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PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Section 03 10 00: Concrete Formwork and Accessories.
- .2 Section 03 20 00: Concrete Reinforcing.

1.2 REFERENCES

- .1 Abbreviations and Acronyms:
 - .1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
 - .1 Type GU or GUb - General use cement.
 - .2 Type MS or MSb - Moderate sulphate-resistant cement.
 - .3 Type MH or MHb - Moderate heat of hydration cement.
 - .4 Type HE or Heb - High early-strength cement.
 - .5 Type LH or LHb - Low heat of hydration cement.
 - .6 Type HS or HSb - High sulphate-resistant cement.
 - .2 Fly ash:
 - .1 Type F - with CaO content less than 8%.
 - .2 Type CI - with CaO content ranging from 8 to 20%.
 - .3 Type CH - with CaO greater than 20%.
 - .3 GGBFS - Ground, granulated blast-furnace slag.
 - .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C494/C494M-11, Standard Specification for Chemical Admixtures for Concrete.
 - .4 ASTM C1017/C1017M-07, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .5 ASTM D1751-04(2008), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
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1.2 REFERENCES
(Cont'd)

.2 Reference Standards:(Cont'd)

.1 ASTM International:(Cont'd)

- .6 ASTM C1059/C1059M-99(2008), Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- .7 ASTM D6690-07, Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
- .8 ASTM D1752-04a(2008), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .9 ASTM 0638-10, Standard Test Method for Tensile Properties of Plastics.
- .10 ASTM D412-06, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension.
- .11 ASTM D746-07, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- .12 ASTM D747-10, Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
- .13 ASTM F593-02(2008)e1, Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.

.2 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
- .2 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

.3 CSA International:

- .1 CSA A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .2 CSA A283-06(R2011), Qualification Code for Concrete Testing Laboratories.
- .3 CSA A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
- .4 CAN/CSA-G30.18-09: Carbon Steel Bars for Concrete Reinforcement.

1.3 ADMINISTRATIVE .1
REQUIREMENTS

- Pre-installation Meetings: convene pre-installation meeting two weeks prior to beginning concrete works.
- .1 Ensure key personnel, site supervisor, Departmental Representative speciality contractor - finishing, forming, concrete producer, and testing laboratories attend.
 - .1 Verify project requirements.

1.4 ACTION AND .1
INFORMATIONAL
SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 At least 4 weeks prior to beginning Work, provide Departmental Representative with samples of materials proposed for use as follows:
 - .1 1 m length of each type of joint filler.
 - .2 1 m length of each type of waterstops.
- .3 Certificates:
 - .1 A minimum of 8 weeks prior to placement of concrete, submit to the Departmental Representative manufacturer's test data and certification by the concrete producer with material samples verified by a qualified independent inspection and testing laboratory that the following materials will meet the specified requirements of this Contract.
 - .1 Portland cement.
 - .2 Blended hydraulic cement.
 - .3 Supplementary cementing materials.
 - .4 Admixtures.
 - .5 Aggregates.
 - .2 Submit certification that plant, equipment, and materials to be used in concrete Work comply with requirements of CAN/CSA A23.1/A23.2, most recent edition.
 - .3 Submit certification that Ready Mix concrete producer has current qualification of Ready Mix Concrete Association of Ontario (RMCAO) Special Seal of Quality.
 - .4 Submit test results and certification demonstrating that aggregates will not, nor have the potential to, react with cement to result in deleterious expansion in the concrete. Ensure these tests are current and represent the aggregates being supplied.
 - .5 Submit test results and certification that deleterious substances in aggregate are within limits specified in CSA A23.1/A23.2, Table 12 Limits for Deleterious Substances

1.4 ACTION AND
INFORMATIONAL
SUBMITTALS
(Cont'd)

- .3 Certificates:(Cont'd)
 - .5 (Cont'd)
and Physical Properties of Aggregates.
Ensure these tests are current and
represent the aggregates being supplied.
- .4 Reports:
 - .1 Submit for the Departmental Representative
review the quality control plans which
describe the material, equipment and
procedures to be used for the following
activities.
 - .1 Uniform and consistent concrete
finishing.
 - .2 Cold weather protection.
 - .3 Hot weather protection.
 - .4 Concrete curing.
 - .5 Concrete placing.
 - .2 Mix design:
 - .1 Submit performance based mix design 8
weeks prior to placement of concrete
using RMCAO Mix Design Submission Form
or equivalent acceptable to the
Departmental Representative.
 - .2 Alkali aggregate reactivity problems
may occur under certain circumstances.
Ensure mix design is adjusted suitably
to prevent such problems.
 - .3 Do not place concrete before
performance based mix designs have
been reviewed by the Departmental
Representative.
 - .4 Submit mix design for patching
material to the Departmental
Representative for written acceptance.

1.5 QUALITY
ASSURANCE

- .1 Quality Assurance: in accordance with Section
01 45 00.
- .2 Provide Departmental Representative, minimum 8
weeks prior to starting concrete work, with
valid and recognized certificate from plant
delivering concrete.
 - .1 Provide test data and certification by
qualified independent inspection and
testing laboratory that materials and mix
designs used in concrete mixture will meet
specified requirements.
- .3 Minimum 8 weeks prior to starting concrete
work, provide proposed quality control

1.5 QUALITY
ASSURANCE
(Cont'd)

- .3 (Cont'd)
procedures for review by Departmental Representative on following items:
 - .1 Falsework erection.
 - .2 Hot weather concrete.
 - .3 Cold weather concrete.
 - .4 Curing.
 - .5 Finishes.
 - .6 Formwork removal.
 - .7 Joints.
- .4 Quality Control Plan: provide written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.
- .5 Manufacturer's qualifications:
 - .1 Ready mix concrete supplier: Member in good standing of Ready Mix Concrete Association of Ontario (RMCAO). Batching plant facilities are required to maintain RMCAO Special Seal of Quality.
 - .2 Batching and delivery facilities: Facilities capable of producing minimum of 75 m3/h, conform to requirements of CSA A23.1/A23.2.
- .6 Tolerances:
 - .1 Make concrete in place plumb, level and true. Have maximum variations (non cumulative) conform to CSA A23.1/A23.2, unless noted otherwise.
 - .2 Do not construe variation permitted by the Departmental Representative in one part of construction or in one Section of Specifications as permitting violation of more stringent requirements for other part of construction, or in other Specification Sections.
- .7 Inspection and tests:
 - .1 Materials: CSA A23.1/A23.2; Inspected and tested for conformance to requirements of this standard and to Specifications by the Departmental Representative.
 - .2 Tests will be made in accordance with CSA A23.1/A23.2.
 - .3 Cooperate with and assist the Departmental Representative during inspections and tests.
 - .4 Remove defective materials and completed work which fails tests and replace as

1.5 QUALITY
ASSURANCE
(Cont'd)

- .7 Inspection and tests:(Cont'd)
 - .4 (Cont'd)
directed by the Departmental Representative.
 - .5 Inspection or testing by the Departmental Representative will not augment or replace Contractor's quality control nor relieve them of their contractual responsibility.
- .8 Defective concrete:
 - .1 Strength acceptance criteria from cylinder tests will be in accordance with CSA A23.1/A23.2 except as follows:
 - .1 Concrete shall be considered defective for concrete placements less than 200 m³ when a cylinder test fails to meet specified strength. In such cases concrete in that section may be checked by the Departmental Representative by core specimens drilled and tested in accordance with CAN/CSA A23.2. All concrete core extraction and testing shall be conducted by a third party inspection company with a CSA certified testing laboratory with Category I certification.
 - .2 Strength acceptance criteria from core specimens will be in accordance with CSA A23.1/A23.2.
 - .3 Consider concrete defective if it is structurally unsound, lacks moisture resistance, honeycombed or improperly finished, as determined by the Departmental Representative.
 - .4 The Departmental Representative has the right to require replacement, strengthening or correction of impacted portions of defective concrete structure to acceptance of the Departmental Representative.
 - .1 Bear all costs of rectifying defective concrete including inspections, design, coring, testing, strengthening, demolishing, and replacement. Bear investigation and evaluation costs even if further evaluation of design allows unit to be classed as acceptable concrete.
- .9 Records:
 - .1 Before unloading at Site, have concrete producer submit to the Departmental Representative a delivery ticket (with each batch of concrete) on which is printed,

1.5 QUALITY
ASSURANCE
(Cont'd)

- .9 Records:(Cont'd)
 - .1 (Cont'd)
 - stamped or written the following information:
 - .1 Name and location of batch plant.
 - .2 Date and serial number of ticket.
 - .3 Name of Contractor.
 - .4 Specific designation of job (name and location).
 - .5 Approved mix code, specified strength, and specific class or designation of concrete indicated in Concrete Mixes article specified.
 - .6 Amount of concrete in cubic meters.
 - .7 Truck number, cumulative total, and/or load number.
 - .8 Time loaded or time of first mixing of cement and water/aggregate.
 - .9 If water added show amount and have this information initialled by the Departmental Representative.
 - .2 Include the following information, which is to be registered by producer's representative on at least two copies of the delivery ticket, after discharge has been completed:
 - .1 Time that load arrived on Site.
 - .2 Time that discharge of load was started.
 - .3 Time that discharge of load was completed.
 - .4 Type and amount of admixtures, if added at Site.
 - .5 Amount of water, if added at Site.
 - .3 Maintain accurate records of cast-in-place concrete elements. Include in records the following information:
 - .1 Date of placing concrete element.
 - .2 Location of concrete element.
 - .3 Specified strength of concrete.
 - .4 Air and form temperature when concrete was placed
 - .5 Temperature of concrete when placed in the form
 - .6 Test samples taken and results of test samples.
 - .4 Submit additional information designated by the Departmental Representative and required to verify compliance with Specifications upon request.

1.6 DELIVERY,
STORAGE AND
HANDLING

- .1 Concrete delivery: ensure concrete delivery from plant meets CSA A23.1/A23.2.
- .2 Concrete, Site-mixed:
 - .1 Site-mixed concrete is not permitted when:
 - .1 A structure contains more than a total of 50 m³ of concrete.
 - .2 Specified compressive strength is higher than 25 MPa at 28 days.
 - .3 Concrete is prestressed.
 - .4 Ready-mix concrete is specified.
 - .2 Transport of concrete from mixer to point of delivery to conform to requirements of Article 1.2.2.3.
- .3 Concrete, mixed off-Site:
 - .1 When truck mixer or agitator is accepted for mixing or delivery of concrete do not add water to batch after initial introduction of mixing. This requirement may be waived at the start of discharge of concrete when measured slump is less than that specified, and when not more than 60 minutes has elapsed from time of batching to start of discharge. In this case, upon approval as verified by the Departmental Representative initialing of the delivery ticket, water may be added by producer when concrete is delivered to maximum amount of 10% of mix design water. Do not add water to batch at later time.
 - .2 Complete the discharge of concrete within 2 hours after introduction of mixing water to cement and aggregates. If acceptable to the Departmental Representative, as verified in writing 14 days prior to placement, the 2 hour time limitation may be waived if concrete is initially proportioned to contain a chemical retarder or hydration stabilizer to delay the initial set.
 - .3 If measured slump or entrained-air content falls outside specified limits, ensure another portion of same sample is tested immediately. If second failure occurs, concrete will be considered to have failed requirements of Specification and will be rejected.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 20.

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- 1.7 SITE CONDITIONS
- .1 Conform to CSA A23.1/A23.2.
 - .2 Do not place concrete during or prior to rain. If rain occurs after placing and prior to initial set of concrete, prevent rain water from reaching newly placed concrete.
 - .3 Cold weather protection:
 - .1 Maintain protection equipment, in readiness on Site. Use such equipment when the ambient temperature is at or below 5 degrees Celsius, or when, in the opinion of the Departmental Representative the temperature may fall below 5 degrees Celsius before concrete has cured.
 - .2 Do not place concrete upon or against surface which is at temperature lower than 5 degrees Celsius.
 - .3 Provide temperature-controlled enclosures for areas where concrete is placed whenever ambient air temperature is 5 degrees C or lower.
 - .4 Protect concrete from the adverse effects of space-heated enclosures including local overheating and combustion products.
 - .5 Heat mix water and, if necessary, aggregates when air temperature is at or below, or predicted to go below, 5 degrees C at any time during the next 24 hours.
 - .6 Maintain temperature of reinforcing bars and forms above 10 degrees C prior to placing concrete.
 - .7 Maintain temperature of concrete when deposited in forms not less than 15 degrees C but not higher than 25 degrees C.
 - .8 Maintain temperature of concrete at surfaces at least 10 degrees C for a minimum period of seven days after placing and achieving minimum 75 percent of specified strength. Concrete temperature may then be lowered to ambient air temperature at a rate of 1/2 degrees C per hour or 10 degrees C per day.
 - .9 Use additional protection if full 28 day compressive strength is required at an early age.
 - .10 Keep concrete continuously moist during the curing period.
 - .11 Obtain the Departmental Representative acceptance of method of maintaining minimum temperatures.
-

1.7 SITE CONDITIONS .4
(Cont'd)

Hot weather protection:

- .1 Maintain protection equipment, in readiness on Site. Use such equipment when the ambient temperature is at or above 25 degrees Celsius, or when, in the opinion of the Departmental Representative the temperature may exceed 25 degrees C before concrete has cured.
- .2 When ambient temperature is at or above 25 degrees C, protect concrete from direct sunlight and keep forms moist by sprinkling with cool water, applying wet burlap, or other accepted methods of cooling which will not affect concrete adversely.
- .3 Do not place concrete, when concrete temperature exceeds 25 degrees C in the mixer.
- .4 Concrete, which has a temperature in the mixer between 20 degrees C. and 25 degrees C. shall contain a retarder which reduces mixing water requirements and increases strength, not contain high early strength cement.
- .5 Protect forms and equipment, including both mixing and placing equipment, from the rays of the sun and cool by wetting as necessary to maintain a temperature of not more than 5 degrees C. in excess of ambient temperature nor more than 30 degrees C.
- .6 Prior to placing concrete, wet down forms and reinforcement and the area surrounding the work. Ensure excess water is swept and drained away immediately before casting the concrete.
- .7 Keep mixing time to the minimum, consistent with the production of the quality of concrete specified and place mixed concrete immediately.
- .8 Use sufficient qualified personnel for rapid placing and finishing of concrete.
- .9 Commence continuous wet curing as soon as the concrete has hardened sufficiently to prevent surface damage.

.5 Protection from drying:

- .1 When surface moisture evaporation may exceed 0.75 kg/(m²/h), erect windbreaks around sides of structural element.
- .2 When surface moisture evaporation may exceed 1.0 kg/(m²/h), take additional measures accepted by the Departmental Representative to prevent rapid loss of moisture from surface of concrete. Such

- 1.7 SITE CONDITIONS .5
(Cont'd)
- Protection from drying:(Cont'd)
- .2 (Cont'd)
methods are identified in Clause 7.4.2.2 of CAN/CSA A23.1/A23.2.
- .6 Frost Protection for Footings and Slabs on Grade:
- .1 Protect subgrades prior to casting concrete and maintain a minimum temperature at the subgrade surface and below of 5 degrees C.
- .2 Provide continuous protection for footings and slabs on grade to prevent the subgrade below from freezing during cold weather. Provide heated enclosures and insulation as required.
- .3 The subgrade below completed tanks may be protected against frost by filling the tank with water to a minimum depth of 2000 mm. Maintain water sufficiently warm to prevent ice formation on water.
- .7 Influence of Ambient Concrete Temperature on Concrete Crack Control:
- .1 To minimize the formation of thermal cracks during placement and curing, maintain previously cured concrete and concrete that will be placed against it at the same temperature.
- .2 Failure to minimize temperature differential between adjacent pours may result in temperature induced cracking. Repair such cracks as specified in this Section.

PART 2 - PRODUCTS

- 2.1 DESIGN CRITERIA .1 to CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.
- 2.2 PERFORMANCE CRITERIA .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established by Departmental Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.
-

2.3 MATERIALS

- .1 Reduction in cement from Base Mix to Actual Supplementary Cementing Materials (SCMs) Mix, as percentage.
 - .2 Blended hydraulic cement: Type GUb to CSA A3001.
 - .3 Supplementary cementing materials: with minimum 20% Type F, CI, CMI, Fly Ash Repl., by mass of total cementitious materials to CSA A3001.
 - .4 Water: to CSA A23.1/A23.2.
 - .5 Aggregates: to CSA A23.1/A23.2. All aggregate sources as listed on the MTO's Designated Source Materials (DSM) list.
 - .6 Admixtures:
 - .1 Air entraining admixture: to CSA A23.1/A23.2 and ASTM C260.
 - .2 Chemical admixture: to CAN/CSA A23.1/A23.2 and ASTM C494/C494M. Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
 - .1 Water reducing admixture: ASTM C494/C494M, Type A.
 - .2 Set retarding admixture: ASTM C494/C494M, Type D.
 - .3 Set accelerating admixture: ASTM C494/C494M, Type C.
 - .4 Air entraining admixture: CAN/CSA A23.1/A23.2 and ASTM C260/C260M.
 - .5 Superplasticizer (for use with silica fume): ASTM C494/C494M, Type A.
 - .6 Superplasticizer (cold weather): ASTM C494/C494M, Type F.
 - .7 Superplasticizer (hot weather): ASTM C494/C494M, Type G.
 - .7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2.
 - .1 Compressive strength: 40 MPa at 28 days.
 - .8 Non premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 40 MPa at 28 days.
 - .9 Curing compound: to CSA A23.1/A23.2 white.
-

2.3 MATERIALS
(Cont'd)

- .10 Waterstop: PVC.
 - .1 Size: 25 mm wide by 7 mm thick.
 - .2 Water absorption: 0.005 to 0.02% to ASTM D570.
 - .3 Tear resistance: 102 kg/25.4 mm (225 lb/in) to ASTM D624.
 - .4 Ultimate elongation: 360% to ASTM D638.
 - .5 Tensile strength: 1.3 kPa (200 psi) to ASTM D638 or 13.8 MPa to ASTM D412.
 - .6 Low temperature brittleness: to ASTM D746, passed @ -37.2°C/-38.3 (-35°F/-37).
 - .7 Stiffness in flexure: 4.8 kPa to ASTM D747.
 - .8 Adhesive and sealant as recommended by waterstop manufacturer.
 - .9 Acceptable material: 'CPD PVC Waterstop' manufactured by CPD, 905-669-5013, www.cpd.ca or 'Greenstreak HYDROTITE CJ-0725-3K' manufactured by Greenstreak Global Inc., 800-325-9504, www.greenstreak.com.
- .11 Premoulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
 - .2 Sponge rubber: to ASTM D1752, Type I, flexible firm grade.
 - .3 Self-expanding Standard cork: to ASTM D1752, Type II III.
- .12 Weep hole tubes: plastic.
- .13 Dovetail anchor slots: minimum 0.6 mm thick galvanized steel with insulation filled slots.
- .14 Sump Pit Waterproofing:
 - .1 Primer and Moisture Control: Penetrating two-component primer and moisture control system, standard colour, 3 to 4 mm dry film overall system thickness.
 - .2 Coating: Chemical resistant, semi-gloss finish, standard colour, 2.5 mm dry film overall system thickness; single application.
 - .3 Filler and Grout: Compatible to coating and as recommended by coating manufacturer.
 - .4 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.
 - .5 Joint Sealant: CAN/CGSB-19.24-M, Type 1, Class B, multi-component modified urethane

2.3 MATERIALS
(Cont'd)

- .14 Sump Pit Waterproofing:(Cont'd)
- .5 Joint Sealant:(Cont'd)
base chemical curing; material compatible
with coating and as recommended by coating.

2.4 MIXES

- .1 Performance Requirements:
 - .1 Proportion concrete for structures to
create high performance concrete.
 - .2 Density: Normal density.
- .2 General:
 - .1 Establish proportions of cementing
materials, aggregates, water, and
admixtures required to produce consistent
workable concrete with strength and other
properties specified.
 - .2 Comply with clause 4.3.6-CSA A23.1/A23.2
Volume Stability Considerations.
 - .3 Provide mixes that meet the stringent
requirements of each of the exposures
specified in CSA A23.1 Clause 4.1.1.1.3.
 - .4 Use same types and brand of cement
throughout.
 - .5 Comply with and allow for the supplier's
Standard Deviation as specified in CSA
A23.1/A23.2, Clause 4.4.6.7 Compressive
Strength Requirements.
 - .6 Use high slump concrete by addition of
superplasticizing admixture for walls and
columns.
- .3 Mixes for Normal Density High:
 - .1 High performance concrete for interior
slab:
 - .1 Class C-1 exposure.
 - .2 35 MPa @ 28 days.
 - .3 w/c ratio = 0.40 maximum.
 - .4 Maximum Coarse Aggregate size - 20 mm
Cement.
 - .5 65 % to 80% Normal Portland Cement
Type GU.
 - .6 20 % to 35% Type S Slag cement.
 - .7 Mid-Range Water reducer and shrinkage
reducing admixture Plant added with
the mix water.
 - .8 Slump: between 100 and 150 mm for at
least 90 minutes.
 - .2 Concrete grout for starting structural
walls at construction joint:
 - .1 Class F-1 exposure.
 - .2 35 MPa @ 28 days.
 - .3 w/c ratio = 0.38 maximum.

2.4 MIXES
(Cont'd)

- .3 Mixes for Normal Density High:(Cont'd)
 - .2 (Cont'd)
 - .4 High Cement content paste.
 - .5 Maximum coarse aggregate size - omitted.
 - .6 Utilize the Wall mix below without the coarse aggregate.
 - .3 Concrete for footing, pier and foundation walls:
 - .1 Class F-1 exposure.
 - .2 35 MPa @ 28 days.
 - .3 w/c ratio = 0.40 maximum.
 - .4 Maximum coarse aggregate size - 20 mm cement.
 - .5 65 % to 80% Normal Portland Cement type GU.
 - .6 20 % to 35% Type S Slag cement.
 - .7 Air content 5-8%.
 - .8 Superplasticized.
 - .9 Admixtures plant added with the mix water.
 - .10 Slump: between 150 and 250 mm for at least 90 minutes.
 - .4 Exterior slab, pavements, sidewalk, and curb:
 - .1 Class C-2 exposure.
 - .2 32 MPa @ 28 days.
 - .3 w/c ratio = 0.45 maximum.
 - .4 Maximum coarse aggregate size - 20 mm cement.
 - .5 65 % to 80% Normal Portland Cement type GU.
 - .6 20 % to 35% Type S Slag cement.
 - .7 Air content: 5-8%.
 - .8 Slump: 75 mm maximum.
 - .5 High performance concrete for Approach Slab:
 - .1 Class C-1 exposure.
 - .2 35 MPa @ 28 days.
 - .3 w/c ratio = 0.40 maximum.
 - .4 Maximum coarse aggregate size - 20 mm cement.
 - .5 65 % to 80% Normal Portland Cement type GU.
 - .6 20 % to 35% Type S Slag cement.
 - .7 Air content: 5-8%.
 - .8 Slump: between 100 and 150 mm for at least 90 minutes.
 - .6 Pipe bedding, duct bank and encasement:
 - .1 Class N exposure.
 - .2 15 MPa @ 28 days.
 - .3 Maximum coarse aggregate size - 20 mm cement.
 - .4 Slump: 75 mm maximum.

PART 3 - EXECUTION

3.1 PREPARATION

- .1 Obtain Departmental Representative's written approval before placing concrete.
 - .1 Provide 24 hours minimum notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .6 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing.
- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

3.2 INSTALLATION / APPLICATION

- .1 Perform cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Departmental Representative.
 - .2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.

3.2 INSTALLATION / .2
APPLICATION
(Cont'd)

- Sleeves and inserts:(Cont'd)
- .3 Sleeves and openings greater than 100 x 100 mm not indicated, shall be reviewed by Departmental Representative.
 - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative before placing of concrete.
 - .5 Confirm locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .3 Anchor bolts:
- .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.
 - .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Departmental Representative.
 - .1 Formed holes: 100 mm minimum diameter.
 - .2 Drilled holes: to manufacturers' recommendations.
 - .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
 - .4 Set bolts and fill holes with non-shrink grout.
 - .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.
- .4 Drainage holes and weep holes:
- .1 Form weep holes and drainage holes in accordance with Section 03 10 00. If wood forms are used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.
- .5 Dovetail anchor slots:
- .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
 - .2 Install continuous vertical anchor slots at 800 mm on centre where concrete walls are masonry faced.
- .6 Grout under base plates and machinery using procedures in accordance with manufacturer's

3.2 INSTALLATION / .6
APPLICATION
(Cont'd)

(Cont'd)
recommendations which result in 100% contact
over grouted area.

- .7 Finishing and curing:
 - .1 Finish concrete to CSA A23.1/A23.2.
 - .2 Use procedures as reviewed by Departmental Representative or those noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces. Provide written declaration that compounds used are compatible.
 - .4 Finish concrete floor to CSA A23.1/A23.2. Class B.
 - .5 Provide swirl-trowelled finish unless otherwise indicated.
 - .6 Rub exposed sharp edges of concrete with carborundum to produce 3 mm minimum radius edges unless otherwise indicated.
- .8 Waterstops:
 - .1 Install waterstops to provide continuous water seal.
 - .2 Do not distort or pierce waterstop in way as to hamper performance.
 - .3 Do not displace reinforcement when installing waterstops.
 - .4 Use equipment to manufacturer's requirements to field splice waterstops.
 - .5 Tie waterstops rigidly in place.
 - .6 Use only straight heat sealed butt joints in field.
 - .7 Use factory welded corners and intersections unless otherwise approved by Departmental Representative.
- .9 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Departmental Representative.
 - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .3 Locate and form construction joints as indicated.
 - .4 Install joint filler.
 - .5 Use 12 mm thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to

3.2 INSTALLATION / .9
APPLICATION
(Cont'd)

Joint fillers:(Cont'd)

- .5 (Cont'd)
within 12 mm of finished slab surface
unless indicated otherwise.

.10 Sump Pit Waterproofing:

- .1 Mix and apply work in strict accordance with 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 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 coordinated with subsequent application of materials to ensure optimum adhesion between coating and substrate.

3.3 SURFACE
TOLERANCE

- .1 Concrete tolerance to CSA A23.1/A23.2.

3.4 FIELD QUALITY
CONTROL

- .1 Site tests: conduct tests as follows in accordance with Section 01 45 00 and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Concrete pours.
 - .2 Slump.
 - .3 Air content.
 - .4 Compressive strength at 7 and 28.
 - .5 Air and concrete temperature.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Ensure testing laboratory is certified to CSA A283.
- .3 Ensure test results are distributed for discussion at pre-pouring concrete meeting

3.4 FIELD QUALITY
CONTROL
(Cont'd)

- .3 (Cont'd)
between testing laboratory and Departmental Representative.
- .4 Departmental Representative will pay for costs of tests.
- .5 Departmental Representative will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .6 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.
- .7 Inspection or testing by Departmental Representative will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .1 Materials and Resources Credit MRc2.1 Construction Waste Management: Divert 50% From Landfill and MRc2.2 Construction Waste Management: Divert 75% from Landfill: prepare Construction Waste Management plan in accordance with Section 01 74 20.
 - .2 Divert unused concrete materials from landfill to local quarry or facility after receipt of written approval from Departmental Representative.
 - .3 Provide appropriate area on job site where concrete trucks and be safely washed.
 - .4 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site as approved by Departmental Representative.
 - .5 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
 - .6 Prevent admixtures and additive materials from entering drinking water supplies or streams.

- | | |
|--------------------------|--|
| 3.5 CLEANING
(Cont'd) | .2 Waste Management:(Cont'd) |
| | .7 Using appropriate safety precautions,
collect liquid or solidify liquid with
inert, noncombustible material and remove
for disposal. |
| | .8 Dispose of waste in accordance with
applicable local, Provincial/Territorial
and National regulations. |

PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Section 01 33 00: Submittal Procedures.
- .2 Section 03 30 00: Cast-in-Place Concrete.
- .3 Section 05 12 23: Structural Steel for Buildings.
- .4 Section 05 21 01: Steel Joists.
- .5 Section 05 31 01: Steel Deck.
- .6 Section 07 81 00: Applied Fireproofing.
- .7 Section 09 91 00: Painting.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI):
 - .1 ANSI/NAAMM MBG531-09, Metal Bar Grating Manual.
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A123/A123M-09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A269-10, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .3 ASTM A666-10, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - .4 ASTM A786/A786M-05(2009), Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
 - .5 ASTM A1011/A1011M-12, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - .6 ASTM F593-02(2008), Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- .3 Environmental Choice Program:
 - .1 CCD-047-98 (R2005), Architectural Surface Coating.

1.2 REFERENCES
(Cont'd)

- .3 Environmental Choice Program:(Cont'd)
 - .2 CCD-048-98 (R2006), Surface Coating - Recycled Water - Borne.
- .4 Canadian Standards Association (CSA):
 - .1 CSA BG51-12, Accessible Design for the Built Environment.
 - .2 CSA-G40.20-04(2009)/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .3 CSA-S16-09, Limit States Design of Steel Structures.
 - .4 CAN/CSA-S136-07, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .5 CSA-S136.1-01, Commentary on North American Specification for the Design of Cold Formed Steel Structural Members.
 - .6 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
 - .7 CSA-W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .8 CSA W55.3-08, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .9 CSA-W59-03(R2008), Welded Steel Construction (Metal Arc Welding).
- .5 National Association of Architectural Metal Manufacturers (NAAMM):
 - .1 NAAMM AMP 510-92, Metal Stairs Manual, 5th Edition (1992).

1.3 DESIGN REQUIREMENTS

- .1 Design counter brackets, steel handrails and railings, handrail extensions gratings, trench covers and frames, stairs and landings shelve brackets and bench brackets in accordance with CSA-B651.

1.4 SUBMITTALS

- .1 Submit shop drawings and product data of each item specified in accordance with Sections 01 33 00 and 01 78 00.
 - .1 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.
 - .2 Indicate each item's conformance with CSA-B651.

1.4 SUBMITTALS
(Cont'd)

- .1 (Cont'd)
- .3 Each shop drawing submission shall bear signature and stamp of qualified professional engineer registered or licensed in province of Ontario.
- .4 Submit manufacturer's printed product literature, specifications and data sheet
- .5 Submit two copies of WHMIS MSDS - Material Safety Data Sheets. Indicate VOC's:
 - .1 For finishes, coatings, primers and paints.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 SS bolts, nuts and washers: stainless steel to ASTM F593, minimum 75% recycled content.
- .2 Steel: to CSA G40.20/G40.21, minimum 30% recycled content.
- .3 Rolled structural steel shapes, and flat hot-rolled steel Products: CSA G40.20/G40.21, Grade 350W, minimum 30% recycled content.
- .4 Channels, angles and plates: CSA 40.20/G40.21, Grade 300W, minimum 30% recycled content.
- .5 Hollow Structural Sections (HSS): to CAN/CSA-G40.20/G40.21, Grade 350W, Class H, minimum 30% recycled content.
- .6 Alkyd primer: oil type to CAN/CGSB-1.40, Ecologo certified.
- .7 Galvanizing: hot dip, unpassivated, to ASTM A123/A123M, Coating Grade 85, minimum 600 g/m².
- .8 Zinc rich primer for galvanized surfaces: zinc rich, readymix to CCD-047a, Ecologo certified.
- .9 Grout: non-shrink, non-metallic, flowable, 24 h, 15 MPa, pullout strength 7.9 MPa.
- .10 Steel gratings welded: bearing bars, cross bars, bent connecting bars and anchors, welding quality, mild carbon steel to ASTM A1011/A1011M.
- .11 Steel floor plate(checker plate): to CSA-G40.20/G40.21, raised pattern, hot rolled steel, dimensional tolerances to ASTM A786/A786M.

2.1 MATERIALS
(Cont'd)

- .12 Steel bar grating treads: to ANSI/NAAMM MBG531, Type W-19-4 steel with checker plate nosing.
- .13 Steel bar gratings: to ANSI/NAAMM MBG531, Type W-19-4, mild carbon steel to ASTM A1011/A1011M, minimum 30% recycled content, welded; plain bearing bars 32 x 4.8 mm @ 30 mm o.c., twisted cross bars @ 102 mm o.c., galvanized, complete with galvanized steel angle frame 30 x 50 x 6 mm, with welded bearing bar and concrete anchors.
 - .1 Interior use: hinged.
 - .2 Exterior use: hinged, with padlock securing eyes.
- .14 Aluminum alloy: extrusions to Aluminum Association Designation AA6063-T5, sheet to Designation AA1100, minimum 80% recycled content, brushed aluminum with designation AA-A31 clear anodized finish.
- .15 Cold formed shapes: CAN/CSA S-136.

2.2 FABRICATION

- .1 Fit joints in true planes and securely fasten.
- .2 Weld to CSA W59. File or grind welds smooth and flush with adjoining surface.
- .3 To ANSI/NAAMM MBG 531 and ANSI/NAAMM AMP 510.
- .4 Shop assemble work.

2.3 FINISHES

- .1 Galvanizing: hot dipped galvanizing with zinc coating to ASTM A123/A123M.
- .2 Shop coat primer: to CCD 047a, Ecologo certified.
- .3 Zinc primer: zinc rich, ready mix to CCD 047a, Ecologo certified.

2.4 ISOLATION
COATING

- .1 Isolate aluminum from following components, by means of bituminous paint:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

<u>2.5 SHOP PAINTING</u>	.1	Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.
	.2	Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.
	.3	Clean surfaces to be field welded; do not paint.
<u>2.6 BOLLARDS</u>	.1	6 mm wall steel pipe at diameter indicated. Ground smooth edges.
	.2	Hot dip galvanized finish ASTM A123 Grade 85.
<u>2.7 ACCESS LADDERS</u>	.1	Stringers: steel plates.
	.2	Steel Rungs: 20 mm diameter welded to stringers.
	.3	Brackets: sizes and shapes as indicated, weld to stringers at centres indicated, complete with fixing anchors.
	.4	Finish: galvanize exterior ladders after fabrication.
<u>2.8 CHANNEL FRAMES</u>	.1	Fabricate frames from steel, sizes of channel and opening as indicated.
	.2	Weld channels together to form continuous frame for jambs and head of openings, sizes as indicated.
	.3	Weld steel strap anchors to channel jamb frame.
	.4	Finish: hot dip galvanized.
<u>2.9 TRENCH GRATING & FRAMES</u>	.1	Fabricate from stainless steel and hot-dip galvanized metal grating and frame as indicated. Include anchors for embedding in concrete. Rectangular grate opening, serrated top edge, rectangular bearing bars, rectangular cross bars, welded construction, corners and junctions

2.9 TRENCH
GRATING & FRAMES
(Cont'd)

- .1 (Cont'd)
round smooth. Weld perimeter banding bars, same size as bearing bars, at grating edges and openings. Select depth of bearing and cross bars to match adjacent floor loading indicated on structural drawings.
- .1 Grating Type 1: hot dip galvanized steel bars, 35 mm bearing bar centres, 100 mm cross bar centres. Hot dip galvanized steel anchor frames.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install work straight, plumb and level to a tolerance of 1:600.
- .2 Provide required reinforcing and anchorage.
- .3 Do welding work in accordance with CSA W59 unless specified otherwise.
- .4 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .5 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .6 Provide components for building by other sections in accordance with shop drawings and schedule.
- .7 Make field connections with bolts to CSA-S16, or weld.
- .8 Supply other sections with templates, instructions and built-in items.
- .9 Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .10 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

3.2 LOOSE ANGLE
LINTELS

- .1 Supply masonry section with steel loose angle lintels of sizes required to suit masonry openings.
- .2 Apply alkyd primer to interior lintels. Galvanize exterior lintels.
- .3 Provide 150 mm bearing at ends.
- .4 Weld or bolt together back-to-back angles.

3.3 COUNTER
BRACKETS

- .1 Supply and install steel brackets, supports and angles for support of counter.
- .2 Drill for countersunk screws and anchor bolts.
- .3 Apply alkyd primer.

3.4 STEEL
HANDRAILS AND
RAILINGS

- .1 Supply and install steel pipe handrails and railings.
- .2 Galvanize handrails and railings.
- .3 Secure extruded aluminium brackets to wall.
- .4 Set railing standards in concrete with grout, trowel surface smooth and flush with adjoining surface, or mechanically anchor standards as indicated.

3.5 LATERAL SUPPORT
ANGLES FOR MASONRY
PARTITIONS

- .1 Supply masonry section with steel angles or anchors as indicated to provide lateral support of masonry partitions where they abutt the underside of deck.
- .2 Apply alkyd primer.

3.6 OVERHEAD DOOR
FRAME

- .1 Supply galvanized steel overhead door frame.
- .2 Install frame in opening and securely anchor in place.

3.7 WINDOW
SUPPORT BRACKETS

- .1 Supply and install steel window support brackets.
- .2 Weld required shapes and supply anchors.
- .3 Galvanize after fabrication.

3.8 GRATINGS

- .1 Supply concrete section with galvanized steel angles for mounting in concrete at grating edge.
- .2 Fabricate galvanized steel gratings within the limits shown on page 15 of the Metal Bar Grating Manual, Revised 1979.
- .3 Weld required grating anchors.
- .4 Touch up burnt, scratched or chipped primer.

3.9 TRENCH COVERS
AND FRAMES

- .1 Supply concrete section with galvanized steel trench covers and frames.
- .2 Fabricate from 19 mm thick steel grating set in L25 x 25 x 6 frame and weld anchors at 300 mm oc to metal frame for embedding in concrete, unless otherwise detailed. Galvanize after fabrication.
- .3 Fabricate trench covers in 1200 mm removable lengths.

3.10 BOLLARDS

- .1 Supply concrete section with steel bollards for mounting and filling with concrete.
- .2 Galvanize bollards.

3.11 LADDER

- .1 Supply and install galvanized steel ladder.
- .2 Stringers 400 mm apart.
- .3 Rungs 300 mm centres.
- .4 Wall brackets 2400 mm centres to maintain 150 mm wall clearance.

3.12 STAIRS

- .1 Supply and install galvanized steel stairs to support minimum 5 kPa live load.
- .2 Design, detail and fabricate to NAAMM, Metal Stairs Manual.
- .3 Steel gratetreads, landings, secure to angles welded to stringers.
- .4 Channel stringers with steel plate fascia on outer stringer.
- .5 Clip angles for fastening furring under stair.
- .6 Anchor bolts and plates to connect stair to structure.

3.13 SHELVING AND
BENCH BRACKETS

- .1 Supply concrete section with steel brackets for mounting in concrete and masonry.
- .2 Galvanize surfaces.
- .3 Provide galvanized through bolts for securing wood slats and spacers to bench bracket.

3.14 MISCELLANEOUS
SUPPORTS

- .1 Provide steel supports for louvres, vanities and other construction as indicated and detailed.

3.15 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

PART 1 - GENERAL

1.1 RELATED
SECTIONS

- .1 Section 03 30 00: Cast-in-Place Concrete.

1.2 REFERENCE
STANDARDS

- .1 American National Standard Specifications (ANSI) for the Installation of Ceramic Tile/Ceramic Tile Institute of America (CTIOA):
 - .1 ANSI A108/A118/A136.1-2008, Installation of Ceramic Tile.
 - .1 ANSI A108.1A, Installation of Ceramic Tile in Wet-Set Method, with Portland Cement Mortar.
 - .2 ANSI A108.5, Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - .3 ANSI A118.4, Latex Portland Cement Mortar.
- .2 International Standards Organization (ISO):
 - .1 ISO 10545 Series:
 - .1 ISO 10545-2:1995/Cor 1:1997, Ceramic Tiles -- Part 2: Determination of Dimensions and Surface Quality.
 - .2 ISO 10545-3:1995/Cor 1:1997, Ceramic Tiles -- Part 3: Determination of Water Absorption, Apparent Porosity, Apparent Relative Density and Bulk Density.
 - .3 ISO 10545-4:2004, Ceramic Tiles - Part 4: Determination of Modulus of Rupture and Breaking Strength.
 - .4 ISO 10545-7:1996 Ceramic Tiles - Part 7 Determination of Resistance to Surface Abrasion for Glazed Tiles - First Edition.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.
 - .2 ASTM C373-88(2006), Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products.
 - .3 ASTM C1028-07e1, Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like

1.2 REFERENCE
STANDARDS
(Cont'd)

- .3 (Cont'd)
 - .3 (Cont'd)
Surfaces by the Horizontal Dynamometer
Pull-Meter Method.
- .4 Canadian Standards Association (CSA
International)
 - .1 CAN/CSA-A3001-08, Cementitious Materials
for Use in Concrete.
 - .2 CAN/CSA-A179-04(R2009), Mortar and Grout
for Unit Masonry.
- .5 Terrazzo Tile and Marble Association of Canada
(TTMAC).
 - .1 Hard Surface Maintenance Guide (2000).
 - .2 TTMAC Specification Guide 09 30 00 - Tile
Installation Manual 2009/2010.
- .6 Tile Council of North America (TCNA)
 - .1 Handbook for Ceramic Tile Installation,
2010.
- .7 CAN/CGSB-25.20-95, Surface Sealer Floors.

1.3 SUBMITTALS

- .1 Submit TTMAC Installation Detail No. or shop
drawing showing installation for each tile
specified.
- .2 Submit list of materials suitable for sealing
and finishing each tile specified.

1.4 QUALIFICATIONS

- .1 Use installation and grouting materials
produced by a manufacturer that has been
regularly engaged in producing these materials
for a minimum of 10 years and has completed a
minimum of 5 successful installations of this
type, each at least five years old.
- .2 Employ workmen with previous experience of more
than 5 years in each different assembly
specified.
- .3 Provide references of 3 installations of
similar type and size more than 3 years old for
each assembly.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Porcelain tile: to ISO 10545 Series, glazed tile.
 - .1 Slip resistance for floor tile: to ASTM C1028, wet and dry surface greater than 0.60.
 - .2 Surface flatness: to ISO 10545-2, maximum $\pm 0.4\%$.
 - .3 Moisture resistance: to ASTM C373, MR-1.
 - .4 Water absorption: to ISO 10545-3, 3.0%.
 - .5 Breaking strength: to ISO 10545-4, $>40 \text{ N/mm}^2$.
 - .6 Abrasion resistance: to ISO 10545-7, PEI II-IV.
 - .7 Recycled content: Minimum 5% post-consumer recycled content, or minimum 5% pre-consumer recycled content.
 - .8 Trims: bullnose.
- .2 Portland cement: to CAN/CSA-A3001-08, type GU Normal.
- .3 Sand: to CSA-A179.
- .4 Hydrated Lime: to ASTM C207.
- .5 Latex: formulated for use in cement mortar.
 - .1 Acceptable material: 'Planecrete 50' manufactured by Mapei, 1-800-668-1212.
- .6 Water: potable.
- .7 Waterproofing membrane:
 - .1 Self curing, liquid rubber polymer sheet with anti-fracture reinforcing fabric.
- .8 Thin set bond coat (interior): dry set mortar, pre-mixed, thin set mortar formulated with Portland cement, sand and latex additive. Complying with ANSI A118.4.
- .9 Floor grout (thin set system): pre-mixed, dry set grout. Colour to match tile colour.
- .10 Wall grout (thin set system): pre-mixed, dry set grout. Colour to match tile colour.
- .11 Prefabricated expansion joint: PVC and CPE joint with $\pm 33\%$ movement capability, colour selected from manufacturers standard range.

2.1 MATERIAL
(Cont'd)

- .12 Finish: as recommended by tile manufacturer.

2.2 FABRICATION -
TILE SHEETS

- .1 Arrange mosaic tiles in 305 mm x 610 mm sheet format. Connect tiles using dot mount technique. Maintain uniform tile joints at 3 mm and tile to tile module of 50 mm.

PART 3 - EXECUTION

3.1 SURFACE
PREPARATION

- .1 Do not proceed with installation unless substrate is structurally sound and solid.
- .2 New concrete: properly cured and designed with proper expansion and control joints.
- .3 Surfaces shall be clean and free from dust, dirt, oil, grease, paint, wax, sealers, curing compounds or any other substances which may reduce or prevent adhesion.

3.2 SYSTEM
REQUIREMENTS

- .1 Provide assemblies composed of compatible materials from the same manufacturer.
- .2 Use waterproof membrane, where indicated.
- .3 This membrane will be part of a complete system and this assembly will meet the requirements of TTMAC.

3.3 MIXING

- .1 To ANSI A108.1A.
- .2 Levelling coat (by volume):
- .1 1 part portland cement.
 - .2 4 parts sand.
 - .3 1/10 part latex.
 - .4 1 part water (includes latex additive).
 - .5 Adjust water volume to suit water content of sand.
- .3 Scratch coat (by volume):
- .1 1 part portland cement.
 - .2 1/5 to 1/2 parts hydrated lime.
 - .3 4 parts sand.

3.3 MIXING
(Cont'd)

- .3 Scratch coat (by volume):(Cont'd)
 - .4 1 part water.
 - .5 Adjust water volume to suit water content of sand.
 - .6 Latex, volume recommended by manufacturer.
- .4 Slurry bond coat:
 - .1 Portland cement and water Mix to creamy paste consistency.
 - .2 Latex, volume recommended by manufacturer.
- .5 Wall, mortar bed (by volume):
 - .1 1 part portland cement.
 - .2 1/5 to 1/2 parts hydrated lime.
 - .3 4 parts sand.
 - .4 1 part water.
 - .5 Adjust water volume to suit water content of sand.
 - .6 Latex, volume recommended by manufacturer.
- .6 Floor, mortar bed (by volume):
 - .1 1 part portland cement.
 - .2 4 parts sand.
 - .3 1 part water.
 - .4 Adjust water volume to suit water and content of sand.
 - .5 Latex, volume recommended by manufacturer.
- .7 Thin set bond coat and grout: dry set mortar; mix to manufacturer's written instructions.

3.4 WORKMANSHIP

- .1 Minimum surface and air temperature 12°C, before and during application and during curing period.
- .2 Provide back-buttering in addition to the usual notch-trowel-applied bond coat in the following applications:
 - .1 With rib-backed tiles and heavy lug-backed tiles.
 - .2 In hot, dry or windy weather or where notched mortar bed was prepared too far in advance.
- .3 Backbuttering: remove residual dust, wipe the back of the tile with a damp cloth or sponge, apply a full coverage 2 mm thick coat of mortar, apply no more than 10-15 minutes before tiles are set so that both back-butter and mortar are wet at time of setting.

3.4 WORKMANSHIP
(Cont'd)

- .4 Use Box Screed jig with large sized tiles which are not of uniform thickness.
- .5 Trowel in one direction and press the tile into the mortar with a sliding motion perpendicular to the trowel ridges. Twist, vibrate or beat the tiles to compress the trowel ridges to comply with requirements of ANSI A108.5.
- .6 Perimeter tile minimum 1/2 size.
- .7 Cut tile around corners and built-in objects smooth, even, chip and split free.
- .8 Accurately form intersections, corners and returns.
- .9 Joints uniform:
 - .1 Walls: 1.5-3.0 mm wide.
 - .2 Floor tiles: 3.0-6.0 mm wide.
- .10 Surfaces plumb, straight, true, even and flush to a tolerance of 1:1000.
- .11 Replace broken or hollow sounding tile.
- .12 Allow 24 hours before grouting.
- .13 Fill joints solid with grout, free of voids, cracks, excess mortar or grout.
- .14 Clean surfaces after curing.
- .15 Floors traffic free for 48 hours.
- .16 Seal and finish floors in accordance with manufacturer's recommendations.

3.5 SETTING
BACK-BUTTERED TILE

- .1 Firmly push, twist and immediately beat or vibrate the tiles.

3.6 FLOOR TILE

- .1 Install in accordance with:
 - .1 TTMAC detail 310F-2009/2010 Cement Mortar Bed Over Concrete Slab.
 - .2 Bond coat and grout manufacturer's written instructions.
- .2 Install in accordance with:
 - .1 TTMAC detail 319SR-2009/2010 Details on Shower Receptor.

-
- 3.6 FLOOR TILE .2 Install in accordance with:(Cont'd)
(Cont'd) .2 Bond coat and grout manufacturer's written instructions.
- 3.7 WALL TILE .1 Install in accordance with:
.1 TTMAC details 303W-2009/2010 Tile
Installed Over Masonry or Concrete Walls -
Thin Set Method Interior/Exterior.
.2 Bond coat and grout manufacturer's written instructions.
- 3.8 EXPANSION AND .1 Install movement joints in accordance with
CONTROL JOINTS TTMAC detail 301MJ and in accordance with joint
manufacturer's recommendations and as follows:
.1 Interior: 4.8 m to 6 m each direction.
.2 Where tile abutts restraining surfaces
(walls, dissimilar floors, curbs, columns,
pipes, ceilings and where changes occur in
backing materials.
.3 Where tile spans cold joints, construction
joints, saw-cuts and seismic joints.
- .2 Construct during installation of mortar beds
and/or tile, rather than saw-cutting joints
after installation.

PART 1 - GENERAL

1.1 GENERAL

- .1 This section contains the requirements for the supply, installation, testing and commissioning of service water pumps, building drainage sump pumps and associated motors.
- .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 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 service water system equipment for the respective applications.

1.2 REFERENCES

- .1 Provincial Plumbing Code and the requirements of local authorities having jurisdiction.
 - .2 Canadian Gas Association (CGA).
 - .3 CSA/CSA Label on Fixtures and Equipment.
 - .4 ASTM:
 - .1 A48, Standard Specification for Gray Iron Castings.
 - .2 A48, Gray Iron Castings.
 - .3 A108, Steel Bars, Carbon Cold Finishes, Standard Quality.
 - .4 A276, Stainless Steel and Heat-Resisting Steel Bars and Shapes.
 - .5 A532, Abrasion Resistant Cast Iron.
 - .6 D4101, Specification for Polypropylene Injection and Extrusion Materials.
 - .5 AWWA:
 - .1 C510, Double Check Valve Backflow Prevention Assembly.
 - .2 C511, Reduced-Pressure Principle Backflow Prevention Assembly.
 - .3 C550, Protective Epoxy Interior Coatings for Valves and Hydrants.
-

1.2 REFERENCES
(Cont'd)

- .6 CSA:
 - .1 B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
 - .2 B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
 - .3 C22.1 Canadian Electrical Code (CEC), Safety Standard for Electrical Safety Installations.
- .7 Factory Mutual Engineering and Research Corporation (FM).
- .8 National Electrical Code (NEC).
- .9 National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.
- .10 National Sanitation Foundation International (NSF).
- .11 Underwriters Laboratories Inc. (UL).
- .12 Underwriters Laboratories of Canada (ULC).
- .13 Hydraulic Institute Standards, Standards of the Hydraulic Institute, 14th Edition.

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.
 - .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.

1.3 SUBMITTALS
(Cont'd)

- .1 (Cont'd)
 - .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 from 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 Supply and install required service water pumps and building drainage sump pumps to meet design flow requirements.
- .2 Design and select plumbing equipment specifically with high efficiency, low energy consumption and innovative technology.

2.2 SUBMERSIBLE
CENTRIFUGAL
SUMP PUMPS

- .1 Supply and install submersible pumps for building drainage pumping stations. Stations shall be either simplex or duplex type.
 - .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), sump cover and pump lifting cable(s).
 - .2 Pump metal parts that come into contact with guide rail or cable system shall be made of non-sparking materials.
 - .3 Control panel, level switches and level transmitters, where indicated.
- .2 General:
 - .1 Provide submersible non-clog pumps of the close-coupled integral, wet well submersible type.
 - .2 Provide submersible pumps that operate at given conditions without cavitation or damage to bearings, shaft or any other stationary or rotating parts.
 - .3 Provide pumps suitable for continuous or intermittent operation.
 - .4 Select pumps with head capacity curve continuously rising to shutoff.
 - .5 Provide motors that are non-overloading at any point on the pump operating curve.
- .3 Pump Construction:
 - .1 Impeller shall be semi-open, multi-vane, back swept non-clog design. Supply impeller with heavily back swept edges with a specific angle of distribution sufficient for handling solids, fibrous materials, heavy sludge and other matter found in wastewater.
 - .2 Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti leak seal and

2.2 SUBMERSIBLE
CENTRIFUGAL
SUMP PUMPS
(Cont'd)

- .3 Pump Construction:(Cont'd)
- .2 (Cont'd)
shall be easily accessible from outside. Provide leak detection output signal to control panel. Provide seals that do not require regular maintenance or adjustment.
- .3 Pump motor, electrical power cords and sensor cables shall be suitable for submersible pump applications and shall be oil resistant. Cable sizing shall conform to NEC specifications for pump motors. Cable entry shall be an integral part of the motor housing. Epoxies, silicones, or other secondary sealing systems are not considered acceptable. Cable shall be of sufficient length to reach junction boxes without strain or splicing.
- .4 Provide motors suitable for submerged service. Motor nameplate horsepower shall not be exceeded at any head capacity point on pump curve. Motors shall comply with Section 43 20 70.
- .5 Pump bearings shall be permanently grease-lubricated angular contact and ball bearings designed to withstand the stress of the service specified.
- .6 Sump cover plate shall be provided with vapour tight gasket, hinged equipment doors with drop handles, accessory mounting plates, discharge and vent pipe openings, and sealed power and control cable openings.
- .7 Provide lifting chain or cable, shackle and hook. Chain length shall be long enough so that it can be tethered off at the top of the sump. Provide tethering hook.
- .8 Sliding guide bracket shall be an integral part of pump unit. Pump unit shall be guided by no less than 2 guide bars, or equivalent cable system. Pump shall connect automatically with discharge elbow to form metal to metal contact, preventing leakage, when lowered in place. Ensure that gaskets, O-rings or other sealing arrangements are not required to seal the discharge connection.

2.3 SUMP PUMP
CONTROL PANELS

- .1 Local control panels are to be included in the Vendor Packages, as indicated on contract drawings, containing distribution equipment including but not limited to motor starters,

2.3 SUMP PUMP
CONTROL PANELS
(Cont'd)

- .1 (Cont'd)
transformers, switches, indicators, logic
control unit, relays, and contactors, etc.
- .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 Division 26
and Section 40 90 00.
- .3 Control systems shall be intrinsically safe.
Control systems include level switches, moisture
switches, and temperature switches.
- .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, 120 V 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 120 V ac
contacts for remote indication of:
 - .1 Running.
 - .2 Pump failure (temperature or moisture
alarm).
 - .3 Level High/High alarm.
 - .4 Computer.
 - .8 Terminal strip for interfacing with
external wiring.
 - .9 High temperature indication.
 - .10 Moisture alarm indication.
 - .11 Alarm reset push button.
 - .12 Document pocked located inside panel with
pump and panel operation and maintenance
manual and separate laminated pump curve.
 - .13 Run hour meter.
 - .14 CSA labeled panel.
 - .15 Prewired and factory tested.
 - .16 Mount control switches, indicating lights,
and switches on hinged front panel.

2.4 SERVICE WATER
PUMPS

- .1 Supply and install service water pumps to
supply wastewater treatment plant processes.
 - .1 Pump equipment shall consist of pump(s)
complete with motor(s), control panel,

2.4 SERVICE WATER
PUMPS
(Cont'd)

- .1 (Cont'd)
 - .1 (Cont'd)
control system, power cable(s) and
associated appurtenances.
- .2 General:
 - .1 Provide packaged service water pump system
as indicated in the process and
instrumentation drawings.
 - .2 Pumps shall have inline, direct drives,
complete with shaft couplings and coupling
guards.
 - .3 Pumps shall be fitted with Manufacturer's
standard mechanical seal suitable for
potable water service, complete with seal
flush piping.
- .3 Isolation valves shall be full port ball or
butterfly type. Check valves shall be non-slam
type. Provide in accordance with Section
40 05 23 and 40 05 13.
- .4 Pressure relief valves shall be designed and
sized to relieve minimum pump flow back to the
pump suction to prevent pump overheating and
unstable operation, suitable for continuous
operation. Provide in accordance with Section
40 05 23 and 40 05 13.
- .5 Provide one pressure gauge on the discharge of
each pump and a common gauge on the suction
piping. Provide in accordance with Section
40 05 60 and 40 05 13.
- .6 Variable Frequency Drives (VFD) shall be
provided for service water pumps. Provide in
accordance with Division 26.
- .7 Provide bladder type, hydropneumatic tank and
backflow preventers as part of service water
system.
- .8 Mount equipment and driver on a common
baseplate in a compact arrangement.

2.5 SERVICE WATER
SYSTEM CONTROL
PANEL

- .1 Local control panels are to be included in the
Vendor Packages, as indicated on contract
drawings, containing distribution equipment
including but not limited to motor starters,
transformers, switches, indicators, logic
control unit, relays, and contactors, etc.

2.5 SERVICE WATER
SYSTEM CONTROL
PANEL

(Cont'd)

- .2 Provide NEMA 4 enclosur, for each pump system as noted on contract drawings. Panels shall have a single point electrical connection complete with combination magnetic full voltage starter, interlock panel door with breaker handle to prevent opening of door when the breaker is closed. Panels shall be in conformance with the requirements of Division 26 and 40.
- .3 Control systems shall be intrinsically safe. Control systems include level switches, moisture switches, and temperature switches.
- .4 Control system shall run maintaining a constant system pressure. The pump controller shall compare discharge pressure with the setpoint and adjust the pump speed to maintain the setpoint.
- .5 Provide a monitor for pump seal chamber temperature and prevent overheating during periods of low water demand. On a high temperature condition, energize a solenoid to drain water.
- .6 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 COMPUTER/OFF/HAND switches.
 - .4 Running lights.
 - .5 Provide for the following interconnection inputs:
 - .1 Remote start/stop.
 - .2 System pressure.
 - .3 Discharge pressure setpoint.
 - .4 Remote manual start/stop.
 - .5 Pump minimum speed setting.
 - .6 Provide for the following interconnection outputs:
 - .1 Running status.
 - .2 Pump fault/trouble.
 - .3 Pump speed to VFD for each pump.
 - .4 Computer.
 - .7 Terminal strip for interfacing with external wiring.
 - .8 High temperature indication.
 - .9 Moisture alarm indication.
 - .10 Alarm reset push button.
 - .11 Document pocked located inside panel with pump and panel operation and maintenance manual and separate laminated pump curve.

- | | | |
|--|--------|--|
| 2.5 SERVICE WATER
SYSTEM CONTROL
PANEL
(Cont'd) | .6 | (Cont'd) |
| | .5 | (Cont'd) |
| | .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. |
|
2.6 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 316 L stainless steel, sized
by equipment Manufacturer. |
|
2.7 FINISHES |
.1 |
Finish the pump bowl, column and discharge head
in accordance with Division 09 Finishes. |
|
2.8 SPARE PARTS |
.1 |
Furnish for each size of pump: |
| | .1 | One set mechanical seals. |
| | .2 | One set bearings. |
| | .3 | One set gaskets and O-ring seals. |
| | .4 | One set shaft sleeves. |
| | .5 | One set keys, dowels, pins, etc. |
| | .6 | Impeller wear ring. |
| | .7 | 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. |
|--------------------------------------|----|---|

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- 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 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 and motor.

PART 1 - GENERAL

1.1 INTENT OF
SECTION

- .1 A general description of the equipment is given herein. It is intended that the Contractor provide all components of the systems described in order that the tanks perform in the manner intended.
- .2 This section covers the design, supply, delivery, installation and commissioning of a glass fused-to-steel, bolted steel tanks, and aluminum geodesic dome.
- .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 select the tanks for the respective application. The Contractor must provide design justification (i.e., process calculation) for design basis.
- .4 The Contractor is responsible for overall coordination of the entire tank system, foundation, pipe penetrations, roof dome, mixing system, air distribution system, and all related appurtenances to ensure compatibility of all equipment and the finished product.

1.2 REFERENCES

- .1 The following standard may be referenced in this Section:
 - .1 API 12B - Principles of standard specification for bolted steel tanks.
 - .2 NFPA 22 - Chapter 4 - Water tanks for private fire protection, factory-coated, bolted steel tanks.
 - .3 OSHA - Occupational Safety and Health Act.
 - .4 AISI - American Iron and Steel Institute.
 - .5 AISC - American Institute Steel Constructions.
 - .6 ANSI/AWWA D103, latest revision - Bolted Steel Tanks.
 - .7 Section 10.4 ANSI/AWWA D103 - Coating, latest revision.
 - .8 CSA - Canadian Standards Association.
 - .9 National Building Code - latest edition.
-

1.3 DESIGN
REQUIREMENTS

- .1 Design tanks, wall thickness, methods and locations of support, and stiffener requirements. Design shall be signed and sealed by a Professional Engineer registered in the Province of Ontario.
- .2 Design tank walls to allow for partial backfilling of soil around tank, in accordance with drawings.
- .3 Provide for insulation on tank walls and tank roof, as required for proper performance of the biological system within the tanks.
- .4 Provide for baffles and dividing walls in accordance with Bioreactor Section 46 43 39 in order to provide the required performance of the system.
- .5 The tanks Manufacturer shall be a specialist in the design, fabrication, and erection of factory-coated bolted steel tanks. The manufacturer shall be quality certified, having an active API-Q1 and an ISO 9001 registration.

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Method of fabrication, including industry standards governing fabrication, quality control.
 - .2 Layout, overall dimensions, required clearances and description of equipment.
 - .3 Attachment of equipment, services, auxiliary equipment, accessories.
 - .4 Tanks bottom.
 - .5 Load conditions, design criteria, critical strain values, design factors and similar items used in manufacturing specified tanks.
 - .6 Materials, methods of fabrication, quality control, catalyst-curing system, type and minimum thickness of chemically-resistant veil (barrier) on tanks interior, and other pertinent data on materials, fabrication and similar items.
- .2 Provide shop drawings for the tanks signed and sealed by a Professional Engineer registered in the Province of Ontario.
- .3 During and/or After Construction

- | | | |
|-----------------------------------|----|---|
| <u>1.4 SUBMITTALS</u>
(Cont'd) | .3 | (Cont'd) |
| | .1 | An inspection report detailing all quality assurance measurements taken throughout construction of the structure. |
| | .2 | Certified Mill Test Reports during fabrication of the steel sheets. |
| | .3 | An inspection report detailing all quality assurance measurements taken throughout fabrication and erection of the tanks. |

- | | | |
|------------------------------|----|---|
| <u>1.5 QUALITY ASSURANCE</u> | .1 | Provide equipment and materials of highest quality and best suited to the requirements. Provide materials and finishes in contact with chemicals that are resistant to chemicals or chemical vapours. |
| | .2 | Supply, without additional cost, appurtenances not shown on drawings or specified which are found necessary to complete every portion of equipment specified so that equipment functions as intended by specifications. |

PART 2 - PRODUCTS

- | | | |
|----------------------|----|---|
| <u>2.1 MATERIALS</u> | .1 | Plates and Sheets: |
| | .1 | Plates and sheets used in construction of the tanks shell and tanks roof shall comply with the minimum standards of AWWA D103. Design requirements for mild strength steel shall be ASTM A570 Grade 30 with a maximum allowable tensile stress of 14,586 psi. Design requirements for high strength steel shall be ASTM A607 Grade 50 with a maximum allowable tensile stress of 30,000 psi. The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength. In no event shall yield strength greater than 50,000 psi be utilized for calculations. |
| | .2 | Raw materials delivered to the Manufacturer's plant shall be tested/inspected to ensure compliance with the Manufacturer's requirements for strength and chemical composition. |
| | .3 | Test Certificates and Certificates of Conformity shall be submitted to the Construction Managers for record purposes. |
| | .4 | Bolts joining tanks panels shall conform to the requirements of ASTM A307, ASTM |

2.1 MATERIALS
(Cont'd)

- .1 (Cont'd)
- .4 (Cont'd)
 - A325, and ASTM A490. Acceptable equivalents in accordance with manufacturer's specifications are SAE Grade 2, SAE Grade 5, and SAE Grade 8, or Grade 8.8 and Grade 10.9 bolts.
- .2 Rolled Structural Shapes:
 - .1 Material shall conform to minimum standards of ASTM A36 or AISI 1010.
- .3 Horizontal Wind Stiffeners:
 - .1 Design requirements for intermediate horizontal wind stiffeners shall be per AWWA D103-97, permitting wind loads to distribute around the tanks. A wind stiffener at the top of the tanks shall provide a flat, horizontal, continuous surface at tanks rim level, compatible with any roof type that may be included within the scope of works.
 - .2 Wind stiffeners shall be steel with hot dipped galvanized coating.
- .4 Bolt Fasteners:
 - .1 Bolts joining tanks panels shall conform to the requirements of ASTM A307 and ASTM A325, ASTM A490 or API 1 2B. Nuts for those bolts shall conform to ANSI/ASTM A194 or ASTM A563. Acceptable equivalents in accordance with manufacturer's specifications are SAE Grade 2, SAE Grade 5, and SAE Grade 8, or Grade 8.8 and Grade 10.9 bolts. Bolt, washer and nut finishes shall be either zinc mechanically deposited or hot dip galvanized, in accordance with ASTM A123 or A153.
 - .2 All bolts on the vertical tanks wall shall be installed such that the head portion is located inside the tanks, and the washer and nut are on the exterior.
 - .3 All lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between tanks sheets. Also, bolt lengths shall be selected to achieve a neat and uniform appearance. The torque values (as set down in the Manufacturer's Builders Guide) shall not be exceeded during tanks construction.
 - .4 All lap joint bolts shall include splines on the underside of the bolt head at the shank in order to resist rotating during torquing.

2.1 MATERIALS
(Cont'd)

- .5 Bolt Head Encapsulation:
 - .1 High impact polypropylene co-polymer encapsulation of entire bolt head up to the splines on the shank.
 - .2 Resin shall be stabilized with an ultraviolet light resistant material such that the colour shall appear black.
 - .3 All bolts on the vertical tanks wall shall be installed such that the head portion is located inside the tanks, and the washer and nut are on the exterior.
 - .4 All lap joint bolts shall be installed such that threaded portions will not be exposed in the shear plane between the sheets.
 - .5 Bolt lengths shall be sized to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.
 - .6 All lap joint bolts shall include a minimum of four (4) splines on the underside of the bolt head at the shank in order to resist rotating during torquing.
 - .6 Sealant:
 - .1 The lap joint sealant shall be a one component, moisture cured, polyurethane compound. The sealant shall be suitable for contact with potable water, and be NSF 61 approved.
 - .2 The sealant shall be used to seal lap joints, bolt connections and edge fillets for sheet notches and starter sheets. The sealant shall cure to a rubber like consistency, have excellent adhesion to the glass coating, low shrinkage, and be suitable for interior and exterior use.
 - .3 Sealant curing rate at 23°C and 50% RH:
 - .1 Tack free time - 6 to 8 hrs.
 - .2 Final cure time - 10 to 12 days.
 - .4 Neoprene gaskets and tape sealer is not acceptable.
 - .7 Glass Coating:
 - .1 Surface Preparation:
 - .1 The surface preparation of all sheets shall be per the manufacturers published procedures.
 - .2 At all times, firing of the coating shall be in strict accordance with the Manufacturer's quality process control procedures, including firing time, furnace humidity and temperature control.
-

2.1 MATERIALS
(Cont'd)

- .7 Glass Coating:(Cont'd)
- .1 Surface Preparation:(Cont'd)
- .3 Minimum dry coating thickness shall be 7 to 16 mils.
- .4 Internal tanks sheet colour shall be in accordance with the manufacturer's specification for the application.
- .5 External sheet colour shall be Blue or Green.
- .6 Sample tests shall be carried out by the Manufacturer to ensure that the Enamel/Glass shall meet the physical properties and chemical resistance characteristics of the Manufacturer's published specification.
- .2 Inspection at Factory
- .1 Inspection procedures shall be carried out within the Manufacturer's plant under ISO 9001 Quality Systems.
- .2 Finished sheets shall be inspected for coating thickness using an instrument suitable for a measurement range of 0 to 20.0 mils. The instrument shall be regularly checked against the Manufacturer's approved calibration standard.
- .3 The average thickness of the glass coating shall be maintained in the range from 7.0 mils to 16.0 mils. At no point shall the thickness of the glass coating be less than 7.0 mils. Plates having a coating thickness outside of these limits shall be rejected.
- .4 Electronic colour control shall be used on the external surfaces to ensure that allowable colour uniformity is achieved within the Manufacturer's specified parameters. Sheets of a colour outside of these limits shall be rejected.
- .5 An electrical Holiday detection test shall be performed to the internal surface of every sheet in accordance with the Manufacturer's Published Quality Standards.
- .6 Sheets having any discontinuities in the glass contact surface shall be rejected. Only finished sheets with zero glass continuity defects on the surfaces shall be released for packing.
- .7 The Departmental Representative may be present during these factory
-

2.1 MATERIALS
(Cont'd)

.7 Glass Coating:(Cont'd)
.2 (Cont'd)

inspection procedures at their own cost. The Departmental Representative could request all QC documentation from the manufacturer for inspection of the sheets to be supplied for this project.

.3 Roof:

- .1 The materials, design, fabrication and erection of the aluminum roof to conform to the minimum requirements of ANSI/AWWA D103.
 - .2 Roof shall be constructed of non-corrugated triangular aluminum panels which are sealed and firmly clamped in an interlocking manner to a fully triangulated aluminum space truss system of wide flange extrusions, thus forming a dome structure.
 - .3 The dome shall be clear span and designed to be self-supporting from the periphery structure with primary horizontal thrust contained by an integral tension ring.
 - .4 The dome and tanks shall be designed to act as an integral unit. The tanks shall be designed to support an aluminum dome roof including all specified live loads.
 - .5 Tanks with diameters of 4.3 m (14ft) to 9.4 m (31ft) shall optionally include roofs with either radially sectioned Glass-Fused-to-Steel or Stainless Steel (grade 316) plates utilising the same fixings and sealant as the tanks shell.
 - .6 The roof shall be free span and self-supporting.
 - .7 The roof shall be equipped with a 610 mm (24") roof opening for inspection purposes.
 - .8 The roof shall be air limiting and equipped with suitable venting for air displacement when the tanks is filled, emptied and for process air evacuation so as not to allow an internal pressure or vacuum.
 - .9 All venting shall be screened to prevent bird/animal entrance.
-

2.1 MATERIALS
(Cont'd)

.7 Glass Coating:(Cont'd)

.4 Pipe penetrations:

- .1 Where connections are shown to pass through tanks panels, they shall be pre-cut by the tanks Manufacturer prior to glass application. When necessary and with the approval of the Construction Manager, openings may be field located, saw cut, (Acetylene torch cutting, grinding or welding is not permitted) and shall utilize an interior and exterior flange assembly and the tanks shell reinforcing shall comply with AWWA D103 latest edition. Sealer shall be applied on any cut panel edges or bolt connections.

.5 Outside Tanks Ladder:

- .1 An outside tanks ladder and top observation platform shall be furnished and installed as required for ease of inspection and access.
- .2 Ladders shall be fabricated of aluminum and utilize grooved, skid-resistant rungs.
- .3 Ladders shall be manufactured in accordance with current OSHA standards.

.6 Side Wall Access Doors:

- .1 One (1) access door shall be provided as shown on the contract drawings. Such doors shall be a minimum of 750 mm in diameter, and shall include a properly designed reinforcing frame and access hatch. The access door to have a minimum opening size of 750 mm and shall be located in the middle of the tanks sheet clear of any vertical and horizontal bolt seams. The manway shall include a reinforcing frame and cover plate with a hinged support for cover removal. The manway cover plate shall be sealed with an approved gasket system.

.7 Identification Plate:

- .1 A manufacturer's nameplate shall list the tanks serial number, tanks diameter and height, and maximum design capacity. The nameplate shall be affixed to the tanks exterior sidewall at a location approximately 1.5 m from grade elevation in a position of unobstructed view near the access door.

2.1 MATERIALS
(Cont'd)

- .7 Glass Coating:(Cont'd)
- .8 Cathodic Protection:
 - .1 The cathodic protection system shall be of the Sacrificial Anode type for installation inside a bolted steel tanks.

2.2 QUALITY
CONTROL

- .1 Three (3) inspections of fabrication facility will be made by the Departmental Representative to check and assess resin formulation and control, fabrication methods and procedures, quality-control procedures.
- .2 Inform Departmental Representative of following inspections:
 - .1 Arrange first visit before fabrication begins to review materials, quality control procedures and to discuss testing procedures.
 - .2 Arrange final inspection for finished tanks to check critical dimensions, nozzle elevations and orientations, areas with high stress concentrations (lower knuckle radius) and testing of resin cure.

PART 3 - EXECUTION

3.1 PACKAGING

- .1 All sheets shall be protected from damage prior to packing for shipment.
- .2 Heavy paper or plastic foam sheets shall be placed between each panel to eliminate sheet-to-sheet abrasion during shipment.
- .3 Individual stacks of panels shall be wrapped in heavy mil black plastic and steel banded to special wood pallets built to the roll-radius of the tanks panels where necessary.
- .4 Shipment from the factory shall be in such a manner that the GFS sheets are not damaged.

3.2 CONCRETE FLOOR

- .1 The floor design is of reinforced concrete with an embedded glass coated steel starter sheet per the manufacturer's design and in accordance with AWWA D103, Section 11.4, Type 6.

3.2 CONCRETE FLOOR .2
(Cont'd)

- Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed 3 mm, nor exceed 1.5 mm within any 3 m length.
- .3 A leveling plate assembly shall be used to secure the starter ring, prior to encasement in concrete. Installation of the starter ring on concrete blocks or bricks, using shims for adjustment, is not permitted.
- .4 One butyl rubber elastomer waterstop seal shall be placed on the inside surface of the starter ring below concrete flow line. One (1) bentonite impregnated water seal shall be placed below the butyl rubber seal. Materials shall be installed in accordance with tanks manufacturer's instructions.
- .5 The Contractor and tanks supplier shall coordinate all pipe penetrations required in the concrete floor. The tanks supplier shall adjust the design of the foundation and concrete floor to accept the pipe penetrations, including all necessary reinforcing.

3.3 SIDEWALL
STRUCTURE

- .1 Field erection of the glass-coated, bolted-steel tanks shall be in strict accordance with the procedures outlined in the manufacturer's erection manual performed by an authorized dealer of the tanks manufacturer. An electrical Holiday test shall be performed on all surfaces of the tanks shell plates during erection using a nine (9) volt leak detection device having 90,000 ohms resistance. Any electrical leak points found on the surface shall be repaired in accordance with the Manufacturer's published touch-up procedure. Field records of all Holiday testing to be submitted to the Contractor.
- .2 Specialized building equipment developed by the tanks manufacturer shall be used to erect the tanks.
- .3 Particular care shall be taken in handling and bolting of the tanks panels and members to avoid abrasion or cracking of the coating system. Prior to liquid test, all the surface area shall be visually inspected by the Construction Manager.

3.3 SIDEWALL
STRUCTURE
(Cont'd)

- .4 The tanks installer shall coordinate all supports required for the internal and external piping.

3.4 HYDRAULIC
TESTING AND
DISINFECTING_

- .1 Following completion of erection and cleaning of the tanks, the structure shall be tested for liquid tightness by filling the tanks with clean water to its overflow elevation.
- .2 After tank has been filled with water for a minimum of 12 hours, top up to overflow elevation. The structure will be considered to have failed the test if:
 - .1 Water is observed flowing from the structure or;
 - .2 If moisture other than from precipitation or condensation can be transferred to a dry hand from the external surface of the tanks or foundation or;
 - .3 After taking into account, any external factors, the water level in the tanks drops after the tanks has been left in the full position for 24 hours.
- .3 Any leaks disclosed by this test shall be corrected by the erector in accordance with the manufacturer's recommendations.
- .4 One tanks volume of water required for hydraulic testing shall be furnished by the Owner at no charge to the Contractor. Disposal on-site of test water shall be the responsibility of the Contractor and will be coordinated with the Contractor. Any water required for additional testing will be furnished at the expense of the Contractor.
- .5 Field Evaluation Tests. A performance test shall be run on the tanks after the complete installation of the mixing system, aeration system and pumps (when applicable).
- .6 The performance test shall be run to ensure the pump, aeration system and mixing system as a whole are operating properly as determined by the Contractor. The performance test shall be conducted together by the contractor, a capable representative of the tanks manufacturer, and mixing system manufacturer. The Owner's operating personnel shall assist the contractor in the performance test.

3.4 HYDRAULIC
TESTING AND
DISINFECTING_
(Cont'd)

- .7 A designated representative of the Owner and/or the Contractor shall observe and provide final acceptance of the test.
- .8 Performance Test and Field Evaluation Report. The Contractor shall provide test reports, including all measured data and other recorded data and observations related to the tanks, aeration system, pumps and mixing system. The report shall be submitted to the Construction Manager within 30 days after completion of the tests.

3.5 MANUFACTURER'S
REPRESENTATIVE
FIELD SERVICES

- .1 Verify satisfactory delivery of the equipment by completing Form 100.
- .2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101.
- .3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.
- .4 The minimum periods of Site attendance for each tanks supplied are identified in the following table along with the form to be completed on each of these trips.
- .5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Departmental Representative, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

3.6 INSTALLATION
WITNESSING

- .1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.
- .2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.
- .3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102.

3.7 EQUIPMENT
PERFORMANCE
TESTING

- .1 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.
- .2 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103.

3.8 TRAINING

- .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.