pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all other special storage requirements.

1.6 RESPONSIBILITY OF THE PUMP MANUFACTURER

.1 The pump Manufacturer is responsible for the selection, co-ordination and performance of the metering pumps, motors, and control stations which will be capable of meeting the head, pressure, accuracy and flow requirements specified herein. The pump Manufacturer is

1.6 RESPONSIBILITY OF THE PUMP MANUFACTURER (Cont'd)

.1 (Cont'd) responsible for the selection, co-ordination and performance of the appurtenances.

.2 All major components (pumps and accessories) shall be supplied as a Vendor Package unless specified otherwise.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The supply of peristaltic pumps under this Section shall come from a single Manufacturer.

2.2 PUMPING REQUIREMENTS

.1 Take into account the specific gravity, viscosity, corrosivity and temperature of the fluid being pumped.

.2 Minimum turn-down ratio: 1:100.

.3 Supply a minimum pumping accuracy of +2% of the full range for each pump package.

2.3 PUMP SKIDS

.1 General:

.1 The pumps shall come with factory fabricated pump skids as shown in the P&IDs and described herein. Pump skids to be pre-tested in factory complete with certification. The pumping skids includes metering pumps, controls, calibration column, pressure relief valves, ball valves, pressure gauges, and all associated piping and fittings, in accordance with the Drawings.

.2 Construct the pump parts in contact with the commodity being pumped from materials suitable for the application.

.3 Peristaltic pumping action shall be created by the compression of the flexible tube between the pump head rollers and track, inducing forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components. Pumps shall be dry

2.3 PUMP SKIDS (Cont'd)

.1 General:(Cont'd)

.3 (Cont'd)
self priming, capable of being run dry without damaging effect to pump or tube.

.4 Pump head shall 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 roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Supply and Install two spring-loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pump head.

.5 Supply and Install 316L SST clamps for each tube connection.

.6 All components of the chemical feed pump skids including pump, speed controller, motor, and related appurtenances unit shall be pre-plumbed and pre-wired.

.2 Accessories:

.1 Each pump shall be Supplied with pre-piped calibration column and pressure relief valve. The calibration column shall be constructed of material which is compatible with the chemical and shall be complete with a vented top cap and shall be graduated in millilitres.

.3 Drives shall be self-supporting and shall not require anchoring. Drive shall be brushless DC motor with integral gearbox and tachometer feedback. Circuitry shall be complete with temperature and load compensation and protection. Drives and operator interface will be integral with pumphead with a pressure cast aluminum housing with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. Drives shall have a nine-foot length mains power cord with standard 115v 3-prong plug and screw down terminals suitable for up to 18AWG field wire and accessible through four glanded cable entry points on the pump.

.4 Supply drives suitable for 120v/1/60hz power supply.

2.3 PUMP SKIDS (Cont'd)

.5 Supply and Install a floor-mounted support frame for the skid assembly. Fabricate support frame of chemically resistant FRP or chemically resistant epoxy coated carbon steel. Provide sufficient strength to allow the support frame to carry the full weight of all of the skid components when full of chemical.

.6 Supply chemical resistant tubing.

2.4 PIPING AND VALVES

.1 Supply and Install valves and appurtenances of material suitable for the specified chemicals.

2.5 PUMP SKID OPERATION

.1 The pump Manufacturer shall Supply and Install all wiring and conduit within a skid package.

2.6 SPARE PARTS AND MAINTENANCE MATERIALS

.1 Supply the following spare parts for each pump skid:

.1 One spare pump head assembly and rotor per pump.

.2 Supply two 15 m continuous rolls of specified tubing size per pump.

.3 Two spare sets of tubing quick disconnects per pump.

.2 Supply a list of spare parts which would be expected to be required over a period of five years under normal conditions.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

.1 Manufacturer's Representative shall be required to attend the site to instruct the Contractor, witness the installation and supervise testing, to ensure the equipment is installed and operated as intended.

3.2 INSTALLATION TRAINING

.1 Instruct the Contractor in the methods and precautions to be followed in the installation of the pump.

3.2 INSTALLATION TRAINING (Cont'd)

.2 Attest to the Contractor's understanding by required Form 101 appended to these contract documents.

3.3 INSTALLATION

.1 Manufacturer's Representative shall ensure that the pump is installed as required to provide satisfactory service.

.2 Manufacturer's Representative shall cooperate with the Contractor as documented by Form 102.

3.4 TESTING

.1 Ensure that the pump, including all component parts, operates as intended.

.2 Cooperate with Contractor to fulfill the requirements for satisfactory performance of the equipment as documented by Form 103.

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the Owner's personnel in the proper operation and maintenance of the equipment as documented by Form T1.

3.5 COMMISSIONING

.1 Attend during commissioning of the process system which includes the pump specified in this section to ensure that the pump functions as intended in the process system.

3.6 FACTORY ACCEPTANCE TESTING

.1 Prior to shipping, conduct factory performance testing.

.2 Testing will include the complete pump assembly, including pump, variable speed drive

END

PART 1 - GENERAL

1.1 GENERAL

.1 This section contains the requirements for the supply, installation, testing and commissioning of submersible pumps and motor.

.2 This Section should be read in conjunction with the provided process and instrumentation drawings and general layout drawings.

.3 Refer to Section 43 20 70.

.4 The WWTP will comprose of a variety of submersible liquid pump applications (e.g. process sump pumps, building drainage sump pumps). It is the Contractor's responsibility to assess and evaluate the provided bid information (e.g. Process and Instrumentation Drawings, Design Rationale and Process Control Description, Pilot Trial Report) and size and select the appropriate submersible liquid pump equipment for respective applications.

1.2 REFERENCES

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

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

.2 A48, Standard Specification for Gray Iron Castings.

.3 A576, Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality.

.4 Hydraulic Institute Standards (HIS).

.5 National Electric Code (NEC).

.6 National Electrical Manufacturers Association (NEMA).

.7 National Fire Protection Association (NFPA): 70, National Electric Code.

.8 Underwriters Laboratories (UL).

1.3 SUBMITTALS

.1 Submit the following shop drawings in accordance with Section 01 33 00:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

1.3 SUBMITTALS (Cont'd)

.1 (Cont'd)

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.

.4 Detailed mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.5 Power and control wiring diagrams, including terminals and numbers.

.6 Control Panel external face layout and inter layout drawings and electrical wiring diagrams.

.7 Complete motor nameplate data, as required by NEMA, from motor Manufacturer.

.8 Factory finish system.

.9 Bearing life calculations.

.10 Certified shop test results for motor vibration measurements.

.2 Quality Control Submittals:

.1 Factory and field performance test reports and logs.

.2 Manufacturer's certification of compliance that factory finish system meets requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions, including pump specific vibration and alignment tolerances.

.5 Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Provide an operation and maintenance manual and maintenance summary in conformance with the requirements of Section 01 33 00 and Section 01 45 00.

.8 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.9 External utility requirements: air, water, power, etc. for each component

1.4 COORDINATION

.1 Coordinate with other Divisions to ensure that there is no conflict with the work.

1.5 SHIPMENT, PROTECTION, AND STORAGE

.1 Ship all equipment skid-mounted and pre-assembled, to the degree which is practicable.

PART 2 - PRODUCTS

2.1 DESIGN

.1 The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid.

.2 The supply of process submersible pumps under this Section shall come from a single Manufacturer.

.1 Supply and install required pumps to meet design flow requirements.

2.2 COMPONENTS

.1 Pump equipment shall consist of pump(s) complete with motor(s), control system where applicable, guide rail and anchoring brackets, base elbow, power cable(s), and pump lifting cable(s).

.1 Pump metal parts that come into contact with guide rail or cable system shall be made of nonsparking materials.

.2 Control panel, level switches and level transmitters, where indicated.

.2 Sliding guide bracket shall be integral part of pump unit. Pump unit shall be guided by no less than 2 guide bars, or equivalent cable system, and pressed tightly against discharge connection elbow with metal to metal contact or through use of profile type gasket, provided that gasket is attached to pump's flange and can be easily accessed for inspection when pump is lifted out of wetwell.

.3 Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti leak seal and shall be easily accessible from outside. Provide leak detection output signal to control panel.

2.2 COMPONENTS (Cont'd)

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

.5 Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cable shall be of sufficient length to reach junction boxes without strain or splicing.

.6 Cable Entry System:
- .1 Junction chamber and motor shall be separated by stator lead sealing gland or terminal board that shall prevent foreign material entering through pump top.
- .2 Utilize cable with factory installed sealing gland with nonshrink epoxy seal system.
- .3 O ring compression seal between sealing gland and cable entry point shall also be acceptable.

.7 Provide for dry run protection.

2.3 ACCESSORIES

.1 Equipment Identification Plate: 16 gauge stainless steel with 6 mm die stamped equipment tag number securely mounted in readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kg.

.3 Anchor Bolts: Type 316L stainless steel, sized by equipment Manufacturer.

2.4 FINISHES

.1 Finish the pump bowl, column and discharge head in accordance with Division 09 Finishes.

2.5 CONTROL PANEL

.1 Local control panels are to be included in the Vendor Packages, as indicated on Drawings.

.2 Provide NEMA 4 316 stainless steel enclosure for indoor duty, for each pump system as noted on contract drawings. Panels shall be in conformance with the requirements of Section 40 90 00.

.3 Free standing, post mounted.

2.5 CONTROL PANEL (Cont'd)

.4 Control panel shall include the following as further described in contract drawings:
- .1 Main circuit breaker disconnect interlocked with panel door.
- .2 Combination circuit breaker type, NEMA rated motor starters.
- .3 Fused control power transformer, 120V ac.
- .4 COMPUTER/OFF/HAND switches.
- .5 Running lights.
- .6 Contact closure inputs for:
  - .1 Low level interlock
  - .2 Remote start
- .7 Normally closed, dry, 5 amps at 120V ac contacts for remote indication of:
  - .1 Running.
  - .2 Pump failure (temperature or moisture alarm).
  - .3 Computer.
- .8 Terminal strip for interfacing with external wiring.
- .9 High temperature indication.
- .10 Moisture alarm indication.
- .11 Document pocket located inside panel with pump and panel operation and maintenance manual and separate laminated pump curve.
- .12 Run hour meter.
- .13 CSA labeled panel.
- .14 Prewired and factory tested.
- .15 Mount control switches, indicating lights, and switches on hinged front panel.
- .16 Single Feed: 600 volt, three phase.

2.6 SPARE PARTS

.1 Furnish for each size of pumps:
- .1 One set mechanical seals.
- .2 One complete set of special tools required to dismantle pump.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

.1 Manufacturer's Representative shall be required to attend the site to instruct the Contractor, witness the installation and supervise testing, to ensure the equipment is installed and operated as intended.

3.2 INSTALLATION TRAINING

.1 Instruct the Contractor in the methods and precautions to be followed in the installation of the pump.

.2 Attest to the Contractor's understanding by required Form 101 appended to these contract documents.

3.3 INSTALLATION

.1 Manufacturer's Representative shall ensure that the pump is installed as required to provide satisfactory service.

.2 Manufacturer's Representative shall cooperate with the Contractor as documented by Form 102.

3.4 TESTING

.1 Ensure that the pump, including all component parts, operates as intended.

.2 Cooperate with the Contractor to fulfil the requirements for satisfactory performance of the equipment as documented by Form 103.

3.5 COMMISSIONING

.1 Attend during commissioning of the process system which includes the pump specified in this section to ensure that the pump functions as intended in the process system.

3.6 FACTORY ACCEPTANCE TESTING

.1 Prior to shipping, conduct a factory performance testing.

.2 Testing will include the complete pump assembly, including pump, variable speed drive and motor.

END

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 This Section specifies the supply and installation of Hydrochloric Acid feed pump panels complete with metering pumps and all appurtenances required for chemical feed system.

.2 Hydrochloric acid solution is required in the following points of application:
- .1 To the RO system pH adjustment tank.
- .2 To the evaporation pH adjustment tank.

.3 It is the Contractor's responsibility to assess and evaluate the provided bid information (e.g. Process and Instrumentation Drawings, Design Rationale and Process Control Description, Pilot Trial Report) and size and design the appropriate dosing system including any ancillary equipment. The Contractor must provide design justification (i.e. process calculation) for design basis.

1.2 SUBMITTALS

.1 Shop Drawings: Submit in accordance with Section 01 33 00.

.2 Manufacturer's data and information.

.3 Chemical resistance charts to indicate compatibility of equipment when exposed to the chemical used.

.4 Shop drawings including dimensions and sectional view of equipment showing details of construction, arrangement and installation.

.5 Operation and Maintenance Data: Provide for incorporation in the Operation and Maintenance Manual as specified in Section 01 33 00. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

1.3 COORDINATION

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

1.4 SHIPMENT, PROTECTION, AND STORAGE

.1 Ship pre-assembled to the degree possible.

.2 Identify special storage requirements. Store on-site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

PART 2 - PRODUCTS

2.1 DESCRIPTION

.1 All equipment to be for use in:
  .1 Pumping and piping to deliver Hydrochloric Acid with dedicated dosing pumps.

.2 The Contractor is to provide chemical spill containment pallet for the chemical totes as required for 110% the capacity of the chemical tote.

.3 Supply a dedicated feed pump panel complete with valves, storage tanks, pressure indication, back pressure valves, strainers, flow switch, pulsation dampener, calibration chamber, flexible hose connections and metering pumps to dedicated locations as described in this Section.
  .1 pH adjustment prior to evaporation.
  .2 ph adjustment prior to the RO system.

.4 Pumps shall be supplied complete with electric motor, variable frequency drive (VFD) and baseplate.

.5 Hydrochloric acid tank to be provided with unloading scrubber system to suppress fumes.

.6 Vent line and overflow line of the storage tank shall be connected to a gas absorption system (i.e., scrubber) installed in the containment area. The scrubber should be designed to absorb gases and fumes generated during unloading. The acid washing liquid has to be drained and to be neutralized.

2.2 CAPACITIES AND PERFORMANCE

.1 Select and design equipment specifically for continuous exposure to the chemical application.

.2 The fluid temperature is expected to range from 5°C to 30°C.

.3 Size the system to meet the following requirements:
- .1 Hydrochloric Acid.
- .2 Recommended storage capacity based on 14 days and based on average flow conditions.

2.3 MATERIALS

.1 Chemical metering pump panel component materials shall be chemically resistant to the chemical application.

.2 Chemical Metering Pumps:
- .1 Fabricate materials suitable for continuous exposure to the compound being pumped.
- .2 Casing:
  - .1 Supply all wetted parts, including quick opening ball check valves, which are resistant to corrosion by materials being pumped.
  - .2 Supply pump with internal hydraulic relief valves to protect pump against over pressure.
  - .3 Supply each pump with an interlocking flow switch.
- .3 Motor and Drive Unit:
  - .1 Supply pumps with DC motors, DC variable speed drive controllers, and controllers.
- .4 Controls:
  - .1 Supply the following on the face of the pump:
    - .1 On - Off switch.
    - .2 Speed controller dial.
    - .3 Remote-Local switch.
- .5 Ancillaries:
  - .1 Foot Valve: where required to maintain prime, supply foot valve, make valve suitable for immersion in chemicals being pumped.
  - .2 Back pressure Valve: where discharge pressure is less than 15 m, supply back pressure valve adjustable between 10 m and 70 m.
- .6 Spare Parts:

2.3 MATERIALS (Cont'd)

.2 Chemical Metering Pumps:(Cont'd)

.6 Spare Parts:(Cont'd)

.1 For each pump, supply the following spare parts:

.1 1 - set of each size and type of bearings.

.2 1 - set of each size and type of seals.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Ensure the equipment is installed as required to provide satisfactory service.

3.2 TESTING

.1 Ensure the equipment, including all component parts, operates as intended.

END

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 This Section specifies the supply and installation of Urea feed pump panels complete with metering pumps and all appurtenances required for chemical feed system.

.2 Urea solution is required in the following point of application:
.1 Splitter Box.

.3 It is the Contractor's responsibility to assess and evaluate the provided bid information (e.g. Process and Instrumentation Drawings, Design Rationale and Process Control Description, Pilot Trial Report) and size and design the appropriate dosing system including any ancillary equipment. The Contractor must provide design justification (i.e. process calculation) for design basis.

1.2 SUBMITTALS

.1 Shop Drawings: Submit in accordance with Section 01 33 00.

.2 Manufacturer's data and information.

.3 Chemical resistance charts to indicate compatibility of equipment when exposed to the chemical used.

.4 Shop drawings including dimensions and sectional view of equipment showing details of construction, arrangement and installation.

.5 Operation and Maintenance Data: Provide for incorporation in the Operation and Maintenance Manual as specified in Section 01 33 00. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

1.3 COORDINATION

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

1.4 SHIPMENT, PROTECTION, AND STORAGE

.1 Ship pre-assembled to the degree possible.

.2 Identify special storage requirements. Store on-site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

PART 2 - PRODUCTS

2.1 DESCRIPTION

.1 All equipment to be for use in:
  .1 Pumping and piping to deliver Urea solution with dedicated dosing pumps.

.2 The Contractor is to provide chemical spill containment pallet for the chemical totes as required for 110% the capacity of the chemical tote.

.3 Supply a dedicated feed pump panel complete with valves, storage tanks or totes, pressure indication, back pressure valves, strainers, flow switch, pulsation dampener, calibration chamber, flexible hose connections and three metering pumps to dedicated locations as described in this Section.

.4 Pumps shall be supplied complete with electric motor, variable frequency drive (VFD) and baseplate.

2.2 CAPACITIES AND PERFORMANCE

.1 Select and design equipment specifically for continuous exposure to the chemical application.

.2 The fluid temperature is expected to range from 5°C to 30°C.

.3 Size the system to meet the following requirements:
  .1 Recommended storage capacity based on 14 days and based on average flow conditions

.4 Guideline for dosing flow: 2 L/h for a 50% Urea solution.

2.3 MATERIALS

.1 Chemical metering pump panel component materials shall be chemically resistant to the chemical application.

.2 Chemical Metering Pumps:

.1 Fabricate materials suitable for continuous exposure to the compound being pumped

.2 Fabricate shaft of stainless steel, Type 316.

.3 Casing:

.1 Supply all wetted parts, including quick opening ball check valves, which are resistant to corrosion by materials being pumped.

.2 Supply pump with internal hydraulic relief valves to protect pump against over pressure.

.3 Supply each pump with an interlocking flow switch.

.4 Motor and Drive Unit:

.1 Supply pumps with DC motors, DC variable speed drive controllers, and controllers.

.5 Controls:

.1 Supply the following on the face of the pump:

.1 On - Off switch.

.2 Speed controller dial.

.3 Remote-Local switch.

.6 Ancillaries:

.1 Foot Valve: where required to maintain prime, supply foot valve, make valve suitable for immersion in chemicals being pumped.

.2 Back pressure Valve: where discharge pressure is less than 15 m, supply back pressure valve adjustable between 10 m and 70 m.

.7 Spare Parts:

.1 For each pump, supply the following spare parts:

.1 1 - set of each size and type of bearings.

.2 1 - set of each size and type of seals.

PART 3 - EXECUTION

3.1 INSTALLATION .1 Ensure the equipment is installed as required to provide satisfactory service.

3.2 TESTING .1 Ensure the equipment, including all component parts, operates as intended.

END

PART 1 - GENERAL

1.1 GENERAL

.1 Polymer solution is required in four points of application:
- .1 To the centrifuge biosolids dewatering unit.
- .2 To the plate frame filter press dewatering unit
- .3 As a flocculation aid to the coagulation compartment of the clarifier unit for brine treatment.

.2 It is the Contractor's responsibility to assess and evaluate the provided bid information (e.g. Process and Instrumentation Drawings, Design Rationale and Process Control Description, Pilot Trial Report) and size and design the appropriate storage and solution preparation system including any ancillary equipment. The Contractor must provide design justification (i.e. process calculation) for design basis.

1.2 WORK INCLUDED

.1 Supply and installation, testing, and commissioning of a skid-mounted, pre-piped, pre-wired and pressure-tested, complete and functional polymer feed system, in accordance with the P&ID Drawings and Design rationale.

.2 Polymer solution is required in three points of application:
- .1 To the centrifuge biosolids dewatering unit.
- .2 To the plate frame filter press dewatering unit
- .3 As a flocculation aid to the coagulation compartment of the clarifier unit for brine treatment.

.3 It is the Contractor's responsibility to assess and evaluate the provided bid information (e.g. Process and instrumentation drawings, design rationale, pilot trial report and process control narrative) and size and design the appropriate polymer storage and solution preparation system including any ancillary equipment. The Contractor must provide design justification (i.e. process calculation) for design basis.

1.3 REFERENCES

.1 The unit shall be in compliance with the appropriate sections of the following codes:

.1 NSF International, Standard 61 - Drinking Water System Components.
.2 American Gear Manufacturers Association (AGMA).
.3 American Institute of Steel Construction (AISC).
.4 American Iron and Steel Institute (AISI).
.5 American Society of Mechanical Engineers (ASME).
.6 American National Standards Institute (ANSI).
.7 American Society for Testing and Materials (ASTM).
.8 Canadian Electrical Code (CEC).
.9 Canadian Standards Association (CSA).
.10 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.11 Electrical Safety Authority (ESA).
.12 Institute of Electrical and Electronics Engineers (IEEE).
.13 Instrumentation, Systems and Automation Society (ISA).
.14 National Electrical Code (NEC).
.15 National Fire Protection Association (NFPA).
.16 National Electrical Manufacturers Association (NEMA).
.17 Steel Structures Painting Council (SSPC).
.18 Manitoba Building Code.
.19 Canadian Plumbing Code (CPC).
.20 Occupational Safety & Health Act (OSHA).

1.4 CONTRACTOR SUBMITTALS

.1 Shop Drawings:

.1 Make, model, and weight of each equipment assembly.
.2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.
.3 Detailed mechanical Drawings showing the equipment location and dimensions, size and locations of connections, weights of associated equipment, and construction details.
.4 Performance Specifications of all items of equipment.
.5 Process schematics associated with all items of equipment.
.6 Instrument layout of the control panel.

1.4 CONTRACTOR SUBMITTALS (Cont'd)

.2 Submittal of Interface Material: The following materials, defining the interface between the system specified herein and the remainder of the plant, plus any additional information called for in these Specifications, shall be submitted to the Departmental Representative within 90 days following execution of Contract, and prior to any construction or fabrication that requires interfacing with the system.

.1 Identification, description, and envelope dimensions for each separately installed subassembly or piece of equipment and the associated connection dimensions to permit incorporation of the system selected into the design of the plant.

.2 Information on field and installation requirements, including mounting requirements, access, and approximate total weight of each piece of equipment.

.3 A detailed description of the instrumentation and control system, including a list of all functions monitored, controlled and/or alarmed. Describe all automatic shutdown features and interfaces with the plant instrumentation and control systems. The description of the instrumentation and control system shall be in both word and schematic form. Schematics shall be in accordance with the latest edition of NEMA ICS.

.4 Clearly identify the tag name, model numbers and catalogue numbers for each piece of equipment, component, device, etc., within the Product's technical literature.

.5 Electric motor control schematics. Include locations of control stations, and any special control to be provided by others. Coordinate polymer controls with Plant control System.

.6 A complete description of all interfaces between the system components and between the system and other plant components. Provide a summary by interface link for the following:

.1 Number, size, and type of all process and auxiliary connections.

.2 Number, size, and type of electronic or electrical signal wires.

.3 Number, size, and type of electrical power wires.

1.4 CONTRACTOR SUBMITTALS (Cont'd)

.2 Submittal of Interface Material:(Cont'd)
- .7 Control panel envelope dimensions, mounting requirements, and access requirements (doors, louvers, etc.).
- .8 Fully commented ladder logic listings, I/O printouts, and cross-reference printouts documenting Programmable Controller software program.

.3 Informational Submittals:
- .1 Field Performance Test Report.
- .2 Special shipping, storage and protection, and handling instructions.
- .3 Manufacturer's printed installation instructions.
- .4 Manufacturer's Certificate of Proper Installation.
- .5 Suggested spare parts list to maintain the equipment in service for a period of one (1) year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- .6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- .7 Operation and Maintenance (O&M) Manuals.

1.5 PREPARATION FOR SHIPMENT

.1 Insofar as is practical, equipment specified herein shall be factory assembled and tested. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

1.6 REQUIRED SPARE PARTS AND SPECIAL TOOLS

.1 Spare parts shall be shipped in a wooden box and shall be protected from damage, from moisture and dirt accumulation. Parts shall be protected as for an extended storage period. The box shall be heavily constructed with hinged cover, hasp, and lock, and designed as a permanent storage enclosure for the spare parts. The spare parts shall, if possible, be enclosed within an airtight membrane. Spare parts supplied in matched sets, such as drive belts,

1.6 REQUIRED SPARE PARTS AND SPECIAL TOOLS (Cont'd)

.1 (Cont'd)
shall be wrapped, bound, or labeled to indicate a set.

.2 Furnish one (1) year supply of lubricants including oil and greases, as recommended by the Product Manufacturer. The lubricants shall include summer and winter grades along with alternative references to equal Products of other Manufacturers including Specifications such as AGMA numbers, viscosity.

.3 Furnish for each piece of equipment
- .1 One (1) complete set of packing.
- .2 One (1) complete set of bearings.
- .3 One (1) complete set of gaskets and O-ring seals.
- .4 One (1) complete of set of rod washers.
- .5 One (1) complete set of keys, dowels, pins, etc.
- .6 One (1) stator for each type of pump, if required
- .7 One (1) rotor for each type of pump, if required
- .8 One (1) connecting rod with pair of universal joint(s), if required
- .9 One (1) complete set of any special tools.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Components
- .1 The Mixing/Aging/Storage Tanks shall be of welded polypropylene for corrosion resistance. The interior shall be divided into three compartments of equal volume, separated such that the flow from each upstream compartment flows under a baffle, then up over a weir, to ensure that the fresh polymer cannot short-circuit into aged polymer. Each compartment shall feature a steel mixer. The compartments shall have an external manifold with manual shutoff valves to allow complete utilization of the polymer.
- .2 The Dry polymer feeder shall have adequate storage volume, with dry powder level sensor to alarm upon low powder level. The auger shall be driven by a variable speed motor for calibration, and shall feature a heated powder dryer at the discharge and

2.1 MATERIALS (Cont'd)

.1 (Cont'd)

.2 (Cont'd)
solenoid-type positive closure device to prevent after-run during shutdown.

.3 The Wetting System shall consist of an incoming water line with pressure regulating valve, pressure gauge, flow meter with audible alarm on loss of flow, solenoid valve and manual venture and one to a funnel with water vortex discharging to a vacuum created by the venturi, which discharges to the primary mix compartment, such that newly added powder polymer is always contacting fresh water, eliminating clots of unmixed polymer. Motor driven in-line mixing devices or compressed air type wetting devices shall not be allowed due to shear and operational cost, respectively. A high level overflow weir on the funnel shall discharge to the primary mix compartments, and a high level sensor shall provide an audible alarm upon overflow.

.4 The control panel shall be NEMA 4X, with audible fault alarm and reset button and programmable logic controller. The controller shall allow proportional dosing of the powder to the water flow rate, and shall allow programming of the polymer concentration during operation. Programmable parameters shall include dry feeder speed, dry feeder temperature control, and mixer on/off times.

.2 System Function and Operation:

.1 Calibration to a specific polymer concentration shall be accomplished by programming the desired concentration, which varies the feeder discharge rate in proportion to water flow rate.

.2 Operation shall be continuous, controlled by the level in the storage compartment as drawn down by the pump. Upon high level, the system shall shut down by first stopping polymer feed, then stopping water flow. Upon low level, the system shall automatically re-start, by starting water flow before polymer feed.

.3 Capacities and Performances:

.1 Design Criteria:1

.1 Recommend storage capacity of dry polymer = 14 days based on average conditions. The storage may include

2.1 MATERIALS (Cont'd)

.3 Capacities and Performances:(Cont'd)
.1 Design Criteria:(Cont'd)

hopper volume and storage integrated at the dosing system.
.2 Duty pumps for each dosing location = 4 dosing locations.

.4 All components of the Polymer Unloading and Conveyance System shall be specifically designed for the intended chemical, and shall be constructed from appropriate corrosion and abrasion resistant materials.

.5 All components of the storage conveyance systems that come into contact with the dry polymer are to be electrically grounded to prevent static charge buildup.

2.2 POLYMER PREPARATION EQUIPMENT

.1 The fully automatic Polymer Preparation Systems shall be capable of wetting, diluting and aging polymer solutions from 0.1% to 0.5%. The Polymer Preparation Systems must capable of preparing long chain polymers without imparting excessive shear. Mixed polymer shall be free of polymer clots and 'fish eyes'.

.2 Capacities and Performance:
.1 General:
.1 All components of the Polymer Preparation Systems shall be specifically designed for handling the intended chemicals and shall be constructed from appropriate corrosion and abrasion resistant material.
.2 Supply Products modified as necessary by the Supplier to provide the specified features and to meet the specified performance for the specified operating conditions.
.3 All equipment specified in this Section will be designed and furnished by a single polymer equipment Supplier who is responsible for component compatibility and suitability to the application.
.4 Each polymer preparation unit shall have tankage for mixing and storage with sufficient capacity to allow for adequate aging and storage of polymer solution. Mixing and storage tank

2.2 POLYMER PREPARATION EQUIPMENT (Cont'd)

.2 Capacities and Performance:(Cont'd)

.1 General:(Cont'd)

.4 (Cont'd) operations to be automatic, controlled by the Polymer PLC.

.5 Supplier shall supply all a complete and functional system that shall be controlled by the Polymer PLC.

.6 Provide sufficient mixing energy to activate long chain polymers without imparting excessive shear.

.7 Provide Polymer Preparation System that operates on an automatic, sequential cycle to prepare fully active polymer solution.

.8 The dry polymer to be utilized in the system will be in the microbead or powder form. The dry polymer used can either have a cationic, anionic or non-ionic charge.

.2 Wetting Unit:

.1 Provide a polymer wetting unit capable of preparing long chain polymers without imparting excessive shear.

.3 Mixing/Aging Tank:

.1 Provide mixing/aging tank(s) and appurtenances for mixing of the polymer solution after discharge from the wetting unit and before transfer to the feed tank.

.2 Construct the mixing/aging tank of FRP or equal, to be free standing.

.3 Mixing/Aging tank(s) must include support for mixer bridge.

.4 Provide the mixing/aging tank with a capacity adequate to meet polymer system demand.

.4 Blending Water Control:

.1 Each unit shall incorporate a blending water switch (flow or pressure for polymer preparation and each dosing line) to monitor blending water flow and if required shut down the polymer preparation process on low water flow.

.5 Mixer:

.1 Provide a mixer for the mix tank, fixed and mounted to the tank top bridge.

.2 Mixer to be driven by a TEFC electric motor, operating on 600/3/60 power, conforming to Division 16.

2.2 POLYMER PREPARATION EQUIPMENT (Cont'd)

.2 Capacities and Performance:(Cont'd)

.5 Mixer:(Cont'd)

.3 Ensure all wetted parts of the mixer are stainless steel.

.6 Transfer Valves and Piping:

.1 Provide system to transfer solution from mix tank to feed tank. System shall operate by gravity, with automated valves, controlled by the polymer PLC.

.2 A motorized ball valve shall be provided to transfer polymer solution from the mix/age tank to the feed tank.

.3 Include solution transfer time when sizing related equipment.

.7 Liquid Level Control Sensors:

.1 Provide liquid level control sensors to detect liquid levels in the mix tank.

.2 Ensure all level devices are integrated into the PLC.

.3 Liquid level sensors shall consist of either:

.1 Ultrasonic Level Transmitter.

.2 Non-fouling conductance level probes.

.8 Motor Starters and Starter Cabinet:

.1 Provide motor starters and panel to house the motor starters for the system.

.2 Provide starter panel with a NEMA 12X rated enclosure. Provide panel and panel wiring in accordance with Division 26.

2.3 POLYMER FEED

.1 The polymer solution feed pump skid systems shall convey prepared polymer solution from the feed tank to their respective process dosing points, clarifier, filter press, and biosolids dewatering. As the polymer solution is pumped to their respective polymer dosing points it shall be post-diluted with plant service water.

.2 All components of the Polymer Feed System shall be specifically designed for handling the intended chemical and shall be constructed from appropriate corrosion and abrasion resistant materials.

2.3 POLYMER FEED (Cont'd)

.3 Polymer Feed Tanks

.1 Supply and install polymer solution feed tanks and related appurtenances.

.2 Closed top fibreglass tanks shall be provided. Tank height shall not exceed 4.0 m. Each tank shall have its respective working volume below the overflow outlet pipe and above the top of the discharge pipe. Tank shall be vertical design with integral flat bottom with no bottom or sidewall seam. Tank shall include a translucent exterior protective coating with UV inhibitor. Each tank shall have an appropriate hold down lug system.

.3 Accessories

.1 Provide an ultrasonic level transducer/transmitter in each feed tank. Level transmitters shall supply a 4-20 mA level signal and a discrete fault output to the Polymer PLC.

.2 Each feed tank shall have a clear 25 mm diameter PVC liquid level sight glass calibrated in litres c/w shutoff valve and vent

.3 Each feed tank shall have two (2) 316 stainless steel lifting eyes.

.4 Each feed tank shall be supplied with manway access doors

.5 Furnish each feed tank with the size and number of connections as indicated on Drawings.

.4 Polymer Pump Skids

.1 General:

.1 The supplier shall fabricate pump skids and furnish equipment as shown in the P&IDs and described herein.

.2 All components of the polymer pump skids including pump, speed controller, motor, and post-dilution unit shall be pre-plumbed and pre-wired. Skid shall be 304 stainless steel and fork truck compatible. Mounting hardware shall be 304 stainless steel.

.2 Accessories:

.1 Each pump shall be supplied with pre-piped calibration column and pressure relief valve. The calibration column shall be constructed of clear PVC and shall be complete with a vented top cap. The column shall be graduated in milliliters with a capacity of 500 ml

2.3 POLYMER FEED (Cont'd)

.4 (Cont'd)
.2 Accessories:(Cont'd)
.2 The Installer shall supply and install the following accessories:
.1 Interconnecting piping, fittings, reducers, valves, strainers, flexible fittings, quick connect connections and related appurtenances to make a complete system.

2.4 INSTRUMENTATION AND CONTROL

.1 Refer to 40 90 00 Instrumentation and Control for Process Systems.

.2 All instruments and devices indicated on the P&ID shall be provided, factory wired, and mounted.

2.5 POLYMER PREPARATION SYSTEM CONTROL PANEL

.1 The polymer preparation system shall be furnished with a NEMA 4X control panel containing a factory mounted programmable logic controller (PLC). All controls and instruments shall fail into safe condition. Units shall not operate unless energized, nor can they operate under fault conditions.

.2 Provide separate panels for instrumentation/PLC and motor starters.

.3 Refer to Section 40 90 00 for information to be provided by the Contractor to the control system integrator.

2.6 PIPING AND TUBING

.1 Supply and install all interconnecting piping and tubing within each skid mounted assembly. Unless otherwise specified, provide valves that are the Manufacturer's standard, suitable for the intended service conditions.

.2 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 personnel.

2.7 ACCESSORIES

.1 Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on all equipment provided under this Section in a readily visible location. Plate shall bear the 3/8-inch engraved and black enamel filled equipment identification number indicated in this Specification and/or as shown on Drawings.

.2 Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.

.3 Anchor Bolts: Anchor bolts shall be Type 316 stainless steel and at least 1/2 inch in diameter. Coordinate required size with final Shop Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REPRESENTATIVE

.1 A Contractor's Representative is to attend the Site prior to the arrival of the equipment to train the Installation Contractor and ensure a seamless custody transfer.

.2 A Contractor's Representative shall attend the Site to witness installation and testing to ensure the equipment is installed and operated as intended.

.3 The Contractor's Representative shall verify the Installation Contractor's understanding by completing Form 101.

3.2 INSTALLATION TRAINING

.1 Instruct the Installer in the methods and precautions to be followed in the installation of the pump(s).

.2 The Contractor's Representative shall verify the Installation Contractor's understanding by completing Form 101.

3.3 TESTING

.1 Ensure that each piece of equipment, including all component parts, operates as intended.

.2 Cooperate with the Installation Contractor to fulfill the requirements for successful testing of the equipment, as documented by Form 103.

3.4 COMMISSIONING

.1 Attend during commissioning of the process system which includes the equipment specified in this Section to ensure that each piece of equipment functions as intended in the process system.

3.5 SUPPLY OF CHEMICALS

.1 The contractor is to provide the first filling for each chemical. Refer to Section 46 21 00, Section 1.1.10. Coordinate requirement for chemicals with the Owner and Departmental Representative.

END

PART 1 - GENERAL

1.1 GENERAL

.1 Provide complete, fully tested and operational process systems to meet requirements described herein and in complete accord with applicable codes and ordinances.

.2 It is the responsibility of the contractor to assess and evaluate information provided, including specifications, drawings, design rationale and process control description, and pilot trial report to appropriately select, supply, and install the process system including any ancillary equipment. Together with shop drawing submittal, the contractor shall provide appropriate justification (i.e. process calculation) for the selection/configuration basis.

.3 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.4 Follow Manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.5 The Contractor may refer to the Process Specification Log attached to these specifications (Section 46 21 00 Attachment 1), for a summary listing of all major process equipment specified in these Contract Documents in reference to their tags and the Process and Instrumentation Drawings.

.6 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Departmental Representative at no extra cost.

.7 Install equipment to provide access and ease of maintenance.

.8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors. Un-crate equipment, move

1.1 GENERAL (Cont'd)

.8 (Cont'd) in place and install complete; start-up and test.

.9 The Contractor must supply and install the required identification, labeling or signage for each pipe, valve and piece of equipment, in accordance with the Best Practice Guideline for Occupational Safety and Health (OSHA) Pipes and Signage. In addition, the contractor must be familiar with and follow the AECL Procedure WL-510445-PRO-667 for OSH Safety Signage Procedures.

.10 It is the Contractor's responsibility to provide the power, fuel and water etc. during the individual and the WWTP system checks outs throughout the inactive commissioning phase. Contractor is to provide the first filling for each chemical. Specific volumes and quantities can be found in the relevant sections of the Design Rationale and Process description (section 7.18).

1.2 DISCREPANCIES AND OMISSIONS

.1 These Specifications shall be considered as an integral part of the Drawings, which accompany them, and neither the Drawings nor Specifications shall be used alone. Any items or subject omitted from one but which is mentioned and/or indicated in the other shall be considered as properly and sufficiently specified and shall therefore be provided.

1.3 TRANSPORTATION AND HOISTING

.1 Assume responsibility for transportation, hoisting, warehousing, and demurrage for all equipment and materials to be furnished and installed under this Division.

1.4 DEFINITIONS AND INTERPRETATIONS

.1 Where the term "Provide" is used herein, it shall be understood to include labour, materials, and services necessary to supply, install and make functional the items or Work referenced.

1.4 DEFINITIONS AND INTERPRETATIONS (Cont'd)

.2 Where the term "Instructions" or "As Instructed" or "Where Instructed", etc. is used herein, it shall be understood to mean as instructed in writing by the Departmental Representative.

.3 Where the term "Listed" is used herein, it shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.

.4 Where the term "Approved", "Approval", etc. is used herein, it shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, By-Laws, etc.

.5 Where the term "Acceptable" or "Acceptance", etc. is used herein, it shall be understood to mean acceptable to the Departmental Representative as conforming to the requirements of the Contract Documents.

.6 Where the term "Submit for Review" is used herein, it shall be understood to mean submit to the Departmental Representative.

.7 Where the term "Subject to Review" etc. is used herein, it shall be understood to mean Work shall be laid out for review by the Departmental Representative. No Work shall proceed until written instructions have been obtained from the Departmental Representative. Submit further information, Shop Drawings, samples, etc. as specified and/or as may be reasonably requested by the Departmental Representative.

.8 Where the term "Accessible" is used herein, it shall be understood to mean readily approachable by person or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.

.9 Where working pressure or pressure ratings are specified or shown on the Drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

1.5 SHOP DRAWINGS

.1 Refer to Section 01 33 00 for the general requirements for Shop Drawings.

.2 For specific requirements for Shop Drawings for various pieces of equipment, refer to the relevant specific Sections describing the equipment.

1.6 COORDINATION

.1 Coordinate with other Divisions the location of openings, housekeeping pads and anchor bolts.

.2 Coordinate the connection of the services of other Divisions to the equipment and material supplied under this Division.

1.7 MINOR CHANGES

.1 Equipment and materials are located and arranged generally as shown on the Drawings. However, changes may be required to suit the precise requirements of the actual equipment or materials supplied, or to avoid conflict between services.

.2 Prior to the installation of the relevant equipment or materials, the Contractor shall advise the Departmental Representative of the requirement for any changes (including box-outs and coring) and shall undertake such changes as instructed by the Departmental Representative. Such changes shall be undertaken at no extra cost

.3 The building envelope layout and structural components cannot be modified.

1.8 CUTTING AND PATCHING

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Departmental Representative before cutting or burning structural members.

.4 Patch building where damaged from equipment installation, improperly located holes etc. Use

1.8 CUTTING AND PATCHING (Cont'd)

.4 (Cont'd) matching materials as specified in the respective Section.

1.9 SUBSTANTIAL PERFORMANCE AND CONSTRUCTION COMPLETION

.1 Prior to Substantial Performance, provide a complete list of items which are deficient at the time of the Substantial Performance inspection.

.2 Perform the following items prior to Substantial Performance inspection:

.1 Make systems capable of operation with alarm controls functional and automatic controls in operation generally, but not necessarily finally calibrated.

.2 Make necessary tests on equipment including those required by authorities. Obtain certificates of approval.

.3 Complete valve tagging and identify equipment. Paint equipment, piping and install escutcheon.

.4 Lubricate equipment in accordance with Manufacturer's data.

.5 Mail warranty forms to Manufacturer. Provide copy of original warranty for equipment which has Maintenance Period longer than one (1) year.

.6 Submit Operation and Maintenance Manuals in accordance with Section 01 33 00.

.3 Prior to Construction Completion Inspection, provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Construction Completion Inspection:

.1 Complete final calibration of controls.

.4 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.10 EQUIPMENT PROTECTION AND CLEAN-UP

.1 Protect equipment and materials in storage on Site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

1.10 EQUIPMENT PROTECTION AND CLEAN-UP (Cont'd)

.2 Protect equipment with polyethylene covers and crates.

.3 Thoroughly clean both existing and new piping, ducts and equipment of dirt, cuttings and other foreign substances.

.4 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.11 TEMPORARY USAGE

.1 Usage by the Owner of any process device, apparatus, machinery or equipment prior to Construction Completion being issued is not to be construed as acceptance.

1.12 ACCEPTABLE PRODUCTS AND MANUFACTURES

.1 Wherever possible, all equipment and related coatings, lubricants, etc. must be NSF/ANSI Standard 61 approved.

1.13 SPARE PARTS AND SPECIAL TOOLS

.1 If spare parts or special tools are to be provided with any equipment specified, the specific parts or tools will be listed in the relevant Specification Section and are to be supplied with the equipment.

.2 Where the operation of the equipment for a period of two (2) years would require that some specific spare parts are likely to be required, but are not listed in the Specification, the Contractor shall so inform the Departmental Representative. Costs, delivery periods, and any other information relevant to the procurement of the identified spare parts shall be identified.

.3 Where some specific special tools are required for the maintenance and/or operation of a specific item of equipment, but are not listed, the Contractor shall so inform the Departmental Representative. Costs, delivery periods, and any other information relevant to the procurement of the identified special tools shall be provided.

.4 This clause does not relieve the Contractor of the responsibility to provide, at no cost, any spare parts required during the maintenance period to repair malfunctioning or failed

1.13 SPARE PARTS AND SPECIAL TOOLS (Cont'd)

.4 (Cont'd) equipment. At the end of the maintenance period, the spare parts inventory shall be replenished to allow for the above.

1.14 ABBREVIATIONS

.1 ABMA - American Bearing Manufacturers Association.

.2 AISI - American Iron and Steel Institute.

.3 ANSI - American National Standards Institute.

.4 API - American Petroleum Institute.

.5 ASME - American Society of Mechanical Consultants.

.6 ASTM - ASTM International (formerly American Society for Testing and Materials).

.7 AWS - American Welding Society.

.8 AWWA - American Water Works Association.

.9 CGA - Canadian Gas Association.

.10 CGSB - Canadian General Standards Board.

.11 CISPI - Cast Iron Soil Pipe Institute.

.12 CPC - Canadian Plumbing Code.

.13 CSA - Canadian Standards Association.

.14 EJMA - Expansion Joint Manufacturer's Association.

.15 MIL - Military Standard.

.16 MSS - Manufacturers Standardization Society of the Valve and Fittings Industry.

.17 NACE - NACE International (formerly National Association of Corrosion Consultants).

.18 NSF - NSF International (formerly National Sanitation Foundation).

.19 SSPC - Society for Protective Coatings.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Packaged Evaporator System for removal of contaminants from a portion of the treated RO-brine stream from waste water of the Port Granby site.

.2 Includes electric heating system, exhaust system, mist elimination, evaporator feed pump, Evaporator unit, process controller, exhaust blower, heat exchanger, concentrate drain for a completely operational treatment system.

.3 The WWTP will comprise a packaged evaporator system which removes contaminants from a portion of the treated brine stream of the reverse osmosis treatment to reduce the overall salt content in the process. It is the responsibility of the contractor to assess and evaluate information provided, including specifications, drawings, design rationale and process control description, and pilot trial report to appropriately select, supply, and install the appropriate evaporator system including any ancillary equipment. Together with shop drawing submittal, the contractor shall provide appropriate justification (i.e. process calculation) for the selection/configuration basis.

1.2 SECTION INCLUDES

.1 Calibration, certification, and commissioning of the supplied equipment.

.2 All equipment furnished under this specification section shall be new.

1.3 SUBMITTALS

.1 Submit according to Section 01 33 00.
- .1 Shop Drawings:
- .2 Include Evaporator system layout and cross-sections.
- .3 Show equipment, piping, valves, and devices on Drawings.
- .4 Wiring diagrams.
- .5 Control equipment.
  - .1 Panel fabrication and dimension drawings, nameplate legends, Engineer's tag numbers, and wiring and piping schematic diagrams.

1.3 SUBMITTALS (Cont'd)

.1 (Cont'd)
.5 (Cont'd)
.2 Equipment dimension drawings.
.3 Component specification sheets.
.4 Equipment terminal and piping connections.
.5 Loop-by-loop system electrical schematic including terminal-to-terminal interconnections between panel and field equipment.

.2 Operating and Maintenance (O&M) Data: Provide for incorporation in O&M Manual as specified in Section 01 33 00. Include the following:
.1 Complete description of operation including detailed operating sequence descriptions, Clean-in-Place operation, and maintenance.
.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.
.5 Complete spare parts list.

1.4 QUALITY ASSURANCE

.1 Standardization and System Responsibility:
.1 For specific purposes of standardization and total system responsibility, equipment included in this section shall be furnished by single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 The Contractor shall be responsible for equipment delivery to the Site. When the Contractor accepts the equipment delivery, he shall certify the delivery by completing Form 100.

.2 The Contractor shall be responsible for all equipment at the Site or any alternative storage location.

.3 The Contractor shall ensure that he is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage including any required maintenance.

1.5 DELIVERY, STORAGE, AND HANDLING (Cont'd)

.4 If equipment off-site storage is required, then the second move of the equipment to the Site will be at the Contractor's cost.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESCRIPTION

.1 Process:

.1 The Port Granby WWTP will treat waste water, surface run off and leachate during a site remediation project at the Port Granby waste management facility.

.2 The Evaporator removes contaminants from a portion of the treated brine stream of the reverse osmosis treatment. Highly soluble salts such as sodium, chloride, and sulphate are not removed from the system by biological pre-treatment or the chemical precipitation, and would otherwise concentrate due to the brine recycle. A bleed stream of untreated or treated brine (supernatant) is therefore pH adjusted and fed to the Evaporator to remove these highly soluble salts from the water treatment system.

.2 Once the concentrate has reached a sufficient stage of moisture reduction, it shall be directed to a slurry tank for further processing. Clean condensate from the evaporator shall be discharged to the final effluent tank and combined with the permeate from the RO system.

.3 The evaporator described herein shall be a mechanical vapour compression style evaporator. Supply the following equipment as specified herein and as indicated:

Evaporator Tag	Capacity
E-09100	3.4 m^3/hour

2.2 DESIGN CRITERIA

.1 General: the supply, testing, and performance of all supplied euqipment shall conform to all standards referred to herein.

.2 Space Limitations: all equipment must fit in the allotted space for the evaporator equipment.

2.2 DESIGN CRITERIA (Cont'd)

.3 Design Requirements:

.1 The Evaporation system must be capable of treating the influent flows and associated loads over the full length of the construction period.

.2 The Evaporator system shall process the required max design flows with one or multiple process units.

.3 Influent quality:

.1 A concentration range for the incoming waste water of the Port Granby site is indicated in the design rationale document (section 2.2.4.2; table 5; influent projections). Additional information is provided in paragraph 2.3.4 of this section.

.2 The waste water received by the Evaporation unit originates from a brine precipitation process at high pH (10-11). This effluent is clarified and subsequently pH adjusted to obtain a neutral pH prior to the evaporation step.

.3 If the brine precipitation process is not operated untreated brine will be fed to the evaporator at neutral pH.

.4 Effluent requirements:

.1 Residual treatment must achieve quality limits which will enable the overall water quality parameter to comply with the effluent goals of table 2-6 in section 2.2.4.3. Of the design rationale and process control description document.

.5 Control requirements:

.1 Automatic control, display and historical storage of all critical evaporator functions.

.2 Safe shut down in case of critical alarms.

.3 Critical shut down alarms to include as a minimum:

.1 Blower contact failure.

.2 Low air flow.

.3 High bath temperature.

.4 High heat exchanger temperature.

.5 High bath level, excessive foaming.

.6 Thermocouple failure.

.6 At a minimum, the main equipment to be included with the Package Evaporator System is listed briefly as follows:

.1 Exhaust system.

.2 Mist elimination.

2.2 DESIGN CRITERIA (Cont'd)

.3 Design Requirements:(Cont'd)

.6 (Cont'd)

.3 Evaporator feed pump.

.4 Residue removal pump.

.5 Evaporator unit.

.6 Process controller.

.7 Exhaust blower.

.8 Heat exchanger.

.9 Concentrate drain.

.10 Residue tank.

.11 System valves for isolation, diversion, control and sampling.

.12 Instrumentation & Controls (HMI, PLC) for a complete automated Evaporation system.

.13 Equipment General Arrangement and Layout Drawings.

.14 Operating & Maintenance (O&M) Manuals

.15 Site visits and personnel training as specified.

.16 Equipment delivery to site.

.17 Field service assistance.

.18 Startup assistance.

.19 Provide recommended spare parts for one (1) year of operation.

.20 O&M training including copies of all training materials in electronic format.

.7 System Control Panel:

.1 Provide run-fail alarm, and equipment status functions in general conformance with Section 40 90 00.

.2 Unless otherwise specified, run signals shall be derived from motor starter normally open auxiliary contacts.

.3 Electrical wiring and control shall conform to Division 26.

.8 Devices and instrumentation in Vendor Packages to be supplied, installed and wired by Vendor Package Supplier unless otherwise stated.

.9 Provide isolated dry contacts rated at 5A, 120 V AC for the following minimum conditions, as well as signals shown on P&ID drawings and other Alarm and Status signals available from the Vendor Package:

.1 Remote Status Selected - indication that LOCAL/OFF/REMOTE selector switch is in REMOTE position.

.2 Running Status - indication that the equipment is operating.

2.2 DESIGN CRITERIA (Cont'd)

.3 Design Requirements:(Cont'd)

.9 (Cont'd)

.3 Emergency Stop Status - indication that emergency stop pushbutton is depressed.

.4 General Alarm - indication that any one of the equipment alarm conditions is in alarm state.

2.3 PERFORMANCE

.1 Capable of treating a maximum influent flow rate of 3.4 m/hour of the influent as specified below.

.2 Equipment Manufacturer to provide process guarantee of greater than or equal to 90 to 95% volume reduction. The process shall meet the following requirements for TDS decrease with respect to the condensate stream.

.3 Evaporator condensate quality shall be suitable for continuous discharge to a surface water body.

.4 Approximate Influence Characteristics:

Parameter	Units	Average	Maximum
Chloride	mg/L	1300	3900
Sulphate	mg/L	1900	19000
Calcium	mg/L	350	1400
Magnesium	mg/L	2000	8500

2.4 REGULATORY REQUIREMENTS

.1 In accordance with Section 01 11 00.

.2 Conform to Ontario Codes as required. TSSA for all pressure vessels, power elements, conform to the Canadian National Electrical Code.

2.5 EQUIPMENT HEALTH AND SAFETY

.1 System Safety and "Zero Energy":

.1 The purpose of this paragraph is to establish the minimum requirements for the system safety, lockout of energy sources, and isolating devices. This applies to the system safety during normal operations and the control of energy during servicing and/or maintenance of machines and equipment.

2.5 EQUIPMENT HEALTH AND SAFETY (Cont'd)

.1 (Cont'd)

.2 The machinery must meet applicable Ontario Health and Safety Act and Regulations and other additional requirements as specified.

.3 The system manufacturer is responsible for:

.1 Designing and providing mechanical safety components like barriers, guards, guardrails, protective coverings, etc. to prevent contact between personnel and machinery during normal operation and other safety measures which provide effective protection of personnel and machinery.

.2 Designing and providing components, procedures and lockout instructions to meet "zero energy" requirement whenever maintenance or servicing is done on machines or equipment. "Zero energy" means isolation from all forms of energy (electricity, pneumatic, hydraulics, gravity, etc.) and other hazards like confined space, fire, chemical, radiation or biological exposure, etc.

.4 Provide each motor or system component using electricity to transform into other form of energy (actuator, heater, etc.) that operates at more than 50 volts to ground with separate local safety disconnect switch. Enclosed Safety Switch Assemblies shall be non-fusible type, load interrupter, quick-make, quick-break switch with external operable handle lockable in OFF position. Current rating as required, corrosion resistant plated current carrying parts. Type (NEMA) 4X enclosure rating.

.5 Provide each pneumatic (compressed air, etc.) system with manual, lockable, isolation valve.

.6 Provide each hydraulic system with manual, lockable, blocking valve and an interlocked and monitored mechanical device to prevent unintended movement.

.7 Provide other systems as required with manual, lockable, devices to prevent unintended movement, energy release and prevent hazards.

.2 Guards:

.1 On moving parts, provide sheet expanded guards in accordance with workplace safety regulations.

2.5 EQUIPMENT HEALTH AND SAFETY (Cont'd)

.2 Guards:(Cont'd)
- .2 Fabricate of 14 gauge steel, and painted red after fabrication to same standard as parent equipment.
- .3 Guards to be removable to facilitate maintenance of moving parts.
- .4 Make provision to extend lube fittings through guards.

.3 Caution Signs:
- .1 For all rotating equipment drives provide caution signs.
- .2 For caution signs, use vinyl stick-on type decals placed onto clean, smooth surface of equipment to be posted.
- .3 Where insufficient space exists, use decal applied to galvanized mild steel, fibreglass, or plastic sheet fastened to equipment.
- .4 Provide signs that read CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME.
- .5 Letters to be 25 mm in height, red, on a yellow background.
- .6 Provide mounting posts and hardware and mount close to guarded moving parts.

2.6 ACCEPTABLE COMPONENTS

.1 Major mechanical components shall be items with14-day parts or unit replacement available in Canada.

.2 All other mechanical, control, and electrical components shall be standard stock items with 7-day parts or unit replacement available in Canada.

.3 Any special delivery units or over 14 days delivery shall be listed as an exception.

2.7 EVAPORATOR PROCESS COMPONENTS

.1 Pumps:
- .1 Inlet Feed Pump: inlet feed pump from RO concentrate in main plant area shall be controlled by evaporator control panel. Two centrifugal pumps (duty/standby) shall be supplied in accordance with Section 46 45 10 with run/stop signals coming from the evaporators. The pumps will be on VFD's.
- .2 Recirculation Pump:
  - .1 Pump shall be direct coupled, with 6% moly stainless steel internals.

2.7 EVAPORATOR PROCESS COMPONENTS (Cont'd)

.1 Pumps:(Cont'd)
- .2 Recirculation Pump:(Cont'd)
  - .2 Maximum pump speed shall be 1800 rpm.
  - .3 Pump shall be able out discharge concentrate at a minimum 103 kPag measured at the outlet connection of the pre-packaged skid. Flow rate shall be determined by manufacturer.
- .3 Slurry Discharge Pump:
  - .1 Pump shall be Air Operated Diaphragm Pump (AOD).
  - .2 The pump shall use a maximum of 9.43 L/s of air at 860 kPag.
  - .3 Pump shall be made from PVDF wetted parts and outer piston with cross linked EPDM and polypropylene diaphragms and ceramic balls.
- .4 Condensate Pump:
  - .1 Centrifugal pump shall be direct coupled, with 2205 duplex stainless steel internals. Have a cast iron casing meeting the requirements of ASTM A48 Class 30.
  - .2 Maximum pump speed shall be 1800 rpm.
  - .3 Pump shall be able out discharge concentrate at a minimum 1 measured at the outlet connection of the pre packaged skid. Flow rate shall be determined by equipment manufacturer.
  - .4 38 mm flanged discharged connection.
  - .5 Pump Motors: in accordance with Section 40 90 00.

.2 Heat Exchangers:
- .1 All heat exchangers much have applicable registration with Canadian authorities including, but not limited to CRN numbers if applicable.
- .2 Feedstock heat exchanger:
  - .1 Heat exchanger internals must be corrosion resistant, titanium alloy, capable of handling the process liquid specified at a minimum of 105°C.
  - .2 Outfitted with inlet and outlet pressure sensors to initiate cleaning.
  - .3 Outfitted with inlet and outlet temperature sensors.

.3 Main Heat Exchanger:
- .1 Heat exchanger internals must be corrosion resistant, 6% moly, capable of handling the process liquid specified at a minimum of 115°C.

2.7 EVAPORATOR PROCESS COMPONENTS (Cont'd)

.3 Main Heat Exchanger:(Cont'd)
- .2 Outfitted with inlet and outlet pressure sensors to initiate cleaning.
- .3 Outfitted with inlet and outlet temperature sensors.

.4 Liquid/Vapour Separator Tank:
- .1 Heating Elements:
  - .1 Shall have wetted components constructed from titanium alloy.
  - .2 Shall have a minimum of three 30 kWh low watt density heating elements powered from evaporator control panel.
- .2 Tank shall be manufactured out of 4 mm thick minimum 2205 duplex stainless steel capable of handling the process liquid specified at a minimum of 110°C.
- .3 Tank shall be outfitted with an air vent, valve, vacuum breaker, and rupture disk.
- .4 Tank shall be enclosed in protective insulation as specified by vendor, rated to 480°C, and thick enough to ensure minimal CSA safety requirements are met and minimal heat loss occurs.
- .5 Site Glasses:
  - .1 Shall have two 102 mm diameter site glasses installed on the separator tank.
- .6 Access:
  - .1 Top of separator tank to be outfitted with an access cover with davit arm.

.5 Mist Pad:
- .1 Compression fit dual density mist pad rate for 10/2 microns.
- .2 Mist pad shall be manufactured from 316 L stainless steel.

.6 Vapour Compressor:
- .1 Vapour compressor to be rated for a nominal flow rate of 88 m 3 /minute at the required pressure for the system designed by the manufacturer.
- .2 The vapour compressor housing and rotors with retractable seals shall be constructed from 316 stainless steel.
- .3 The vapour compressor shall have a 149.5 kW TEFC motor rated for 575V, 3-phase, 60 Hz.
- .4 Main Bearings:
  - .1 Main bearings to be spherical or cylindrical roller bearings.
  - .2 Main bearings to be grease lubricated.

2.7 EVAPORATOR PROCESS COMPONENTS (Cont'd)

.6 Vapour Compressor:(Cont'd)
- .4 Main Bearings:(Cont'd)
  - .3 Design main bearings for ABFMA L-10 rating life of at least 100,000 hours.
- .5 High strength impeller case shall be heavily ribbed and shall feature oversized dowel pins for precise mounting and alignment of head plates. This shall result in reduced noise and more stable, vibration free operation.
- .6 Impellers shall be machined to an exact profile and shall be permanently fastened to shafts. They shall be dynamically balanced for smooth operation in any assembly position.
- .7 Timing gears shall be precision machined and shall be permanently pinned to the shafts to assure non-slip timing even under the most strenuous loading conditions.
- .8 Resettable pressure relief valve located downstream of vapour compressor.

.7 Condensate Receiving Tank: receives discharge from condensate side of feed stock heat exchanger. Tank is outfitted with 2-level sensors. The condensate pump suction line is connected to the tank, and transfer condensate to the splitter box upstream of the biological pretreatment.

.8 Sample Ports: provision should be made to sample, clean condensate and slurry.

.9 Feedstock Strainer:
- .1 Duplex strainer for incoming fluid feed line. Strainer shall have a diverter valve to allow for continuous operation while either strainer is taken out for cleaning. Duplex strainer shall be integrated into PLC to notify operator when cleaning is required.
- .2 Strainer basket shall be made of a minimum 316 L stainless steel.

.10 Piping:
- .1 Feedline shall be constructed from CPVC.
- .2 Recirculation line shall be constructed from 2205 duplex stainless steel.
- .3 Residue line shall be constructed from 2205 duplex stainless steel.

.11 Insulation:
- .1 Heat Exchangers: removable insulation blankets shall be installed on heat

2.7 EVAPORATOR PROCESS COMPONENTS (Cont'd)

.11 Insulation:(Cont'd)

.1 Heat Exchangers:(Cont'd)

exchangers. The reusable insulation shall be constructed from 76 mm low density fiberglass compressed to 38 mm. Fiberglass shall be enclosed in silicone impregnated cloth, with PTFE stitched seams.

.2 Piping:

.1 Greater than 100 mm diameter: minimum insulation thickness of 50 mm.

.2 38 to 100 mm diameter: minimum insulation thickness of 38 mm.

.3 Less than 38 mm diameter: minimum insulation thickness of 25 mm.

.4 K=0.035 W/(m degree C) at 24°C.

.5 Glass Fiber Density: 80 kg/m 3.

.6 To ASTM C547 Class 2.

.7 Fire Hazard Ratings for Insulation Systems: maximum flame spread rating of 25, fuel contributed rating of 50, and maximum smoke developed rating of 50 to NFPA 255, ASTM E84, and ULC S102 for components of insulation systems.

2.8 ELECTRICAL AND CONTROL SYSTEMS

.1 Refer to Section 40 90 00.

.2 Provide UL Listed NEMA 4, 24 VDC PLC control panel with 120 VAC receptor plug, internal lighting.

2.9 OPERATIONS SEQUENCES

.1 General rules and Anticipated Operation of the Packaged System: intention of this paragraph is to establish the packaged system supplier with information on the control and monitoring of equipment that is associated directly or indirectly with packaged system. This document should be used as an aid in developing the control strategy and integrating the system into the operation of the complete facility. If this document does not properly describe the system operation, the supplier shall notify Departmental Representative.

.2 Under this paragraph "packaged system" refers to complete system including auxiliary systems controlled and monitored by the packaged system and provided by third party and not just packaged system itself only.

2.9 OPERATIONS SEQUENCES (Cont'd)

.3 Packaged system shall be controlled by a programmable logic controller with electronic operator interface which shall be factory programmed and tested prior to shipment.

.4 Overall controls system programming shall be a supplier responsibility. Plant system integrator shall provide details on Canadian standards related to presentation of information, alarms and interface with ancillary systems.

.5 Control logic shall perform start up, shutdown and monitoring of the complete packaged system in accordance with manufacture's "know how" procedures and incorporating control provisions specified herein.

.6 System shall operate automatically. Facility SCADA and supervisory controllers shall exchange control and operation signals. It is anticipated that most of the control and monitoring signals shall be exchanged through the Ethernet/IP network with provisions for basic hardwired connections.

.7 Evaporator System Operation:

.1 Operation (general):

.1 Command for the evaporator system to start is issued.

.2 Control system starts the evaporator.

.3 Evaporator shall start its cycle by drawing water from the evaporation pH adjustment tank. Evaporator feed pumps shall automatically fill up this tank to the high level limit once the evaporator has started to draw water from the tank.

.4 Evaporator shall automatically control the electric heating elements in the liquid/vapour separation vessel, the speed of the vapour compressor, feed and recirculation pumps.

.5 Residue (slurry) shall be periodically discharged to the slurry tank.

.6 Command is issued for the evaporator system to stop.

.7 Control system under normal circumstances shall recirculate the process liquid that is currently in the system to stop concentrate from solidifying. Separator vessel contents

2.9 OPERATIONS SEQUENCES (Cont'd)

.7 Evaporator System Operation:(Cont'd)
- .1 Operation (general):(Cont'd)
  - .7 (Cont'd) shall be discharged to the slurry tank before a normal shutdown.
- .2 Control Features:
  - .1 Cleaning cycle.
  - .2 Operation.
  - .3 Purge (empty) evaporator system.
- .3 Operation in Manual Mode:
  - .1 Plant operator issues the commands for evaporator and subsystems to start in Manual mode. (Note: it is anticipated that this mode shall be used when there is a problem with one of the subsystems, during optimization, troubleshooting, etc.; the plant operator shall manually follow automated sequence.)
  - .2 In manual mode the logic shall allow for stand alone operation of the evaporator\ and independent operation (start/stop/adjustment) of the feed pumps, evaporator CIP system (any other subsystem) from the evaporator system electronic operator interface.
  - .3 Control logic shall also permit independent operation (start/stop/adjustment) of feed pumps, evaporator CIP system (any other subsystem) from the external operator interfaces related to that equipment.
  - .4 Program control logic shall monitor operation of the subsystems based on the available data.
  - .5 Control logic shall allow for automated cleaning cycle in manual mode. Program logic shall initiate cleaning cycle when requested (starts wash pump, open valve(s), etc.) and flush the evaporator for a set period of time.
- .4 Malfunction:
  - .1 Control system shall monitor equipment operating conditions and automatically respond to conditions endangering personnel, and/or potentially leading to the equipment failure and damage.
  - .2 The evaporator shall shutdown following the auto shutdown sequence upon alarm conditions and shut down instantaneously upon any critical alarm conditions. Detailed malfunction

2.9 OPERATIONS SEQUENCES (Cont'd)

.7 Evaporator System Operation:(Cont'd)
.4 Malfunction:(Cont'd)
.2 (Cont'd)
and shutdown scenarios shall be based on manufacture's experience for the offered manufacture's top of the line alarm management system.

.8 Ancillary Systems Control (cleaning system, etc.): ancillary equipment shall operate independently in Hand mode and in response to the control requests from the evaporator control system in Auto mode. Supplier shall assure that the provided interface has all necessary discrete/analog input/output control signals for required interface system.

.9 Electronic operator interface interacting with logic controller system shall provide following information (as a minimum):
.1 Graphics presenting ancillary systems.
.2 System and Devices Statuses:
.1 Evaporator system (control modes, operational statuses).
.2 Evaporator system (process data, temperatures, levels, pressure).
.3 Evaporator feed pump status (N/A, auto, stopped/running, speed, fail).
.4 Recirculation pump (N/A, auto, stopped/running, speed, fail).
.5 Vapor Compressor (N/A, auto, stopped/running, speed, fail).
.6 Slurry (residue) pump (N/A, auto, stopped/running, fail).
.7 Heating element(s) (N/A, auto, on/off, fail).
.8 Other as required by equipment manufacturer.
.3 System and devices control and control setpoints:
.1 Evaporator system operation (control mode selection, setpoints and configuration).
.2 Ability to monitor analog transmitters and associated alarm settings. The operator shall be able to edit alarm setpoints (HiHi, Hi, Lo, LoLo) in engineering units, enable/disable each alarm level, set over/under-range filter, deadband, and acknowledge or reset alarm.
.3 Other as required by manufacturer.
.4 Critical Alarms, Alarms, Warnings and "Trip" Setpoints: manufacturer

2.9 OPERATIONS SEQUENCES (Cont'd)

.9 (Cont'd)
.3 (Cont'd)
.4 (Cont'd)
specific controls and alarms are not listed in detail, but shall be included to provide fully operational, manufacturer top of the line control system. Alarms shall be organized and provide fully detailed, utilizing all available data, easy to troubleshoot alarming system.
.1 Emergency stop.
.2 External interlock shutdown.
.3 Evaporator system (foam detection, high separation vessel water and vapour temperature, separation vessel pressure, heat exchanger differential pressure).
.4 Evaporation pH adjustment tank(feed water) tank low level.
.5 Slurry (concentrate) tank high level.
.6 Intake feed strainer differential pressure alarm.
.7 Other required by equipment manufacturer.
.5 Recording, Trending, and Other:
.1 Current alarm list (screen).
.2 Configurable password protected configuration setpoints screens.
.3 Help - general control overview, how to operate machine (minimum 2 screens).
.4 As required by equipment manufacturer.

.10 Control system shall provide and accept (as a minimum) following signals to interface facility systems:
.1 Provision for 1 spare external interlock (dry contact; Off (0) shutdown, On (1) OK; maintained; provide jumper at terminal blocks).
.2 Analog inputs (4-20 mA, 24 VDC):
.1 Evaporation pH adjustment tank level.
.2 Slurry tank level.
.3 Evaporator condensate conductivity.
.3 Analog outputs (4-20 mA, 24 VDC):
.1 Influent wastewater temperature.
.2 Effluent condensate temperature.
.3 Separation vessel water temperature.
.4 Separation vessel vapour pressure.
.5 Differential pressure for main heat exchanger.

2.9 OPERATIONS SEQUENCES (Cont'd)

.10 (Cont'd)

.3 (Cont'd)

.6 Differential pressure for feedstock heat exchanger.

.4 Discrete inputs (control power from dewatering system; Off (0), On (1); maintained):

.1 Evaporator system remote start/stop command (auto mode).

.2 Evaporation pH adjustment tank.

.3 Slurry tank.

.4 Spare Status Signal #1 (including programming and implementation).

.5 Spare Status Signal #2 (including programming and implementation).

.5 Discrete outputs (dry contacts; Off (0) stop/close, On (1) start/open; maintained):

.1 Evaporator system control mode.

.2 Evaporator system operational status bit #1 (2 bits, coded).

.3 Evaporator system operational status bit #2 (2 bits, coded).

.4 Shutdown.

.5 Alarm.

.6 Warning.

.7 Spare Control Signal #1 (including programming and implementation).

.8 Spare Control Signal #2 (including programming and implementation).

.6 Network Communication via Ethernet/IP (control): evaporator system in auto mode (system start/stop including adjustments of operating selected parameters as per electronic operator interface).

.7 Network Communication via Ethernet/IP (monitoring): all data shall be gathered and organized into continuous data blocks:

.1 All information available at the electronic operator interface.

.2 Detailed and complete event (alarms/warnings/statuses) system.

.11 Master control system (by others) shall provide remote access via telephone line to the packaged control system PLC and EOI over plant Ethernet/IP network using Allen Bradley Dial In Ethernet Modem (9300 RADES). PLC and EOI shall be configured to allow packaged system supplier remote system support, programming, and troubleshooting.

2.10 INSTRUMENTATION

.1 Instruments and sensors to be CSA or ULC certified. Where there is no alternative to supplying equipment that is not certified, obtain special approval from the Electrical Safety Authority. Manufacturers and approval labels must be visible and legible after equipment is installed.

.2 Provide instrumentation as recommended by the manufacturer to measure items directly related to packaged system performance, and required for operation of fully automated system.

.3 Evaporator system can be provided with analog level signals (ultrasonic type) and level statuses (floats) from Evaporation pH adjustment tank and slurry tank from facility instruments (provided by others), but supplier may provide own level monitoring devices if required for system warranty or performance.

2.11 SPARE PARTS

.1 Included in the proposal, the manufacturer shall include the following spare parts including any special tools required for the system:

- .1 1 complete spare set of all gaskets that are used.
- .2 1 spare rupture disk with vacuum support.
- .3 Include spare components for any analytical instrumentation that has consumables/special tools.
- .4 Manufacturers recommended amount of spare thermocouples.
- .5 1 spare AOD slurry pump, as specified.
- .6 1 spare 30 kW heating element, as specified.
- .7 1 spare analog level probe.

PART 3 - EXECUTION

3.1 GENERAL

.1 Design and construct complete packaged system in accordance with Contract Documents. Conform to the best practices applicable to this type of systems.

.2 Provide submittals as required and specified herein.

.3 Canada and Departmental Representative reserves the right and may inspect packaged system at any time.

.4 Canada and Departmental Representative will be present for the inspections, testing, training, etc. that are generally referred to as start-up and commissioning activities.

.5 Inspection, start-up, and commissioning activities must be completed in specified sequence with completion and approval of the earlier activities prior to commencement of the next scheduled activity. Commissioning guidelines are set forth in Section 01 91 13, which are to be followed for the commissioning plan of the packaged systems. The commissioning activities and schedule specific to the Water Treatment Plant are addressed in the Commissioning Plan.

.6 Coordination of the detailed start-up schedule with the completion of related processes and ancillary systems is the sole responsibility of the manufacturer and Contractor, refer to the Commissioning Plan for details.

.7 Contractor and manufacturer shall prepare and submit a detailed procedure and schedule for each specified task under this specification section to Departmental Representative for approval.

.8 The manufacturer understands that the schedule for carrying out the inspections, testing, training, etc. depends on the completion of related processes and ancillary systems, overall construction progress, and the availability of treatment chemicals, power, control, and utility systems.

3.1 GENERAL (Cont'd)

.9 Unless otherwise specified, or listed as a part of supplies under Part 2 - PRODUCTS, Canada will bear the cost for supply of treatment chemicals and utilities (electric power, water, compressed air). Howver, the Contractor is to provide the first filling for each chemical. Refer to Section 46 21 00, paragraph 1.1.10. Contractor to provide unloading and handling of all treatment chemicals prior to and during start-up and non-active commissioning tests.

3.2 MANUFACTURER'S SERVICES - GENERAL

.1 Provide manufacturer's representative to perform the services herein specified. Manufacturer's representative shall be a factory trained qualified technical personnel capable of completing specified tasks and other necessary activities required to start-up and commission packaged system.

.2 Inspect, operate, test and adjust the equipment. Provide training.

.3 The packaged system manufacturer shall specify the number of visits to the site that are required but under no circumstances is this to be less than the minimum number of days herein specified.

.1 If manufacturer's normal start up and commissioning on-site support services requires greater than the number of working days listed herein, manufacturer shall make reference to this paragraph in the bid and quote required number of manufacturer recommended working days.

.2 The date and duration of each trip will be arranged by Contractor and subject to approval by Departmental Representative.

.4 State in tender the total price (including all travel expenses: accommodation, meals, transportation, travel time, etc.) of providing the specified manufacturer's field services. As minimum, a manufacturer's representative shall be present at site for the specified activities.

.5 The time indicated under this section is for services required for complete work listed under this specification unless specified otherwise.

.6 Indicate per diem cost (including all travel expenses as listed above) for additional days on site for manufacturer's representative.

3.3 FACTORY ACCEPTANCE TESTS (FAT)

.1 The tests include factory internal checks followed by a witnessed Factory Acceptance Test.

.2 Packaged system shall be factory tested for compliance with the construction and functional requirements specified herein, and certification of the results of these tests shall be submitted to Departmental Representative.
- .1 Complete assembly checklist and record product information for individual system components.
- .2 Complete factory standard tests and quality system procedures.
- .3 For all systems that are not pressure vessels, test components for water tightness at system maximum allowable working pressure.
- .4 Provide non-destructive testing of tank welds (i.e. X-ray, dye penetrant, ultrasonic, other) in accordance with applicable specifications (ASME Section VIII Division 1, or other).
- .5 Verify operation of the electrical, instrumentation, and control system in accordance with related electrical specifications.

.3 Factory acceptance test:
- .1 Provide overview of the packaged system:
  - .1 Present system design basis, implementation, related drawings and design documents.
  - .2 Describe components, function, and system assembly.
  - .3 Present operation of the control system.
  - .4 Present preliminary (first draft) of the Operation and Maintenance Manual.
- .2 Provide facilities, utilities (electric power, water, compressed air, etc.), manufacturer's representative, and related services for the test. Provide temporary setup complete with required appurtenances to complete Factory Acceptance Test.

.4 Include FAT supporting documentation and sign-off sheets as attachments to the Certificate of Completion, and submit to Departmental Representative prior to shipping.

.5 Upon satisfactory completion of factory verification checks, prepare packaged system for shipping and storage as per manufacturer's standard.

3.4 INSTALLATION AND CONSTRUCTION SUPPORT

.1 Prior to commencement of installation, review all related work (mechanical, electrical, structural, etc.) to ensure that the equipment can be correctly installed. Immediately advise Departmental Representative in writing of any deficiencies or deviations from the installation instructions, during the installation of the packaged system.

.2 A manufacturer's representative shall instruct Contractor on preparation, rigging, assembly, as well as installation procedures and details.

.3 Install equipment in accordance with manufacturer's written instructions.

.4 Provide the services of manufacturer's representative(s) to provide instructions and support installation and construction support.

.5 Protect equipment and finishes from construction work by leaving equipment in manufacturer transport packaging as long as possible. Isolate the equipment from piping systems until such times as the piping systems are completed, pressure tested and cleaned to prevent foreign debris from entering into the equipment.

.6 Provide services of manufacturer's representative for a minimum of 3 non-consecutive days (a minimum of 6 hours per day at site) to support and oversee installation work.

3.5 INSTALLATION ACCEPTANCE INSPECTION

.1 Upon completion of equipment installation, provide services of manufacturer's representative to:

.1 Conduct final installation inspection and sign-off.
.2 Energize equipment.
.3 Perform "Dry Run".
.4 Verify that packaged system is ready for start-up testing.
.5 Provide classroom and on-site hands-off training sessions.

.2 Manufacturer to specify the number of personnel, the number of visits, and time at site that is required to complete this task; include time for training as specified.

3.5 INSTALLATION ACCEPTANCE INSPECTION (Cont'd)

.3 The installation inspection shall ensure that the complete packaged system was correctly installed. In general, but not limited to, the following items shall be inspected:
- .1 Soundness (damaged parts or components).
- .2 Correctness of setting, alignment and relative arrangement of various parts.
- .3 Completeness on all installation process connections.
- .4 Adequacy of lubricants and equipment related liquids.
- .5 Adequacy of energy sources.
- .6 Completeness on all installation wiring connections.
- .7 Check that the equipment has been installed consistent with installation instructions.

.4 Upon completion of installation inspection:
- .1 Verify the safety and readiness of the process, mechanical, electrical and control system prior to energization.
- .2 Energize equipment (electric power, water, compressed air, supply or exhaust air, etc.).
- .3 Ensure operation of all components and devices.
- .4 Verify control system setup. Adjust settings.
- .5 Bring equipment into ready to accept process streams operating condition.
- .6 As far as possible or practicable perform "Dry Run". Please notice that actual process or test streams (liquids, slurry, sludge, etc.) will not be introduced into packaged system at this stage.
- .7 Verify operation of associated equipment.
- .8 Ensure that equipment has received all necessary regulatory inspections and certification.

.5 Immediately correct deficiencies revealed during installation acceptance checks. Advise Departmental Representative of any deficiencies or deviations from the installation instructions.

.6 Submit a signed and dated report to Departmental Representative, covering the inspection findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed and confirming that the equipment is satisfactorily installed,

3.5 INSTALLATION ACCEPTANCE INSPECTION (Cont'd)

.6 (Cont'd)
in proper working order, and ready for the next phase of testing.

.7 Provide manufacturer's representative training services for 2 days for operator training during or immediately following installation acceptance inspection. The operation and maintenance training shall include:
- .1 Classroom training (a maximum of 3 hours) with overview of equipment operation, technology, and principles. Provide presentation, study, and training materials. Canada will provide training location.
- .2 On-Site, Hands-Off training (a maximum of 3 hours) with presentation by the instructor:
  - .1 Describe components, function, and system assembly.
  - .2 Safety and lockouts.
  - .3 Overview of control system.

3.6 STARTUP TESTING

.1 In general, work include:
- .1 Introduce clean water into the equipment.
- .2 Bring the complete packaged system online.
- .3 Perform "Wet Run".
- .4 Demonstrate that packaged system is suitable for continuous online operation.
- .5 Integrate with plant SCADA system.
- .6 Provide on-site hands-on training session.

.2 Manufacturer shall specify the number of personnel, number of visits, and time at the site that is required to complete this task; however time required shall not be less than 5 consecutive days (minimum of 8 hours per day at site) to complete specified activities.

.3 In general equipment operation shall include:
- .1 Bring packaged system into operating condition.
- .2 Ensure operation of equipment and devices.
- .3 Operate packaged system in different modes, perform multiple starts and stop sequences; adjust settings.
- .4 Simulation of failures and confirmation of alarm activation.
- .5 Operation of associated equipment.

3.6 STARTUP TESTING (Cont'd)

.4 Immediately correct deficiencies revealed during initial operation. Correct and adjust equipment operation.

.5 Allow for minimum of 1 day of time for integration with plant SCADA system to ensure that system operates as intended within the integrated water treatment plant process stream. This time shall be exclusively dedicated to:
- .1 Plant system integrator for integration with SCADA.
- .2 Other packaged system manufacturers and their respective systems.
- .3 Allow for wiring modifications, field programming and data layout checks and modifications, "test-run", etc. to ensure the equipment control system performs as intended.
- .4 Complete electrical, control, instrumentation, and software Site Acceptance Tests in accordance with Section 40 90 00.

.6 Complete SAT report and TAB report and submit signed copies to Departmental Representative for approval.

.7 Immediately address any deficiencies in site preparation or installation identified by the manufacturer representative during the start-up testing. Costs associated with correcting the documented deficiencies and the additional time for the manufacturer representative to complete the start-up testing will be borne by Contractor.

.8 The start-up testing is deemed complete if no malfunctions occur during testing with equipment running for minimum of 12 hours in total, and 1 continuous operation of not less then 4 hours. If malfunctions occur during the operation, perform and complete corrective action and restart the packaged system.

.9 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as

3.6 STARTUP TESTING (Cont'd)

.9 (Cont'd)
malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.10 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.11 Submit a signed and dated letter report to Departmental Representative, covering the start-up testing findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is satisfactorily installed, in proper working order, and ready for a non-active functional testing.

.12 Allow for approximately half a day for operator training during start-up testing. The training shall include:
.1 On-Site, Hands-On training: presentation by the instructor with Canada's operators following and physically performing and learning maintenance operations:
.1 Operation Overview.
.2 Safety and lockouts.
.3 Cleaning, maintenance inspection and checks.
.4 Replacement of frequently changed components.
.5 Responding to alarm conditions.

3.7 NON-ACTIVE FUNCTIONAL TESTING

.1 In general, work includes:
.1 Plant operation by Contractor.
.2 On-site, hands-on training.

.2 Provide services of manufacturer's representative for a minimum of 40 hours (1 week, 5 days per week, 8 continuous hours per day at site) to complete specified tasks.

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.3 Non-active functional testing is part of plant wide commissioning to demonstrate complete water treatment system functional operation. Non-active functional testing will be performed using clean water without introduction of active influent. For clean water requirements, refer to the Commissioning Plan.

.4 Plant operation by Contractor:
- .1 Manufacturer's representative shall operate packaged system and related ancillary systems as applicable. Provide all services required for complete control, monitoring, tuning of the packaged system.
- .2 Canada's operators will observe events, but they will not be an active participant or responsible for the operation until the successful completion of the non-active functional testing by Contractor.
- .3 Respond to Canada's operators technical inquires related to package system operation and maintenance during non-active functional testing.
- .4 Allow for minimum of half a day for scheduled operator training by manufacturer's representative. The training shall focus on:
  - .1 Packaged system operation; controls, monitoring, alarms.
  - .2 Troubleshooting; simulate alarms and warnings, explain causes, and give details on corrective measures and procedures.

.5 The non-active functional testing is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.7 (Cont'd)
regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to Departmental Representative, covering the observations from the non-active functional test, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the next stage of testing.

.10 If, in the opinion of Departmental Representative, the non-active performance test is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the readiness of the system for non-active operation training.

3.8 NON-ACTIVE OPERATIONAL TRAINING

.1 In general, work includes:
.1 Plant operation by Canada's operators with Contractor supervision.
.2 Support training.

.2 Provide services of manufacturer's representative for a minimum of 40 hours (1 week, 5 days per week, 8 continuous hours per day at site) to complete specified tasks.

.3 Non-active operation training will follow completion of non-active functional testing and it will be part of plant wide commissioning to provide no-risk training for Canada's operators

3.8 NON-ACTIVE OPERATIONAL TRAINING (Cont'd)

.3 (Cont'd)
and to prove complete water treatment system functional operation. Non-active operation training will be performed using clean water only.

.4 Plant operation by Canada's operators with Contractor supervision.
.1 Manufacturer's representative shall provide support and guidance to Canada's operators as required to operate packaged system.
.2 Respond to Canada's operators technical inquires related to packaged system operation and maintenance during non-active operation training.

.5 The non-active operation training is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, shutdowns related to Canada's operators' actions will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site

3.8 NON-ACTIVE OPERATIONAL TRAINING (Cont'd)

.8 (Cont'd)
.2 (Cont'd)
start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to Departmental Representative, covering the observations from the non-active operating training, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the active performance testing.

.10 If, in the opinion of Departmental Representative, the non-active operation training is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system and readiness for Active Performance Testing.

3.9 ACTIVE PERFORMANCE TESTING

.1 After completion and approval of non-active functional testing and operation training, performance testing using active influent shall be performed. Performance testing shall occur at such time as the entire water treatment plant as a whole is complete.

.2 Active performance testing will be performed by Canada's operators due to the regulatory requirements.

.3 Task includes:
.1 Plant operation by Canada's operators.
.2 Performance testing and support by manufacturer's representative.

.4 Provide services of manufacturer's representative for 5 consecutive working days of the active performance test, for a minimum of 8 hours per day with 24 hours "on call" support. The manufacturer's representative shall respond to all communication (i.e. phone, fax, or e-mail) within 24 hours throughout the remainder of the active performance test.

.5 Manufacturer's representative services during on-site activities.
.1 Assistance during performance testing (fine tuning, adjustment of the operational settings, etc.).

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.5 (Cont'd)
.2 Respond to Canada's operators technical inquires related to packaged system operation.
.3 Demonstrate to Departmental Representative that the packaged system performance during the active performance testing meets or exceeds the minimum performance requirements defined in this section.

.6 Refer to the Commissioning Plan for details on the active performance testing procedure.

.7 If malfunctions occur during the operation, perform and complete corrective action and bring packaged system to operational condition. Provide corrective services within maximum of 5 working days with no additional cost.
.1 If malfunction prevents system from operation, additional operation time will be required.
.2 The additional time will be time lost plus 1 additional day of testing.

.8 Sampling and Analysis:
.1 All analyses to be performed by an independent laboratory accredited by the Canadian Association for Environmental Analytical Laboratories and approved by the Canadian Nuclear Safety Commission.
.2 Canada's operators and/or Departmental Representative will conduct sampling and monitoring activities during active performance testing.
.3 Departmental Representative will summarize the collected data at the conclusion of the test period and submit the results to Canada.
.4 Departmental Representative shall make all operating and performance monitoring data for the packaged system available to the manufacturer's representative upon request, in addition to the analytical reports for any samples that were collected to monitor the performance of the packaged system.
.5 Refer to following paragraph for performance testing details.

.9 Acceptance of the packaged system:
.1 Active performance testing will be deemed complete based on functional operation and process performance results.

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.9 Acceptance of the packaged system:(Cont'd)

.2 The functional operation is deemed acceptable if no major malfunctions occur during the operation.

.1 Major malfunction is defined as equipment failure when a component of the packaged system does not function at all, and puts the packaged system out of service. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.2 A maximum of 2 attempts to successfully complete the active performance testing are allowed for the packaged system.

.3 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process.

.3 Any interruption of active performance testing for reasons beyond the control of Contractor and manufacturer will not affect the continuity of the active performance testing.

.4 Upon receiving the commissioning forms completed by manufacturer's representative and operators throughout the active performance testing and the verified analytical reports from the accredited laboratory, Departmental Representative shall prepare a Commissioning Report.

.5 If, in the opinion of Departmental Representative, the active performance testing is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system.

.6 If, in the opinion of Departmental Representative, a packaged system fails to meet the performance requirements specified herein following the conclusion of the active performance testing, Canada will notify Contractor in writing of the unacceptable performance.

.7 In the event of unacceptable performance, perform any supplemental testing, analysis, equipment adjustments, modifications, changes or additions and request a retest

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.9 Acceptance of the packaged system:(Cont'd)

.7 (Cont'd) of the unacceptable system at no additional cost to Canada.

.8 If the active performance testing re-test is not successful, Canada at its sole discretion may reject the equipment and require replacement.

END

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 The WWTP will comprise a packaged reverse osmosis system which removes metals and radionuclides from waste water at the Port Granby site. It is the responsibility of the contractor to assess and evaluate information provided, including specifications, drawings, design rationale and process control description, and pilot trial report to appropriately select, supply, and install the appropriate reverse osmosis system including any ancillary equipment. Together with shop drawing submittal, the contractor shall provide appropriate justification (i.e. process calculation) for the selection/configuration basis.

.2 Includes feed - and booster pump, pre-filter, valves, piping, fittings, membranes, flow indicators, controls, and Clean-in-Place packaged equipment complete with Clean-in-Place pump, heater and tanks for a completely operational treatment system.

1.2 SYSTEM DESCRIPTION

.1 Process:

.1 The Port Granby WWTP will treat waste water, surface run off and leachate during a site remediation project at the Port Granby waste management facility.

.2 Filtrate from the membrane filtration systems overflows the MBR Filtrate / Backwash Tank and flows by gravity to the RO System pH Adjustment Tank. Antiscalant, Biocide and Hydrochloric Acid are added.

.3 The MBR Filtrate enters the tank at a pH of approximately 7. Hydrochloric Acid is added to decrease the pH to an operator adjustable target of approximately 6 (+/- 0.5), in order to minimize scaling potential in the RO System.

.2 Design Requirements:

.1 The RO system must be capable of treating the influent flows and associated loads over the full length of the construction period.

1.2 SYSTEM DESCRIPTION (Cont'd)

.2 Design Requirements:(Cont'd)
- .2 The RO system shall process the required design flows with two process units.
- .3 Influent quality:
  - .1 A concentration range for the incoming waste water is indicated in the design rationale and process description (section 2.2.4.2; table 2-5, section 2.2.4.4 and section 2.3).

.3 Effluent requirements:
- .1 Effluent (permeate of the RO system) must achieve quality limits which will enable the overall water quality parameter to comply with the effluent goals of table 2-6 in section 2.2.4.3 Of the design rationale and process description.

.4 Design rates:
- .1 The design flux rate shall not exceed 5 to 10 lmh at 25°C.
- .2 The recovery rate shall be 75% at minimum with a single pass system.

.5 At a minimum, the main equipment to be included with the Package RO System is listed briefly as follows:
- .1 Two (2) 50% RO Systems capable of treating the maximum throughput on a continuous basis.
- .2 A sufficient number of RO membrane modules to meet design hydraulic conditions and treatment objectives.
- .3 Pre-RO cartridge filtration system, designed for the maximum throughput with filter elements rated at 1 micron nominal.
- .4 RO feed pumps.
- .5 Booster pump.
- .6 Chemical feed pumps.
- .7 System valves for isolation, diversion, control and sampling.
- .8 Instrumentation & Controls (HMI, PLC) for a complete automated RO system.
- .9 Clean-in-Place System including cleaning chemicals, CIP tank, CIP heating element, CIP pump.
- .10 Module rack and housings.
- .11 Control panel including variable frequency drives (VFDs) for equipment integral with the system.
- .12 Equipment General Arrangement and Layout Drawings.
- .13 Operating & Maintenance (O&M) Manuals.

1.2 SYSTEM DESCRIPTION (Cont'd)

.5 (Cont'd)
- .14 Site visits and personnel training as specified.
- .15 Equipment delivery to site.
- .16 Field service assistance.
- .17 Startup assistance.
- .18 Provide recommended spare parts for one (1) year of operation.
- .19 The Contractor is to provide the first filling of each chemical. Refer to Section 46 21 00, paragraph 1.1.10.
- .20 5 year Membrane Guarantee.
- .21 O&M training including copies of all training materials in electronic format.

.6 System Control Panel:
- .1 Provide run-fail alarm, and equipment status functions in general conformance with Section 40 90 00.
- .2 Unless otherwise specified, run signals shall be derived from motor starter normally open auxiliary contacts.
- .3 Electrical wiring and control shall conform to Division 26.

1.3 SUBMITTALS

.1 Submit according to Section 01 33 00.

.2 Shop Drawings:
- .1 Include RO system and Clean-in-Place system layout and cross-sections.
- .2 Show equipment, piping, valves, and devices on Drawings.
- .3 Wiring diagrams.
- .4 Control equipment.
  - .1 Panel fabrication and dimension drawings, nameplate legends, Engineer's tag numbers, and wiring and piping schematic diagrams.
  - .2 Equipment dimension drawings.
  - .3 Component specification sheets.
  - .4 Equipment terminal and piping connections.
  - .5 Loop-by-loop system electrical schematic including terminal-to-terminal interconnections between panel and field equipment.

.3 Operating and Maintenance (O&M) Data: Provide for incorporation in O&M Manual as specified in Section 01 33 00. Include the following:
- .1 Complete description of operation including detailed operating sequence

1.3 SUBMITTALS (Cont'd)

.3 (Cont'd)
- .1 (Cont'd) descriptions, Clean-in-Place operation, and maintenance.
- .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.
- .5 Complete spare parts list.

1.4 QUALITY ASSURANCE

.1 Standardization and System Responsibility:
- .1 For specific purposes of standardization and total system responsibility, equipment included in this section shall be furnished by single manufacturer.
- .2 To ensure proper operating systems, manufacturer of RO equipment shall also be responsible for providing following:
  - .1 Control valves, equipment and instrumentation as shown to be provided by RO equipment manufacturer on Shop Drawings.
  - .2 Piping as shown to be provided by RO equipment manufacturer on Shop Drawings and in accordance with requirements of this section.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 The Contractor shall be responsible for equipment delivery to the Site. When the Contractor accepts the equipment delivery, he shall certify the delivery by completing Form 100.

.2 The Contractor shall be responsible for all equipment at the Site or any alternative storage location.

.3 The Contractor shall ensure that he is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage including any required maintenance.

.4 If equipment off-site storage is required, then the second move of the equipment to the Site will be at the Contractor's cost.

PART 2 - PRODUCTS

2.1 RO MEMBRANES AND HOUSINGS

.1 Membrane cartridges together with the housing shall be referred to as a membrane module and shall meet the following minimum requirements:

.2 The membrane modules shall be capable of withstanding all internal and external pressures and forces placed thereupon.

.3 The modules shall not require special lifting mechanisms for handling and must be able to be individually removed from the membrane rack.

.4 The membranes shall have a guaranteed lifetime of at least 5 years. Copies of manufacturer's guarantee for the membranes shall be submitted with the shop drawings.

2.2 PRE-FILTER

.1 Pre-filter cartridge shall be 1 micron nominal, stainless steel.

2.3 CLEAN-IN-PLACE SYSTEM

.1 The Clean-in-Place system shall be designed to be automatic semi-automatic operation, but will be manually initiated by the operator when indicated by the control system. Procedures for the operation of the Clean-in-Place System shall be provided by the Contractor.

.2 The Clean-in-Place system shall be a skid mounted assembly consisting of a water storage tank with water heater, level sensor, CIP pump, filters and all required cleaning chemicals and ancillary valves and piping as recommended by manufacturer and shown in the Shop Drawings.

.3 The Clean-in-Place wastewater shall be piped to the brine reaction tank (refer to the process & instrumentation drawings).

2.4 RO AND CLEAN-IN-PLACE ANCILLARY EQUIPMENT

.1 The Contractor shall supply and install all pressure gauges, pressure transducers, flow, level, conductivity and temperature sensors recommended by the manufacturer and shown on the Shop Drawings.

2.4 RO AND CLEAN-IN-PLACE ANCILLARY EQUIPMENT (Cont'd)

.2 All gauges, transducers and sensors shall be consistent with the rest of the water treatment plant.

.3 The Contractor shall provide sufficient sampling and flush points to facilitate collection of feed, permeate, concentrate and CIP samples.

2.5 RO AND CLEAN-IN-PLACE SYSTEM PIPING.

.1 Pipe materials and installation shall comply with Section 40 05 13.

2.6 RO AND CLEAN-IN-PLACE VALVES

.1 All RO and Clean-in-Place system valves shall comply with 40 05 23.

.2 Provide all valves required for proper operation of RO and Clean-in-Place systems as determined by the manufacturer and shown on the Drawings.

2.7 AUTOMATED RO SYSTEM CONTROLS

.1 Devices and instrumentation in Vendor Packages to be supplied, installed and wired by Vendor Package Supplier unless otherwise stated.

.2 Provide LOCAL/OFF/REMOTE selector switch and provision for remote operation (Command Start / Permissive) via dry contacts from a remote PLC.

.3 Provide isolated dry contacts rated at 5A, 120 V AC for the following minimum conditions, as well as signals shown on P&ID drawings and other Alarm and Status signals available from the Vendor Package:

.1 Remote Status Selected - indication that LOCAL/OFF/REMOTE selector switch is in REMOTE position

.2 Running Status - indication that the equipment is operating

.3 Emergency Stop Status - indication that emergency stop pushbutton is depressed

.4 General Alarm - indication that any one of the equipment alarm conditions is in alarm state

.4 RO Control Panel complete with HMI:

.1 Programmable logic controller (PLC).

2.7 AUTOMATED RO SYSTEM CONTROLS (Cont'd)

.4 RO Control Panel complete with HMI:(Cont'd)
.2 Pressure gauges, selector switches, pilot lights, adjustable timers, and push buttons to be mounted on front of control panel.

.5 Front Panel Devices:
.1 Automatic-semi-automatic-manual RO control mode selector switch.
.2 Open-auto-close selector switch for each motorized valve.
.3 1 green service position light for each motorized valve.
.4 1 amber backwash position light for each motorized valve.
.5 Digital water level indicators for the Clean-in-Place tank.

2.8 COATING

.1 Surface preparation, priming, and finish coating of exterior of vessels and piping, valves, and appurtenances shall comply with Section 43 90 10 and 43 90 20.

.2 Colors:
.1 Piping, Valves, and Appurtenances: Comply with Division 9.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Ensure that RO and Clean-in-Place systems are installed in accordance with manufacturer's instructions and Section 43 21 00 as required to provide satisfactory service.

3.2 EQUIPMENT PERFORMANCE TESTING

.1 The Contractor shall ensure that all equipment, including all component parts, operates as intended.

.2 The Contractor shall demonstrate satisfaction of requirements specified herein.

.3 The Contractor shall to fulfill the requirements for successful testing of the equipment as documented by Form 103.
.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the Owner's personnel in the proper operation

3.2 EQUIPMENT PERFORMANCE TESTING (Cont'd)

.3 (Cont'd)

.1 (Cont'd) and maintenance of the equipment as documented by Form T1.

.4 For all instruments, submit completed Calibration forms and Instrument Installation Checklist forms in Section 01 91 33.

END

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Supply and delivery of 2 dedicated cleaning systems to circulate cleaning solution through the evaporator and slurry dryers.

.2 Calibration, certification, and commissioning of the supplied equipment.

.3 All equipment furnished under this specification section shall be new.

1.2 REFERENCES

.1 Canadian Standards Association (CSA).

.2 National Electrical Manufacturers Association (NEMA).

.3 Underwriters' Laboratories of Canada (ULC).

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Progress Submittals:

- .1 Product Data: include:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations, and troubleshooting protocol.
  - .2 Product transportation, storage, handling, and detailed installation requirements.
  - .3 Equipment Information including pump controls, discharge pressure requirements, included options, valve controls, all other controls, brochure cuts indicating dimensions and weights, and location from where system services and technical support would be provided.
  - .4 A list of all supplied equipment including the length and material of construction of supplied piping/tubing as part of the hookup requirements.
  - .5 A system schematic and process and control narrative.
- .2 Shop Drawings: indicate:
  - .1 Overall dimensions of equipment.
  - .2 Fixing support dimensions.

1.3 SUBMITTALS (Cont'd)

.2 Progress Submittals:(Cont'd)
- .2 Shop Drawings:(Cont'd)
  - .3 Equipment layout.
  - .4 Arrangement and dimensions of accessories.
  - .5 Process and instrumentation.
  - .6 Dimension drawing and foundation loading data.
  - .7 Diagram of connections.
  - .8 Installation data.
  - .9 Electrical and control system in accordance with Section 40 90 00.
- .3 Test Reports:
  - .1 FAT Test Reports:
    - .1 Indicate: log time of hours run through "clean water" test. Indicate all down time reasons and required fixes.
    - .2 Submit all calibration and controls verification reports.

.3 Closeout Submittals:
- .1 Provide closeout submittals in accordance with Section 01 78 00.
- .2 Warranties: completed original warranty forms filled out in Canada's name and registered with manufacturer.

1.4 QUALITY ASSURANCE AND CONTROL

.1 Include prerequisites, standards, limitations, and criteria which established an overall level of quality for products and workmanship under this specification section.

.2 If required, make reference to national standards. State class and revision.

.3 Only quality workmanship will be accepted, not only in regard to durability, efficiency and safety, but also in regard to neatness of detail. Work done under Contract must present a neat and clean appearance when completed, to the satisfaction of Departmental Representative. Any unsatisfactory workmanship will be replaced at no extra cost. Conform to the best practices applicable to this type of work.

.4 Canada reserves the right and may inspect the equipment during all stages of production, construction and tests whether at the supplier factory or that of other parties supplying materials or parts, which will be used in the construction of the unit.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Provide all requirements for transporting, handling, storing, and protecting products.

.2 Protect system components, nozzles and mountings against damage during transportation.

.3 Blind flange/install plugs in all process connections to protect equipment from dust and debris.

.4 Wrap equipment in plastic to protect from dust and debris as required.

1.6 SITE AMBIENT CONDITIONS

.1 Cleaning systems shall be located indoors, in the residuals management area along with the local operator panel. Anticipated room temperature is 10 to 40°C, 0 to 95% relative humidity.

1.7 WARRANTY

.1 Manufacturer shall warrant against any defects in design, material or workmanship of the clean-in-place system and framework. This warranty shall extend for a period of 12 months from the date of successful completion of active performance testing.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESCRIPTION

.1 The equipment specified in this section shall provide the utilities as described: evaporator and slurry dryers shall undergo Clean-In-Place (CIP) cycles on a regular basis to prevent scale formation in the vessels. The evaporator CIP cycle shall be triggered by the differential pressure measured across the feedstock and main heat exchangers. The slurry dryer CIP cycle shall be triggered after a set number of operating cycles, based on input from the operator. One CIP system shall be dedicated to the evaporator, and 1 CIP system shall be dedicated to the 3 slurry dryers. When a CIP cycle is triggered, a 10% phosphoric acid solution shall be pumped from the dedicated CIP tank to the vessel. Upon completion of the CIP cycle, the phosphoric acid cleaning solution shall be returned to the CIP tank. When the solution conductivity in the CIP tank decreases

2.1 EQUIPMENT DESCRIPTION (Cont'd)

.1 (Cont'd) below an operator-defined setpoint, a blowdown valve shall open automatically and drain the tank until the solution level reaches a low level switch. The low level switch shall close the blowdown valve and open the solenoid valve on the dilution water (final effluent) supply. A hi level switch shall close the solenoid valve on the dilution water supply line and start the phosphoric acid metering pump. An operator-defined volume of the 50% phosphoric acid solution shall be added to CIP tank to produce a 10% phosphoric acid solution in the CIP tank.

2.2 DESIGN CRITERIA

.1 General: the supply, testing, and performance of all supplied equipment shall conform to all standards referred to herein.

.2 Space Limitations: all equipment must fit in the allotted space for the cleaning systems in the residuals management area located below the mezzanine floor of the slurry dryers.

2.3 PERFORMANCE

.1 Capable of supplying a maximum flow rate of 3.4 m^3/hour of 10% phosphoric acid solution to the equipment undergoing the CIP cycle.

.2 Equipment manufacturer shall provide process guarantee for corrosion resistance of the tank, all instrumentation and piping.

2.4 REGULATORY REQUIREMENTS

.1 Conform to Ontario Codes as required. TSSA for all pressure vessels, power elements, conform to the Canadian National Electrical Code.

2.5 ACCEPTABLE COMPONENTS

.1 Major mechanical components (pumps, actuators, etc.) shall be items with 14-day parts or unit replacement available in Canada.

.2 All other mechanical, control, and electrical components shall be standard stock items with 7-day parts or unit replacement available in Canada.

2.5 ACCEPTABLE COMPONENTS (Cont'd)

.3 Any special delivery units or over 14 days delivery shall be listed as an exception.

2.6 CLEAN-IN-PLACE SYSTEM PROCESS COMPONENTS

.1 Process Piping:
- .1 Support: All clean-in-place system piping shall be supported by the skid.
- .2 All Clean-In-Place process piping shall be constructed from Duplex stainless steel, unless alternative materials of construction are indicated on the proves and instrumentation drawings.

.2 CIP/Recirculation Pumps:
- .1 Construction: direct coupled, with Hastelloy C or Titanium internals.
- .2 Capacity: rated for 3.4 m^3/hour at a discharge gauge pressure of 103 kPa.

.3 Filter: disposable cartridge filter designed for sediment removal, constructed of polypropylene or equivalent corrosion resistant material.

.4 CIP tank:
- .1 Evaporator CIP tank (ECT-09700):
  - .1 Construction: Hastelloy, conical bottom.
- .2 Slurry dryer CIP tank (DCT-09800):
  - .1 Construction: Hastelloy, conical bottom.

.5 Dilution Water Assembly:
- .1 The unit shall have an electric solenoid valve for on/off control of total dilution water flow.
- .2 Pressure Gauges: pressure gauges shall be 63 mm in diameter, stainless steel, liquid filled.

2.7 ELECTRICAL AND CONTROL SYSTEMS

.1 Refer to Section 40 90 00.

.2 Provide UL Listed NEMA 4, 24 VDC PLC control panel with 120 VAC receptor plug, internal lighting.

2.8 OPERATIONS SEQUENCES

.1 General Rules and Anticipated Operation of the Packaged System: intention of this paragraph is to establish the packaged system supplier with information on the control and monitoring of equipment that is associated directly or indirectly with packaged system. This document should be used as an aid in developing the control strategy and integrating the system into the operation of the complete facility. If this document does not properly describe the system operation, the supplier shall notify Departmental Representative.

.2 Under this paragraph "packaged system" refers to complete system including auxiliary systems controlled and monitored by the packaged system and provided by third party and not just packaged system itself only.

.3 Packaged system shall be controlled by a programmable logic controller with electronic operator interface which shall be factory programmed and tested prior to shipment.

.4 Overall controls system programming shall be a supplier responsibility. Plant system integrator shall provide details on Canada's standards related to presentation of information, alarms and interface with ancillary systems.

.5 Control logic shall perform start up, shutdown and monitoring of the complete packaged system in accordance with manufacture's "know how" procedures and incorporating control provisions specified herein.

.6 System shall operate automatically. Facility SCADA and supervisory controllers shall exchange control and operation signals. It is anticipated that most of the control and monitoring signals shall be exchanged through the Ethernet/IP network with provisions for basic hardwired connections.

.7 Cleaning System Operation:

.1 Operation (General):

.1 Command for the cleaning/recirculation pump to start is issued.

.2 Control system starts the CIP/recirculation pump.

.3 CIP/recirculation pump shall start its cycle by pumping a 10% phosphoric acid solution from the CIP tank to the

2.8 OPERATIONS SEQUENCES (Cont'd)

.7 Cleaning System Operation:(Cont'd)

.1 Operation (General):(Cont'd)

.3 (Cont'd) vessel undergoing the CIP cycle. The CIP/recirculation pump shall automatically fill this vessel to the hi level switch.

.4 Command is issued for the CIP/recirculation pump to stop.

.5 Upon completion of the CIP cycle, the phosphoric acid solution shall be discharged to the CIP tank.

.6 Control system under normal circumstances shall intermittently recirculate the phosphoric acid solution in the CIP tank to prevent solids from settling and plugging the pump suction line at the base of the CIP tank. CIP cycles shall be performed on all vessels before a normal shutdown.

.2 Control Features:

.1 Recirculation.

.2 Operation.

.3 Blowdown and make-up.

.3 Operation in Manual Mode:

.1 Plant operator issues the commands for cleaning system and subsystems to start in Manual mode. (Note: it is anticipated that this mode shall be used when there is a problem with one of the subsystems, during optimization, troubleshooting, etc.; the plant operator shall manually follow automated sequence.)

.2 In manual mode the logic shall allow for stand alone operation of the cleaning system and independent operation (start/stop/adjustment) of the CIP/recirculation pump, valves (any other subsystem) from the cleaning system electronic operator interface.

.3 Control logic shall also permit independent operation (start/stop/adjustment) of CIP/recirculation pump and valves (any other subsystem) from the external operator interfaces related to that equipment.

.4 Program control logic shall monitor operation of the subsystems based on the available data.

2.8 OPERATIONS SEQUENCES (Cont'd)

.7 Cleaning System Operation:(Cont'd)

.4 Malfunction:

.1 Control system shall monitor equipment operating conditions and automatically respond to conditions endangering personnel, and/or potentially leading to the equipment failure and damage.

.2 The cleaning system shall shutdown following the auto shutdown sequence upon alarm conditions and shut down instantaneously upon any critical alarm conditions. Detailed malfunction and shutdown scenarios shall be based on manufacture's experience for the offered manufacture's top of the line alarm management system.

.8 Ancillary Systems Control (cleaning system, etc.): ancillary equipment shall operate independently in Hand mode and in response to the control requests from the cleaning system in Auto mode. Supplier shall assure that the provided interface has all necessary discrete/analog input/output control signals for required interface system.

.9 Electronic operator interface interacting with logic controller system shall provide following information (as a minimum):

.1 Graphics presenting ancillary systems.

.2 System and Devices Statuses:

.1 Cleaning system (control modes, operational statuses).

.2 Cleaning system (process data, conductivity, level, CIP/recirculation pump flow).

.3 CIP/recirculation pump status (N/A, auto, stopped/running, speed, fail).

.4 CIP valve (N/A, open/closed, fail).

.5 Recirculation valve (N/A, open/closed, fail).

.6 Return valve (N/A, open/closed, fail).

.7 Blowdown valve (N/A, open/closed, fail).

.8 Dilution water (final effluent) valve (N/A, open/closed, fail).

.9 Other as required by equipment manufacturer.

.3 System and devices control and control setpoints:

2.8 OPERATIONS SEQUENCES (Cont'd)

.9 (Cont'd)
.3 (Cont'd)
.1 Cleaning system operation (control mode selection, setpoints and configuration).
.2 Ability to monitor analog transmitters and associated alarm settings. The operator shall be able to edit alarm setpoints (HiHi, Hi, Lo, LoLo) in engineering units, enable/disable each alarm level, set over/under-range filter, deadband, and acknowledge or reset alarm.
.3 Other as required by manufacturer.
.4 Critical Alarms, Alarms, Warnings and "Trip" Setpoints: Manufacturer specific controls and alarms are not listed in detail, but shall be included to provide fully operational, manufacturer top of the line control system. Alarms shall be organized and provide fully detailed, utilizing all available data, easy to troubleshoot alarming system.
.1 Emergency stop.
.2 External interlock shutdown.
.3 Cleaning system (lolo CIP tank level, hihi CIP tank level).
.4 Other required by equipment manufacturer.
.5 Recording, Trending, and Other:
.1 Current alarm list (screen).
.2 Configurable password protected configuration setpoints screens.
.3 Help - general control overview, how to operate machine (minimum 2 screens).
.4 As required by equipment manufacturer.

.10 Control system shall provide and accept (as a minimum) following signals to interface facility systems:
.1 Provision for 1 spare external interlock (dry contact; Off (0) shutdown, On (1) OK; maintained; provide jumper at terminal blocks).
.2 Analog inputs (4-20 mA, 24VDC):
.1 Phosphoric acid metering pump speed.
.3 Analog outputs (4-20 mA, 24VDC):
.1 CIP tank level.
.2 CIP tank conductivity.
.3 CIP/recirculation pump flow.

2.8 OPERATIONS SEQUENCES (Cont'd)

.10 (Cont'd)

.4 Discrete inputs (control power from dewatering system; Off (0), On (1); maintained):

.1 Cleaning system remote start/stop command (Auto mode).

.2 Evaporator/slurry dryer vessel.

.3 Spare Status Signal #1 (including programming and implementation).

.4 Spare Status Signal #2 (including programming and implementation).

.5 Discrete outputs (dry contacts; Off (0) stop/close, On (1) start/open; maintained):

.1 Cleaning system control mode.

.2 Cleaning system operational status bit #1 (2 bits, coded).

.3 Cleaning system operational status bit #2 (2 bits, coded).

.4 Shutdown.

.5 Alarm.

.6 Warning.

.7 Spare Control Signal #1 (including programming and implementation).

.8 Spare Control Signal #2 (including programming and implementation).

.6 Network Communication via Ethernet/IP (control): CIP system in Auto mode (system start/stop including adjustments of operating selected parameters in accordance with electronic operator interface).

.7 Network Communication via Ethernet/IP (monitoring): all data shall be gathered and organized into continuous data blocks:

.1 All information available at the electronic operator interface.

.2 Detailed and complete event (alarms/warnings/statuses) system.

.11 Master control system (by others) shall provide remote access via telephone line to the packaged control system PLC and EOI over plant Ethernet/IP network using Allen Bradley Dial In Ethernet Modem (9300 RADES). PLC and EOI shall be configured to allow packaged system supplier remote system support, programming, and troubleshooting.

2.9 INSTURMENTATION

.1 Flow Meter:

.1 Dilution water assembly: the dilution water flow rate shall be monitored by a paddle meter.

2.9 INSTURMENTATION (Cont'd)

.2 Instruments and sensors to be CSA or ULC certified. Where there is no alternative to supplying equipment that is not certified, obtain special approval from the Electrical Safety Authority. Manufacturers and approval labels must be visible and legible after equipment is installed.

.3 Provide instrumentation as recommended by the manufacturer to measure items directly related to packaged system performance, and required for operation of fully automated system.

2.10 SPARE PARTS

.1 The manufacturer shall include the following spare parts including any special tools required for the system:

.1 One complete spare set of all gaskets that are used.

.2 One set of spare cartridge filters.

.3 Include spare components for any analytical Instrumentation that has consumables/special tools (i.e. conductivity calibration solution).

2.11 MISCELLANEOUS MATERIALS AND ACCESSORIES

.1 Provide miscellaneous devices and accessories as indicated and necessary for fully operational system.

.2 Piping Connections: all piping connections shall be U.S. standard pipe sizes with ANSI B16.5 class 150 lb flanges for pipes 50 mm and larger, and NPT for pipes 38 mm and smaller.

.3 Equipment Identification Plates: a 16-gauge, 316L stainless steel identification plate shall be securely mounted on the CIP tanks with stainless steel pan head screws. The identification plate shall be in a readily visible location. The plate shall bear the die-stamped equipment identification number indicated in this section and as indicated on the P&ID drawings in 12 mm high lettering.

.4 Lifting Lugs: equipment and removable equipment components weighing over 45 kg shall be provided with suitable lifting lugs to permit easy handling.

PART 3 - EXECUTION

3.1 GENERAL

.1 Design and construct complete packaged system in accordance with Contract Documents. Conform to the best practices applicable to this type of systems.

.2 Provide submittals as required and specified herein.

.3 Canada and Departmental Representative reserves the right and may inspect packaged system at any time.

.4 Canada and Departmental Representative will be present for the inspections, testing, training, etc. that are generally referred to as start-up and commissioning activities.

.5 Inspection, start-up, and commissioning activities must be completed in specified sequence with completion and approval of the earlier activities prior to commencement of the next scheduled activity. Commissioning guidelines are set forth in Section 01 91 13, which are to be followed for the commissioning plan of the packaged systems. The commissioning activities and schedule specific to the Water Treatment Plant are addressed in the Commissioning Plan.

.6 Coordination of the detailed start-up schedule with the completion of related processes and ancillary systems is the sole responsibility of the manufacturer and Contractor, refer to the Commissioning Plan for details.

.7 Contractor and manufacturer shall prepare and submit a detailed procedure and schedule for each specified task under this section to Departmental Representative for approval.

.8 The manufacturer understands that the schedule for carrying out the inspections, testing, training, etc. depends on the completion of related processes and ancillary systems, overall construction progress, and the availability of treatment chemicals, power, control, and utility systems.

.9 Unless otherwise specified, or listed as a part of supplies under Part 2 - PRODUCTS of this

3.1 GENERAL (Cont'd)

.9 (Cont'd) specification, Canada will bear the cost for supply of treatment chemicals and utilities (electric power, natural gas, water, compressed air). However, the Contractor is to provide the first filling for each chemical. Refer to Section 46 21 00, paragraph 1.1.10. Contractor to provide unloading and handling of all treatment chemicals prior to and during start-up and non-active commissioning tests.

3.2 MANUFACTURER'S SERVICES - GENERAL

.1 Provide manufacturer's representative to perform the services herein specified. Manufacturer's representative shall be a factory trained qualified technical personnel capable of completing specified tasks and other necessary activities required to start-up and commission packaged system.

.2 Inspect, operate, test and adjust the equipment. Provide training.

.3 The packaged system manufacturer shall specify the number of visits to the site that are required but under no circumstances is this to be less than the minimum number of days herein specified.

.1 If manufacturer's normal start up and commissioning on-site support services requires greater than the number of working days listed herein, manufacturer shall make reference to this paragraph in the bid and quote required number of manufacturer recommended working days.

.2 The date and duration of each trip will be arranged by Contractor and subject to approval by Departmental Representative.

.4 State in bid the total price (including all travel expenses: accommodation, meals, transportation, travel time, etc.) of providing the specified manufacturer's field services. As minimum, a manufacturer's representative shall be present at site for the specified activities.

.5 The time indicated under this section is for services required for complete work listed under this specification unless specified otherwise.

.6 Indicate per diem cost (including all travel expenses as listed above) for additional days on site for manufacturer's representative.

3.3 FACTORY ACCEPTANCE TESTS (FAT)

.1 The tests include factory internal checks followed by a Factory Acceptance Test.

.2 Packaged system shall be factory tested for compliance with the construction and functional requirements specified herein, and certification of the results of these tests shall be submitted to Departmental Representative.

.1 Complete assembly checklist and record product information for individual system components.

.2 Complete factory standard tests and quality system procedures.

.3 Perform Hydrostatic Testing:

.1 Test all components individually and then as a system in accordance with ASME Section VIII Division 1 for pressure vessels for systems that have the potential to operate over 104 kPa gauge.

.2 For all systems that are not pressure vessels, test components for water tightness at system maximum allowable working pressure.

.3 For piping system that operate over 104 kPa gauge, test in accordance with ASME B31.3.

.4 Provide non-destructive testing of tank welds (i.e. X-ray, dye penetrant, ultrasonic, other) in accordance with applicable specifications (ASME Section VIII Division 1, or other).

.5 Vessel shall be stamped and coded with CRN number for province of Ontario when maximum allowable pressure is greater than 104 kPa gauge.

.4 Verify operation of the electrical, instrumentation, and control system in accordance with related electrical specifications.

.3 Factory acceptance test:

.1 Provide facilities, utilities (electric power, natural gas, water, compressed air, etc.), manufacturer's representative, and related services for the test. Provide temporary setup complete with required appurtenances to complete Factory Acceptance Test.

.2 Perform a continuous factory acceptance test at the design flow rate under steady state operating conditions for a minimum period of 4 hours with a clean water feed.

3.3 FACTORY ACCEPTANCE TESTS (FAT) (Cont'd)

.3 Factory acceptance test:(Cont'd)

.2 (Cont'd)

During this period the packaged system shall operate without any mechanical, electrical, instrumentation, control, or any other of the system components failures.

.4 Include FAT supporting documentation and sign-off sheets as attachments to the Certificate of Completion, and submit to the Departmental Representative prior to shipping.

.5 Upon satisfactory completion of factory verification checks, prepare packaged system for shipping and storage in accordance with manufacturer's standard.

3.4 INSTALLATION AND CONSTRUCTION SUPPORT

.1 Prior to commencement of installation, review all related work (mechanical, electrical, structural, etc.) to ensure that the equipment can be correctly installed. Immediately advise Departmental Representative in writing of any deficiencies or deviations from the installation instructions, during the installation of the packaged system.

.2 A manufacturer's representative shall instruct Contractor on preparation, rigging, assembly, as well as installation procedures and details.

.3 Install equipment in accordance with manufacturer's written instructions.

.4 Provide the services of manufacturer's representative(s) to provide instructions and support installation and construction support as required by phone, fax, email, or courier.

.5 Protect equipment and finishes from construction work by leaving equipment in manufacturer transport packaging as long as possible. Isolate the equipment from piping systems until such times as the piping systems are completed, pressure tested and cleaned to prevent foreign debris from entering into the equipment.

.6 Provide services of manufacturer's representative for a minimum of 2 non-consecutive days (a minimum of 6 hours per

3.4 INSTALLATION AND CONSTRUCTION SUPPORT (Cont'd)

.6 (Cont'd) day at site) to support and oversee installation work.

3.5 INSTALLATION ACCEPTANCE INSPECTION

.1 Upon completion of equipment installation, provide services of manufacturer's representative to:
- .1 Conduct final installation inspection and sign-off.
- .2 Energize equipment.
- .3 Perform "Dry Run".
- .4 Verify that packaged system is ready for start-up testing.
- .5 Provide classroom and on-site hands-off training sessions.

.2 Manufacturer to specify the number of personnel, the number of visits, and time at site that is required to complete this task; include time for training as specified.

.3 The installation inspection shall ensure that the complete packaged system was correctly installed. In general, but not limited to, the following items shall be inspected:
- .1 Soundness (damaged parts or components).
- .2 Correctness of setting, alignment and relative arrangement of various parts.
- .3 Completeness on all installation process connections.
- .4 Adequacy of lubricants and equipment related liquids.
- .5 Adequacy of energy sources.
- .6 Completeness on all installation wiring connections.
- .7 Check that the equipment has been installed consistent with installation instructions.

.4 Upon completion of installation inspection:
- .1 Verify the safety and readiness of the process, mechanical, electrical and control system prior to energization.
- .2 Energize equipment (electric power, natural gas, water, compressed air, supply or exhaust air, etc.).
- .3 Ensure operation of all components and devices.
- .4 Verify control system setup. Adjust settings.

3.5 INSTALLATION ACCEPTANCE INSPECTION (Cont'd)

.4 (Cont'd)
.5 Bring equipment into ready to accept process streams operating condition.
.6 As far as possible or practicable perform "Dry Run". Please notice that actual process or test streams (liquids, slurry, sludge, etc.) will not be introduced into packaged system at this stage.
.7 Verify operation of associated equipment.
.8 Ensure that equipment has received all necessary regulatory inspections and certification.

.5 Immediately correct deficiencies revealed during installation acceptance checks. Advise Departmental Representative of any deficiencies or deviations from the installation instructions.

.6 Submit a signed and dated report to Departmental Representative, covering the inspection findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed and confirming that the equipment is satisfactorily installed, in proper working order, and ready for the next phase of testing.

.7 Provide manufacturer's representative training services for 2 days for operator training during or immediately following installation acceptance inspection. The operation and maintenance training shall include:
.1 Classroom training (a maximum of 3 hours) with overview of equipment operation, technology, and principles. Provide presentation, study, and training materials. Canada will provide training location.
.2 On-Site, Hands-Off training (a maximum of 3 hours) with presentation by the instructor:
.1 Describe components, function, and system assembly.
.2 Safety and lockouts.
.3 Overview of control system.

3.6 STARTUP TESTING

.1 In general, work include:
.1 Introduce clean water into the equipment.
.2 Bring the complete packaged system online.
.3 Perform "Wet Run".

3.6 STARTUP TESTING (Cont'd)

.1 (Cont'd)
.4 Demonstrate that packaged system is suitable for continuous online operation.
.5 Integrate with plant SCADA system.
.6 Provide on-site hands-on training session.

.2 Manufacturer shall specify the number of personnel, number of visits, and time at the site that is required to complete this task; however time required shall not be less then 4 consecutive days (minimum of 8 hours per day at site) to complete specified activities.

.3 In general equipment operation shall include:
.1 Bring packaged system into operating condition.
.2 Ensure operation of equipment and devices.
.3 Operate packaged system in different modes, perform multiple starts and stop sequences; adjust settings.
.4 Simulation of failures and confirmation of alarm activation.
.5 Operation of associated equipment.

.4 Immediately correct deficiencies revealed during initial operation. Correct and adjust equipment operation.

.5 Allow for minimum of 1 day of time for integration with plant SCADA system to ensure that system operates as intended within the integrated water treatment plant process stream. This time shall be exclusively dedicated to:
.1 Plant system integrator for integration with SCADA.
.2 Other packaged system manufacturers and their respective systems.
.3 Allow for wiring modifications, field programming and data layout checks and modifications, "test-run", etc. to ensure the equipment control system performs as intended.
.4 Complete electrical, control, instrumentation, and software Site Acceptance Tests in accordance with Section 40 90 00.

.6 Complete SAT report and TAB report and submit signed copies to Departmental Representative for approval.

.7 Immediately address any deficiencies in site preparation or installation identified by the manufacturer representative during the start-up

3.6 STARTUP TESTING (Cont'd)

.7 (Cont'd)
testing. Costs associated with correcting the documented deficiencies and the additional time for the manufacturer representative to complete the start-up testing will be borne by Contractor.

.8 The start-up testing is deemed complete if no malfunctions occur during testing with equipment running for minimum of 12 hours in total, and 1 continuous operation of not less then 4 hours. If malfunctions occur during the operation, perform and complete corrective action and restart the packaged system.

.9 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.10 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
- .1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
- .2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.11 Submit a signed and dated letter report to Departmental Representative, covering the start-up testing findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is satisfactorily installed, in proper working order, and ready for a non-active functional testing.

3.6 STARTUP TESTING (Cont'd)

.12 Allow for approximately half a day for operator training during start-up testing. The training shall include:
- .1 On-Site, Hands-On training: presentation by the instructor with Canada's operators following and physically performing and learning maintenance operations:
  - .1 Operation Overview.
  - .2 Safety and lockouts.
  - .3 Cleaning, maintenance inspection and checks.
  - .4 Replacement of frequently changed components.
  - .5 Responding to alarm conditions.

3.7 NON-ACTIVE FUNCTIONAL TESTING

.1 In general, work includes:
- .1 Plant operation by Contractor.
- .2 On-site, hands-on training.

.2 Provide services of manufacturer's representative for a minimum of 8 hours (1 day per week, 8 continuous hours per day at site) to complete specified tasks.

.3 Non-active functional testing is part of plant wide commissioning to demonstrate complete water treatment system functional operation. Non-active functional testing will be performed using clean water without introduction of active influent. For clean water requirements, refer to the Commissioning Plan.

.4 Plant operation by Contractor:
- .1 Manufacturer's representative shall operate packaged system and related ancillary systems as applicable. Provide all services required for complete control, monitoring, tuning of the packaged system.
- .2 Canada's operators will observe events, but they will not be an active participant or responsible for the operation until the successful completion of the non-active functional testing by Contractor.
- .3 Respond to Canada's operators technical inquires related to package system operation and maintenance during non-active functional testing.
- .4 Allow for minimum of half a day for scheduled operator training by

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.4 Plant operation by Contractor:(Cont'd)

.4 (Cont'd)

manufacturer's representative. The training shall focus on:

.1 Packaged system operation; controls, monitoring, alarms.

.2 Troubleshooting; simulate alarms and warnings, explain causes, and give details on corrective measures and procedures.

.5 The non-active functional testing is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.

.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.

.2 The additional time will be 1 additional day of testing per day lost due malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to Departmental Representative, covering the observations from the non-active functional

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.9 (Cont'd) test, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the next stage of testing.

.10 If, in the opinion of Departmental Representative, the non-active performance test is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the readiness of the system for non-active operation training.

3.8 NON-ACTIVE OPERATION TRAINING

.1 In general, work includes:
- .1 Plant operation by Canada's operators with Contractor supervision.
- .2 Support training.

.2 Provide services of manufacturer's representative for a minimum of 8 hours (1 day per week, 8 continuous hours per day at site) to complete specified tasks.

.3 Non-active operation training will follow completion of non-active functional testing and it will be part of plant wide commissioning to provide no-risk training for Canada's operators and to prove complete water treatment system functional operation. Non-active operation training will be performed using clean water only.

.4 Plant operation by Canada's operators with Contractor supervision.
- .1 Manufacturer's representative shall provide support and guidance to Canada's operators as required to operate packaged system.
- .2 Respond to Canada's operators technical inquires related to packaged system operation and maintenance during non-active operation training.

.5 The non-active operation training is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not

3.8 NON-ACTIVE OPERATION TRAINING (Cont'd)

.6 (Cont'd)
function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, shutdowns related to Canada's operators' actions will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to the Departmental Representative, covering the observations from the non-active operating training, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the active performance testing.

.10 If, in the opinion of Departmental Representative, the non-active operation training is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system and readiness for Active Performance Testing.

3.9 ACTIVE PERFORMANCE TESTING

.1 After completion and approval of non-active functional testing and operation training, performance testing using active influent shall be performed. Performance testing shall occur at such time as the entire water treatment plant as a whole is complete.

.2 Active performance testing will be performed by Canada's operators due to the regulatory requirements.

.3 Task includes:
- .1 Plant operation by Canada's operators.
- .2 Performance testing and support by manufacturer's representative.

.4 Provide services of manufacturer's representative for 2 working days of the active performance test, for a minimum of 8 hours per day with 24 hours "on call" support. The manufacturer's representative shall respond to all communication (i.e. phone, fax, or e-mail) within 24 hours throughout the remainder of the active performance test.

.5 Manufacturer's representative services during on-site activities.
- .1 Assistance during performance testing (fine tuning, adjustment of the operational settings, etc.).
- .2 Respond to Canada's operators technical inquires related to packaged system operation.
- .3 Demonstrate to Departmental Representative that the packaged system performance during the active performance testing meets or exceeds the minimum performance requirements defined in this section.

.6 Refer to the Commissioning Plan for details on the active performance testing procedure.

.7 If malfunctions occur during the operation, perform and complete corrective action and bring packaged system to operational condition. Provide corrective services within maximum of 5 working days with no additional cost to Canada.
- .1 If malfunction prevents system from operation, additional operation time will be required.
- .2 The additional time will be time lost plus 1 additional day of testing.

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.8 Sampling and Analysis:
- .1 All analyses to be performed by an independent laboratory accredited by the Canadian Association for Environmental Analytical Laboratories and approved by the Canadian Nuclear Safety Commission.
- .2 Canada's operators and/or Departmental Representative will conduct sampling and monitoring activities during active performance testing.
- .3 Departmental Representative will summarize the collected data at the conclusion of the test period and submit the results to Canada.
- .4 Departmental Representative shall make all operating and performance monitoring data for the packaged system available to the manufacturer's representative upon request, in addition to the analytical reports for any samples that were collected to monitor the performance of the packaged system.
- .5 Refer to following paragraph for performance testing details.

.9 Acceptance of the packaged system:
- .1 Active performance testing will be deemed complete based on functional operation and process performance results.
- .2 The functional operation is deemed acceptable if no major malfunctions occur during the operation.
  - .1 Major malfunction is defined as equipment failure when a component of the packaged system does not function at all, and puts the packaged system out of service. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.
  - .2 A maximum of 2 attempts to successfully complete the active performance testing are allowed for the packaged system.
  - .3 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process.
- .3 Any interruption of active performance testing for reasons beyond the control of Contractor and manufacturer will not affect

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.9 Acceptance of the packaged system:(Cont'd)

.3 (Cont'd) the continuity of the active performance testing.

.4 Upon receiving the commissioning forms completed by manufacturer's representative and operators throughout the active performance testing and the verified analytical reports from the accredited laboratory, Departmental Representative shall prepare a Commissioning Report.

.5 If, in the opinion of Departmental Representative, the active performance testing is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system.

.6 If, in the opinion of Departmental Representative, a packaged system fails to meet the performance requirements specified herein following the conclusion of the active performance testing, Canada will notify Contractor in writing of the unacceptable performance.

.7 In the event of unacceptable performance, perform any supplemental testing, analysis, equipment adjustments, modifications, changes or additions and request a retest of the unacceptable system at no additional cost to Canada.

.8 If the active performance testing re-test is not successful, Canada at its sole discretion may reject the equipment and require replacement.

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Supply and delivery of 3 slurry dryer systems.

.2 Calibration, certification, and commissioning of the supplied equipment.

.3 All equipment furnished under this specification section shall be new.

1.2 REFERENCES

.1 American Bearing Manufacturers Association (ABMA).

.2 American National Standards Institute (ANSI):
- .1 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

.3 Canadian Standards Association (CSA).

.4 National Electrical Manufacturers Association (NEMA).

.5 Ontario Ministry of Labour (OML):
- .1 Occupational Health and Safety Act R.S.O. 1990, Chapter O.1 (OHSA).

.6 Underwriters' Laboratories of Canada (ULC).

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Progress Submittals:
- .1 Shop Drawings: indicate:
  - .1 Overall dimensions of equipment.
  - .2 Fixing support dimensions.
  - .3 Equipment layout.
  - .4 Arrangement and dimensions of accessories.
  - .5 Process and instrumentation.
  - .6 Dimension drawing and foundation loading data.
  - .7 Arrangement and dimensions of accessories.
  - .8 Diagram of connections.
  - .9 Installation data.
  - .10 Electrical and control system in accordance with Section 40 90 00.

1.3 SUBMITTALS (Cont'd)

.2 Progress Submittals:(Cont'd)
- .2 Product Data: include:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations, and trouble shooting protocol.
  - .2 Product transportation, storage, handling, and detailed installation requirements.
  - .3 Equipment Information: includes heating element details, controls, options, brochure cuts indicating dimensions and weights, number of installations in North America, and location from where system services and technical support would be provided.
  - .4 A list of all supplied equipment including the length and material of construction of supplied piping/tubing as part of the hookup requirements.
  - .5 A system schematic and process and control narrative.
- .3 Test Reports:
  - .1 FAT Test Reports:
    - .1 Submit all welding examinations, leak test and controls verification report.

.3 Closeout Submittals:
- .1 Provide closeout submittals in accordance with Section 01 78 00.
- .2 Warranties: completed original warranty forms filled out in Canada's name and registered with manufacturer.

1.4 QUALITY ASSURANCE AND CONTROL

.1 Include prerequisites, standards, limitations, and criteria which established an overall level of quality for products and workmanship under this specification section.

.2 If required, make reference to national standards. State class and revision.

.3 Only quality workmanship will be accepted, not only in regard to durability, efficiency and safety, but also in regard to neatness of detail. Work done under Contract shall present a neat and clean appearance when completed, to the satisfaction of Departmental Representative. Any unsatisfactory workmanship will be replaced at

1.4 QUALITY ASSURANCE AND CONTROL (Cont'd)

.3 (Cont'd) no extra cost. Conform to the best practices applicable to this type of work.

.4 Canada reserves the right and may inspect the equipment during all stages of production, construction and tests whether at the supplier factory or that of other parties supplying materials or parts, which will be used in the construction of the unit.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Provide all requirements for transporting, handling, storing, and protecting products.

.2 Protect system components, nozzles and mountings against damage during transportation.

1.6 AMBIENT CONDITIONS

.1 Slurry dryers shall be located indoors, in the residuals handling area along with the local operator panel. The anticipated room temperature is 10 to 40°C, 0 to 95% humidity.

1.7 WARRANTY

.1 Manufacturer shall warrant against any defects in design, material or workmanship of the slurry dryer systems and framework. This warranty shall extend for a period of 12 months from the date of successful completion of active performance testing.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESCRIPTION

.1 The volumetric flow rate of the reverse osmosis brine stream or the supernatant of the brine treatment process shall be reduced to a highly concentrated slurry by a mechanical vapour compression evaporator. The slurry from the evaporator system shall be stored in a slurry tank with a volume of approximately 9.1 m^3, which shall then be pumped to the slurry dryers by the slurry transfer pumps. Each dryer shall discharged dried slurry to a storage sack for disposal. Exhaust from the dryer vessels shall be transferred to a scrubber for additional treatment prior to discharge to atmosphere.

2.1 EQUIPMENT DESCRIPTION (Cont'd)

(Cont'd)

.2 The slurry dryers describe herein shall use electricity as the source to heat the dryer contents. Supply the following equipment as specified herein and as indicated.

Equipment Tag	Equipment Description	Evaporation Capacity
BBF-09250	Slurry Dryer	3 m^3/day
BBF-09350	Slurry Dryer	3 m^3/day
BBF-09450	Slurry Dryer	3 m^3/day

2.2 DESIGN CRITERIA

.1 General: supply, testing, and performance of all supplied equipment shall conform to all standards referred to herein.

.2 Space Limitations: all equipment must fit in the allotted space for the drying equipment. The approximate footprint for each dryer unit shall be 4.8 m in length by 2.2 m in width by 1.5 m in height.

.3 Capacity: slurry dryer vessel shall have a holding capacity of greater than 0.56 m^3.

2.3 PERFORMANCE CRITERIA

.1 Capable of processing 3 m^3/day per unit.

.2 Equipment manufacturer shall provide a process guarantee that the slurry dryers can achieve to 95% DS in the dried slurry.

2.4 REGULATORY REQUIREMENTS

.1 In accordance with Section 01 91 13.

.2 Conform to national or local regulatory requirements as required (i.e. TSSA for all pressure vessels, CSA/CGA for gas piping, ESA, etc.).

2.5 PROCESS COMPONENTS

.1 Dryer Vessel:
  .1 Shall have an equivalent minimum internal dryer area of 0.9 m in diameter by 4 m in length.

.2 Heating Elements:
  .1 Provide a drying temperature of up to 120°C.

2.5 PROCESS COMPONENTS (Cont'd)

.2 Heating Elements:(Cont'd)
- .2 Heating shall be provided by electric heaters.
- .3 Multiple heating zones with adjustable temperature controls.
- .4 Two of four heating zones shall have independent thermal over temperature protection.

.3 Internal Components:
- .1 Materials of Construction:
  - .1 Parts that are heated and in contact with the slurry are to be super stainless steel alloy AL 6XN (heating panel, end plates, etc).
  - .2 All other internal parts (mixing screws, drive shafts, continuous mixer) are to be Type 316 stainless steel.
- .2 Bearings:
  - .1 Main bearings shall be spherical or cylindrical roller bearings.
  - .2 Main bearings shall be grease lubricated.
  - .3 Design main bearings for ABFMA L-10 rating life of at least 100,000 hours.
  - .4 Tub penetrations to have air purged seals.

.4 Cover:
- .1 Cover shall be actuated to allow remote opening and closing of the rolling cover. Shall include a provision for manual override.
- .2 Air cylinder shall be actuated with serpentine stainless steel cable drive for positive alignment.
- .3 Nesting cover design to reduce footprint.
- .4 Shall have adjustable speed control for smooth operation.

.5 Process Connections:
- .1 Slurry Inlet: 50 mm.
- .2 CIP Solution Inlet: 50 mm.
- .3 CIP Solution Return: 50 mm.
- .4 Compressed Air: 6 mm.
- .5 Drying Air Inlet: 250 mm.
- .6 Drying Air Exhaust: two 150 mm connections.

.6 Discharge Door:
- .1 Discharge door shall be a positive seal closure with toggle mock mechanism operated by a pneumatic cylinder.

2.5 PROCESS COMPONENTS (Cont'd)

.6 Discharge Door:(Cont'd)
.2 Provide air control valve with open/close/neutral positions.
.3 Shall allow remote operation of the discharge door.

.7 Discharge Chute:
.1 Clamping arrangement on discharge chute shall facilitate clamping of plastic liner of disposal 0.75 m^3 woven polyethylene skid-mounted Super-Sac container to discharge chute for positive seal against escaping dust. Plastic liner is tightly sealed in position by spring ring clamps using a strap with toggle ratchet for operator ease.

2.6 ELECTRICAL AND CONTROL SYSTEM

.1 Refer to Section 40 90 00.

.2 Control panel enclosure shall be rated NEMA 12, Allen Bradley PLC components with provision for communication to central control via Ethernet communication port.

2.7 INSTRUMENTATION

.1 Instruments and sensors to be CSA or ULC certified. Where there is no alternative to supplying equipment that is not certified, obtain special approval from the Electrical Safety Authority. Manufacturers and approval labels must be visible and legible after equipment is installed.

.2 Provide instrumentation as recommended by the manufacturer to measure items directly related to packaged system performance, and required for operation of fully automated system.

2.8 ACCESSORIES

.1 Provide miscellaneous devices and accessories as indicated and necessary for fully operational system.

.2 Compressed air system shall include as a minimum: main and individual isolation valves, safety lock out valves, filter(s), mandatory pressure regulator(s), pressure gauge, and low (or high if required) pressure switch(s). Air compressor and dryer shall be provided by others.

2.8 ACCESSORIES (Cont'd)

.3 Cleaning, water lubrication, or similar system shall include as minimum: main and individual isolation/bypass valves, solenoid valves, pressure regulator(s), pressure gauge, and low (or high if required) pressure switch(s).

.4 Equipment Identification Plate: a 16 gauge 316 L stainless steel identification plate shall be securely mounted on the dryers with stainless steel pan head screws. The identification plate shall be in a readily visible location. The plate shall bear the die-stamped equipment identification number indicated in this section and as shown on the P&ID Drawings in 12 mm high lettering.

.5 Lifting Lugs or alternative engineered lifting points for rigging provisions: equipment and removable equipment components weighting over 45 kg shall be provided with suitable lifting lugs to permit easy handling.

2.9 SPARE PARTS

.1 Manufacturer shall include the following spare parts:

.1 Include any other spare parts/special tools required.

2.10 ACCEPTABLE COMPONENTS

.1 Major mechanical components (motors, etc.) shall be items with 14-day parts or unit replacement available in Canada.

.2 All other mechanical, control, and electrical components shall be standard stock items with 7-day parts or unit replacement available in Canada.

.3 Any special delivery units or over 14 days delivery shall be listed as an exception.

PART 3 - EXECUTION

3.1 GENERAL

.1 Design and construct complete packaged system in accordance with Contract Documents. Conform to the best practices applicable to this type of systems.

.2 Provide submittals as required and specified herein.

.3 Canada and Departmental Representative reserves the right and may inspect packaged system at any time.

.4 Canada and Departmental Representative will be present for the inspections, testing, training, etc. that are generally referred to as start-up and commissioning activities.

.5 Inspection, start-up, and commissioning activities must be completed in specified sequence with completion and approval of the earlier activities prior to commencement of the next scheduled activity. Commissioning guidelines are set forth in Section 01 91 13, which are to be followed for the commissioning plan of the packaged systems. The commissioning activities and schedule specific to the Water Treatment Plant are addressed in the Commissioning Plan.

.6 Coordination of the detailed start-up schedule with the completion of related processes and ancillary systems is the sole responsibility of the manufacturer and Contractor, refer to the Commissioning Plan for details.

.7 Contractor and manufacturer shall prepare and submit a detailed procedure and schedule for each specified task under this specification section to Departmental Representative for approval.

.8 The manufacturer understands that the schedule for carrying out the inspections, testing, training, etc. depends on the completion of related processes and ancillary systems, overall construction progress, and the availability of treatment chemicals, power, control, and utility systems.

3.1 GENERAL (Cont'd)

.9 Unless otherwise specified, or listed as a part of supplies under Part 2 - PRODUCTS, Canada will bear the cost for supply of treatment chemicals and utilities (electric power, water, compressed air). However, the Contractor is to provide the first filling for each chemical. Refer to Section 46 21 00, paragraph 1.1.10. Contractor to provide unloading and handling of all treatment chemicals prior to and during start-up and non-active commissioning tests.

3.2 MANUFACTURER'S SERVICES - GENERAL

.1 Provide manufacturer's representative to perform the services herein specified. Manufacturer's representative shall be a factory trained qualified technical personnel capable of completing specified tasks and other necessary activities required to start-up and commission packaged system.

.2 Inspect, operate, test and adjust the equipment. Provide training.

.3 The packaged system manufacturer shall specify the number of visits to the site that are required but under no circumstances is this to be less than the minimum number of days herein specified.

.1 If manufacturer's normal start up and commissioning on-site support services requires greater than the number of working days listed herein, manufacturer shall make reference to this paragraph in the bid and quote required number of manufacturer recommended working days.

.2 The date and duration of each trip will be arranged by Contractor and subject to approval by Departmental Representative.

.4 State in bid the total price (including all travel expenses: accommodation, meals, transportation, travel time, etc.) of providing the specified manufacturer's field services. As minimum, a manufacturer's representative shall be present at site for the specified activities.

.5 The time indicated under this section is for services required for complete work listed under this specification unless specified otherwise.

.6 Indicate per diem cost (including all travel expenses as listed above) for additional days on site for manufacturer's representative.

3.3 FACTORY ACCEPTANCE TESTS (FAT)

.1 The tests include factory internal checks followed by a witnessed Factory Acceptance Test.

.2 Packaged system shall be factory tested for compliance with the construction and functional requirements specified herein, and certification of the results of these tests shall be submitted to Departmental Representative.
- .1 Complete assembly checklist and record product information for individual system components.
- .2 Complete factory standard tests and quality system procedures.
- .3 For all systems that are not pressure vessels, test components for water tightness at system maximum allowable working pressure.
- .4 Provide non-destructive testing of tank welds (i.e. X-ray, dye penetrant, ultrasonic, other) in accordance with applicable specifications (ASME Section VIII Division 1, or other).
- .5 Verify operation of the electrical, instrumentation, and control system in accordance with related electrical specifications.

.3 Factory acceptance test:
- .1 Provide overview of the packaged system:
  - .1 Present system design basis, implementation, related drawings and design documents.
  - .2 Describe components, function, and system assembly.
  - .3 Present operation of the control system.
  - .4 Present preliminary (first draft) of the Operation and Maintenance Manual.
- .2 Provide facilities, utilities (electric power, water, compressed air, etc.), manufacturer's representative, and related services for the test. Provide temporary setup complete with required appurtenances to complete Factory Acceptance Test.

.4 Include FAT supporting documentation and sign-off sheets as attachments to the Certificate of Completion, and submit to Departmental Representative prior to shipping.

.5 Upon satisfactory completion of factory verification checks, prepare packaged system for shipping and storage in accordance with manufacturer's standard.

3.4 INSTALLATION AND CONSTRUCTION SUPPORT

.1 Prior to commencement of installation, review all related work (mechanical, electrical, structural, etc.) to ensure that the equipment can be correctly installed. Immediately advise Departmental Representative in writing of any deficiencies or deviations from the installation instructions, during the installation of the packaged system.

.2 A manufacturer's representative shall instruct Contractor on preparation, rigging, assembly, as well as installation procedures and details.

.3 Install equipment in accordance with manufacturer's written instructions.

.4 Provide the services of manufacturer's representative(s) to provide instructions and support installation and construction support.

.5 Protect equipment and finishes from construction work by leaving equipment in manufacturer transport packaging as long as possible. Isolate the equipment from piping systems until such times as the piping systems are completed, pressure tested and cleaned to prevent foreign debris from entering into the equipment.

.6 Provide services of manufacturer's representative for a minimum of 3 non-consecutive days (a minimum of 6 hours per day at site) to support and oversee installation work.

3.5 INSTALLATION ACCEPTANCE INSPECTION

.1 Upon completion of equipment installation, provide services of manufacturer's representative to:

- .1 Conduct final installation inspection and sign-off.
- .2 Energize equipment.
- .3 Perform "Dry Run".
- .4 Verify that packaged system is ready for start-up testing.
- .5 Provide classroom and on-site hands-off training sessions.

.2 Manufacturer to specify the number of personnel, the number of visits, and time at site that is required to complete this task; include time for training as specified.

3.5 INSTALLATION ACCEPTANCE INSPECTION (Cont'd)

.3 The installation inspection shall ensure that the complete packaged system was correctly installed. In general, but not limited to, the following items shall be inspected:
- .1 Soundness (damaged parts or components).
- .2 Correctness of setting, alignment and relative arrangement of various parts.
- .3 Completeness on all installation process connections.
- .4 Adequacy of lubricants and equipment related liquids.
- .5 Adequacy of energy sources.
- .6 Completeness on all installation wiring connections.
- .7 Check that the equipment has been installed consistent with installation instructions.

.4 Upon completion of installation inspection:
- .1 Verify the safety and readiness of the process, mechanical, electrical and control system prior to energization.
- .2 Energize equipment (electric power, water, compressed air, supply or exhaust air, etc.).
- .3 Ensure operation of all components and devices.
- .4 Verify control system setup. Adjust settings.
- .5 Bring equipment into ready to accept process streams operating condition.
- .6 As far as possible or practicable perform "Dry Run". Please notice that actual process or test streams (liquids, slurry, sludge, etc.) will not be introduced into packaged system at this stage.
- .7 Verify operation of associated equipment.
- .8 Ensure that equipment has received all necessary regulatory inspections and certification.

.5 Immediately correct deficiencies revealed during installation acceptance checks. Advise Departmental Representative of any deficiencies or deviations from the installation instructions.

.6 Submit a signed and dated report to Departmental Representative, covering the inspection findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed and confirming that the equipment is satisfactorily installed,

3.5 INSTALLATION ACCEPTANCE INSPECTION (Cont'd)

.6 (Cont'd)
in proper working order, and ready for the next phase of testing.

.7 Provide manufacturer's representative training services for 2 days for operator training during or immediately following installation acceptance inspection. The operation and maintenance training shall include:
- .1 Classroom training (a maximum of 3 hours) with overview of equipment operation, technology, and principles. Provide presentation, study, and training materials. Canada will provide training location.
- .2 On-Site, Hands-Off training (a maximum of 3 hours) with presentation by the instructor:
  - .1 Describe components, function, and system assembly.
  - .2 Safety and lockouts.
  - .3 Overview of control system.

3.6 STARTUP TESTING

.1 In general, work include:
- .1 Introduce clean water into the equipment.
- .2 Bring the complete packaged system online.
- .3 Perform "Wet Run".
- .4 Demonstrate that packaged system is suitable for continuous online operation.
- .5 Integrate with plant SCADA system.
- .6 Provide on-site hands-on training session.

.2 Manufacturer shall specify the number of personnel, number of visits, and time at the site that is required to complete this task; however time required shall not be less than 5 consecutive days (minimum of 8 hours per day at site) to complete specified activities.

.3 In general equipment operation shall include:
- .1 Bring packaged system into operating condition.
- .2 Ensure operation of equipment and devices.
- .3 Operate packaged system in different modes, perform multiple starts and stop sequences; adjust settings.
- .4 Simulation of failures and confirmation of alarm activation.
- .5 Operation of associated equipment.

3.6 STARTUP TESTING (Cont'd)

.4 Immediately correct deficiencies revealed during initial operation. Correct and adjust equipment operation.

.5 Allow for minimum of 1 day of time for integration with plant SCADA system to ensure that system operates as intended within the integrated water treatment plant process stream. This time shall be exclusively dedicated to:

.1 Plant system integrator for integration with SCADA.

.2 Other packaged system manufacturers and their respective systems.

.3 Allow for wiring modifications, field programming and data layout checks and modifications, "test-run", etc. to ensure the equipment control system performs as intended.

.4 Complete electrical, control, instrumentation, and software Site Acceptance Tests in accordance with Section 40 90 00.

.6 Complete SAT report and TAB report and submit signed copies to Departmental Representative for approval.

.7 Immediately address any deficiencies in site preparation or installation identified by the manufacturer representative during the start-up testing. Costs associated with correcting the documented deficiencies and the additional time for the manufacturer representative to complete the start-up testing will be borne by Contractor.

.8 The start-up testing is deemed complete if no malfunctions occur during testing with equipment running for minimum of 12 hours in total, and 1 continuous operation of not less then 4 hours. If malfunctions occur during the operation, perform and complete corrective action and restart the packaged system.

.9 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as

3.6 STARTUP TESTING (Cont'd)

.9 (Cont'd)
malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.10 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.11 Submit a signed and dated letter report to Departmental Representative, covering the start-up testing findings, including a list of items checked, problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is satisfactorily installed, in proper working order, and ready for a non-active functional testing.

.12 Allow for approximately half a day for operator training during start-up testing. The training shall include:
.1 On-Site, Hands-On training: presentation by the instructor with Canada's operators following and physically performing and learning maintenance operations:
.1 Operation Overview.
.2 Safety and lockouts.
.3 Cleaning, maintenance inspection and checks.
.4 Replacement of frequently changed components.
.5 Responding to alarm conditions.

3.7 NON-ACTIVE FUNCTIONAL TESTING

.1 In general, work includes:
.1 Plant operation by Contractor.
.2 On-site, hands-on training.

.2 Provide services of manufacturer's representative for a minimum of 40 hours (1 week, 5 days per week, 8 continuous hours per day at site) to complete specified tasks.

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.3 Non-active functional testing is part of plant wide commissioning to demonstrate complete water treatment system functional operation. Non-active functional testing will be performed using clean water without introduction of active influent. For clean water requirements, refer to the Commissioning Plan.

.4 Plant operation by Contractor:
- .1 Manufacturer's representative shall operate packaged system and related ancillary systems as applicable. Provide all services required for complete control, monitoring, tuning of the packaged system.
- .2 Canada's operators will observe events, but they will not be an active participant or responsible for the operation until the successful completion of the non-active functional testing by Contractor.
- .3 Respond to Canada's operators technical inquires related to package system operation and maintenance during non-active functional testing.
- .4 Allow for minimum of half a day for scheduled operator training by manufacturer's representative. The training shall focus on:
  - .1 Packaged system operation; controls, monitoring, alarms.
  - .2 Troubleshooting; simulate alarms and warnings, explain causes, and give details on corrective measures and procedures.

.5 The non-active functional testing is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, simulation of alarms during training, and related shutdowns will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other

3.7 NON-ACTIVE FUNCTIONAL TESTING (Cont'd)

.7 (Cont'd)
regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due malfunction(s). Provide additional on-site start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to Departmental Representative, covering the observations from the non-active functional test, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the next stage of testing.

.10 If, in the opinion of Departmental Representative, the non-active performance test is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the readiness of the system for non-active operation training.

3.8 NON-ACTIVE OPERATION TRAINING

.1 In general, work includes:
.1 Plant operation by Canada's operators with Contractor supervision.
.2 Support training.

.2 Provide services of manufacturer's representative for a minimum of 40 hours (1 week, 5 days per week, 8 continuous hours per day at site) to complete specified tasks.

.3 Non-active operation training will follow completion of non-active functional testing and it will be part of plant wide commissioning to provide no-risk training for Canada's operators

3.8 NON-ACTIVE OPERATION TRAINING (Cont'd)

.3 (Cont'd)
and to prove complete water treatment system functional operation. Non-active operation training will be performed using clean water only.

.4 Plant operation by Canada's operators with Contractor supervision.
.1 Manufacturer's representative shall provide support and guidance to Canada's operators as required to operate packaged system.
.2 Respond to Canada's operators technical inquires related to packaged system operation and maintenance during non-active operation training.

.5 The non-active operation training is deemed complete if no malfunctions occur for the duration specified in Section 01 91 13.

.6 Malfunction is defined as equipment failure when a component of the packaged system does not function according to specifications, does not function at all, or does not provide required functionality (either hardware or software). Shutdowns related to plant wide testing will not count as malfunction (unless system fails to respond to abnormal conditions). Similarly, shutdowns related to Canada's operators' actions will not count as malfunctions. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.7 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process provided that the activities are not required to address failure of mechanical components or failure to meet operational standards.

.8 If malfunctions occur during the operation, perform and complete corrective action and restart packaged system.
.1 If malfunction prevents system from operation for minimum of specified continuous hours per day, additional operation time will be required.
.2 The additional time will be 1 additional day of testing per day lost due to malfunction(s). Provide additional on-site

3.8 NON-ACTIVE OPERATION TRAINING (Cont'd)

.8 (Cont'd)
.2 (Cont'd)
start-up service at no additional cost to Canada.

.9 Submit a signed and dated letter report to Departmental Representative, covering the observations from the non-active operating training, including a list of operating problems encountered, corrective measures taken or to be addressed (if required) and confirming that the equipment is in proper working order and ready for the active performance testing.

.10 If, in the opinion of Departmental Representative, the non-active operation training is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system and readiness for Active Performance Testing.

3.9 ACTIVE PERFORMANCE TESTING

.1 After completion and approval of non-active functional testing and operation training, performance testing using active influent shall be performed. Performance testing shall occur at such time as the entire water treatment plant as a whole is complete.

.2 Active performance testing will be performed by Canada's operators due to the regulatory requirements.

.3 Task includes:
.1 Plant operation by Canada's operators.
.2 Performance testing and support by manufacturer's representative.

.4 Provide services of manufacturer's representative for 5 consecutive working days of the active performance test, for a minimum of 8 hours per day with 24 hours "on call" support. The manufacturer's representative shall respond to all communication (i.e. phone, fax, or e-mail) within 24 hours throughout the remainder of the active performance test.

.5 Manufacturer's representative services during on-site activities.
.1 Assistance during performance testing (fine tuning, adjustment of the operational settings, etc.).

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.5 (Cont'd)
.2 Respond to Canada's operators technical inquires related to packaged system operation.
.3 Demonstrate to Departmental Representative that the packaged system performance during the active performance testing meets or exceeds the minimum performance requirements defined in this section.

.6 Refer to the Commissioning Plan for details on the active performance testing procedure.

.7 If malfunctions occur during the operation, perform and complete corrective action and bring packaged system to operational condition. Provide corrective services within maximum of 5 working days with no additional cost.
.1 If malfunction prevents system from operation, additional operation time will be required.
.2 The additional time will be time lost plus 1 additional day of testing.

.8 Sampling and Analysis:
.1 All analyses to be performed by an independent laboratory accredited by the Canadian Association for Environmental Analytical Laboratories and approved by the Canadian Nuclear Safety Commission.
.2 Canada's operators and/or Departmental Representative will conduct sampling and monitoring activities during active performance testing.
.3 Departmental Representative will summarize the collected data at the conclusion of the test period and submit the results to Canada.
.4 Departmental Representative shall make all operating and performance monitoring data for the packaged system available to the manufacturer's representative upon request, in addition to the analytical reports for any samples that were collected to monitor the performance of the packaged system.
.5 Refer to following paragraph for performance testing details.

.9 Acceptance of the packaged system:
.1 Active performance testing will be deemed complete based on functional operation and process performance results.

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.9 Acceptance of the packaged system:(Cont'd)

.2 The functional operation is deemed acceptable if no major malfunctions occur during the operation.

.1 Major malfunction is defined as equipment failure when a component of the packaged system does not function at all, and puts the packaged system out of service. Classification of the malfunction event shall remain at sole discretion of Departmental Representative.

.2 A maximum of 2 attempts to successfully complete the active performance testing are allowed for the packaged system.

.3 If packaged system must be removed from service in order to perform a cleaning cycle or other regular maintenance, the cleaning or maintenance activities shall be considered part of the continuous operation of the process.

.3 Any interruption of active performance testing for reasons beyond the control of Contractor and manufacturer will not affect the continuity of the active performance testing.

.4 Upon receiving the commissioning forms completed by manufacturer's representative and operators throughout the active performance testing and the verified analytical reports from the accredited laboratory, Departmental Representative shall prepare a Commissioning Report.

.5 If, in the opinion of Departmental Representative, the active performance testing is successful and meet the requirements specified herein, Departmental Representative will recommend to Canada, by letter, the acceptance of the packaged system.

.6 If, in the opinion of Departmental Representative, a packaged system fails to meet the performance requirements specified herein following the conclusion of the active performance testing, Canada will notify Contractor in writing of the unacceptable performance.

.7 In the event of unacceptable performance, perform any supplemental testing, analysis, equipment adjustments, modifications, changes or additions and request a retest

3.9 ACTIVE PERFORMANCE TESTING (Cont'd)

.9 Acceptance of the packaged system:(Cont'd)

.7 (Cont'd)
of the unacceptable system at no additional cost to Canada.

.8 If the active performance testing re-test is not successful, Canada at its sole discretion may reject the equipment and require replacement.

END

PART 1 - GENERAL

1.1 GENERAL

.1 Hydrated lime solution is required for the chemical precipitation at pH 10 to 11 in the brine reaction tank.

.2 It is the responsibility of the contractor to assess and evaluate information provided, including specifications, drawings, design rationale and process control description, and pilot trial report to appropriately select, supply, and install the hydrated lime storage and solution preparation system including any ancillary equipment. Together with shop drawing submittal, the contractor shall provide appropriate justification (i.e. process calculation) for the selection/configuration basis.

1.2 WORK INCLUDED

.1 Design, supply, delivery, installation, testing, and commissioning of a complete self-contained hydrated lime bulk storage and gravity feed system including piping, local control panel, lighting, instrumentation, and appurtenances as specified herein and as shown on the Drawings.

.2 Components of the lime bulk storage and gravity feed system shall include, but are not limited to the following:

- .1 Storage silo for hydrated lime.
- .2 Bin vent filter.
- .3 Flow promotion equipment.
- .4 Knife gate valve.
- .5 Silo level detector, level and volume indicators.
- .6 Lime slurry tanks and mixers c/w tank level indicators.
- .7 Gravity lime slurry feed system.
- .8 Lime dilution system with service water and flow switch.
- .9 All associated piping, valves, and appurtenances.
- .10 Motor starters, remote I/O rack, system control panels, and truck fill panel.
- .11 All appurtenances not expressly specified in this section, but required for the proper installation and commissioning of the complete system.

1.2 WORK INCLUDED (Cont'd)

.3 Provide service water supply to the feed system including connection into nearest water main.

1.3 RELATED WORK

.1 All Divisions.

1.4 SUBMITTALS

.1 Shop drawings: Submit in accordance with Section 01 33 00.

.2 Submit shop drawings as follows:
.1 Detailed drawings of complete system
.2 Mechanical and electrical equipment details, including panels, breakers, etc.
.3 Equipment and material lists
.4 Detailed drawings of enclosure.

.3 Submit certified shop test results for the pumps.

.4 All calculations and related drawings shall be sealed by a Professional Engineer registered in the Province of Ontario.

.5 Submit installation manuals before shipment of any equipment.

.6 Submit operating and maintenance data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 STORAGE SILO

.1 Provide one (1) field-erected storage silo suitable for storing lime. The silo shall be of bolted/welded carbon steel construction and shall be fully skirted and self-supporting. The silo may be prefabricated off site.

.2 The silo shall be designed based on 14 days of storage capacity at average conditions. Silo to be of bolted/welded steel construction. Silo to be skirt supported with an integral equipment support platform.

.3 Interior of the silo shall be coated with two coats of factory-applied coating with 5 mils DFT (Dry Film Thickness). Exterior to be coated to a 3 mils DFT.

2.1 STORAGE SILO (Cont'd)

.4 The silo shall be complete with a 50 mm thick expanded polystyrene insulation and 0.76 mm thick zinc-coated, prepainted 5000 series cladding extended from the ground level to the eaves.

.5 The silo accessories to be included are as follows:

.1 One 500 mm dia. combination man-way with pressure/vacuum relief valve.

.2 OSHA approved galvanized steel vertical full height ladder with cage and rest platform as required.

.3 One perimeter galvanized steel WCB approved guard rail with 150 mm kick plate on silo roof deck.

.4 Bin vent filter, flow promotion equipment, knife gate valve, rotary valve, diverter valve, level detector, piping and valves as specified herein.

.5 One 810 mm x 2032 mm steel door at finished grade.

.6 Flanged roof openings for dust collector.

.6 The silo shall be designed to support the weight of the silo filled with lime at 80 pcf. The silo design shall also be designed for local seismic, snow, and wind loads.

2.2 PIPING

.1 Provide all piping and valves to ensure a complete, workable lime silo and gravity feed system.

.2 Exposed lime solution and water piping shall be heat-traced. Cleanout shall be provided to the lime solution piping at interval of not more than 3 m on straight run and at every bend.

2.3 BIN VENT FILTER

.1 One bin vent filter, complete with filter bags, access door, safety grating, birdscreen, fan, and weatherhood shall be supplied and installed on top of the silo. The filter unit shall prevent escape of dust accompanying the filling of silo and return the dust to the system without subsequent handling.

.2 The filter bag material shall be made of polyester felt complete with an integral fan to provide positive venting to the duct. The filter shall be capable of handling a typical unload.

2.3 BIN VENT FILTER (Cont'd)

.3 The filter unit shall have an automatic cycling air purge system to backwash the filter bags. The air purge system shall have a solid state timer assembly to adjust impulse frequency and duration.

2.4 FLOW PROMOTION EQUIPMENT

.1 Flow promotion is to be provided by a vibrating bin activator, complete with integral gyrator motor and 200 mm discharge. Flexible connections shall be provided to isolate the vibration downstream of the equipment. The unit shall be metalfab or approved alternative.

2.5 KNIFE GATE VALVE

.1 Provide one 200 mm knife gate valve with 304 stainless steel wetted parts for silo discharge. The valve shall be equipped with a handwheel actuator.

2.6 SILO LEVEL DETECTOR, LEVEL AND VOLUME INDICATORS

.1 One ultrasonic level detector shall be supplied and installed and shall be capable of monitoring the level of dry chemical on a continuous basis under all operating conditions.

.2 The level detector shall indicate silo level with volume and shall be complete with high and low level alarms and re-order point lights.

.3 Provide one (1) point level probe for back-up high level monitoring.

2.7 VOLUMETRIC FEEDER

.1 One (1) 25-11 helix-type feeder.

2.8 LIME SLURRY TANK

.1 One cylindrical lime slurry tank shall be provided. The tank shall have adequate capacity and shall be made of welded steel (5.0 mm minimum thickness for tank top, bottom, and shelf). All plates shall conform to CSA G40.21 300 W. The tank shape shall conform to CSA G40.21 300 W. All welding shall be in accordance with CSA W59-03.

2.8 LIME SLURRY TANK (Cont'd)

.2 Surface Preparation:
- .1 Interior - Clean and bare with no corrosion. Remove all scale, debris, and weld splatter.
- .2 Exterior - Minimum SSPC-SP-6 blast.

.3 Coating:
- .1 Interior - Clean and bare.
- .2 Exterior - One coat of epoxy primer with enamel finish coat.

.4 The tank shall be approximately 1.5 m high and shall be complete with:
- .1 Gear driven agitator with TEFC motor. The drive motor shall be suitable for 3/60/575 V service with 1800 rpm maximum speed. The mixer shall have 316 SS wetted parts, single impeller and motor mount.
- .2 Continuous level indication and control system with ultrasonic level detector. The detector shall operate the batch cycle.
- .3 Internal baffles to promote mixing.
- .4 Sloped bottom to drain and drain lines.
- .5 Flanged nozzles for pump suction.
- .6 Overflow.
- .7 Recirculation connection with manual pinch shut-off valve.
- .8 Hinged roof access man-way.

.5 Tank deck supports shall be sized for all loads imposed by the agitator. An allowance shall be inclined for the weight of maintenance personnel.

2.9 ELECTRIC MOTORS

.1 The motors shall be of sufficient capacity to operate the pumps specified.

2.10 COMPRESSED AIR SUPPLY (IF REQUIRED)

.1 One (1) air compressor complete with receiver and air dryer shall be provided to satisfy all air requirements for the lime system.

.2 The compressed air system shall be a two-stage stationary, vertical tank-mounted compressor and shall be complete with a tank, aftercooler, refrigerated dryer, and auto drain valve.

2.11 MISCELLANEOUS

.1 Silo shall also include the following:
- .1 Silo enclosure interior lighting
- .2 Exhaust fans and louvres
- .3 One (1) dual convenience outlet (115 V)

.2 Concrete foundations shall conform to the requirements of the National Building Code of Canada, 2010.

.3 Slurry tank and feed pumps shall have a stainless steel or concrete containment. The containment shall have a volume of not less than 1.5 time the volume of the slurry tank.

.4 Shower and eyewash for personnel protection.

.5 Enclosure heater.

.6 Ventilation system.

.7 Package lime storage and feed system shall have a main panel (600 volt, 3 ph) sized to suit all electrical codes, complete with main circuit breaker. A dry type transformer and a 120 volt panel shall also be provided for 120 volt motors, controls, lighting, and receptacles. Enclosures for panels and transformers shall be CEC Type 1 for indoors and CEC Type 3R for outdoors. Panels shall be complete with typed panel schedules and lamacoid labels for panel door.

2.12 TRUCK FILL PANEL

.1 EEMAC 4X weatherproof panel complete with power switch, bin vent filter on/off switch, light, and silo high level alarm for the silo.

2.13 SYSTEM CONTROL PANELS

.1 Devices and instrumentation in Vendor Packages to be supplied, installed and wired by Vendor Package Supplier unless otherwise stated.

.2 Lime system shall have complete EEMAC 4X control panels to provide operating logic for lime system. Area control panel shall have lamicoid nameplates illustrating general arrangement of lime system complete with switches and indicating lights. Main disconnect, transformer, and fuses shall be included in the panel. All electrical and instrumentation devices shall be CSA approved and labelled.

2.13 SYSTEM CONTROL PANELS (Cont'd)

.3 Provide isolated dry contacts rated at 5A, 120 V AC for the following minimum conditions, as well as signals shown on P&ID drawings and other Alarm and Status signals available from the Vendor Package:

.1 1 Remote Status Selected - indication that LOCAL/OFF/REMOTE selector switch is in REMOTE position

.2 Running Status - indication that the equipment is operating

.3 Emergency Stop Status - indication that emergency stop pushbutton is depressed

.4 General Alarm - indication that any one of the equipment alarm conditions is in alarm state

.4 Specific control shall include:

Lime Storage Silo	- High level alarm and light - Re-order point light - Low level alarm and light
Lime Bottom	- Hand/Off/Auto
Chemical Feeder	- Hand/Off/Auto and light - Alarm for feeder flooding - Totalizing counter - Belt speed read-out - Off-feed alarm
Tank Agitators	- On/Off and light
Slurry Tank	- Low-low level alarm and light - High-high level alarm and light
Bin Vent Filter	- On/Off and Light
Slaker	- Hand/Off/Auto

.5 Interior Lighting shall be provided. A minimum of 3 x 150 watt metal Halide lights per level in the skirt shall be provided.

.6 Circuit breaker type combination motor starters shall be included.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

.1 The periods shall be sufficient to supervise the installation, testing, commissioning, and training of the lime storage and feed system. Allow for a minimum of 5 full days on site.

3.2 INSTALLATION

.1 Ensure that the system is installed as required to provide satisfactory service.

.2 Fulfill the requirements for a successful installation as documented by Forms 201 and 202.

3.3 TESTING AND COMMISSIONING

.1 Ensure that the system, including all sub-systems and component parts, operates as intended.

.2 Attend during commissioning of the lime storage and feed system to ensure that each pump functions as intended in the process system.

.3 Fulfill the requirements for a successful testing of the equipment as documented by Form 203.

.4 For all instruments, submit completed Calibration forms and Instrument Installation Checklist forms in Section 01 91 33.

3.4 OPERATOR TRAINING

.1 The Contractor shall allow for a minimum of one full day for operator training. Scheduling of training is to be arranged with the Departmental Representative.

.2 Training will be by the Supplier's Representative and will include maintenance procedures, troubleshooting, and repair procedures for all electrical and mechanical components.

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the Owner's personnel in the proper operation and maintenance of the equipment as documented by Form T1.

END