1. PART ONE GENERAL

1.1 SUMMARY

.1 Drawings, General Conditions, Division 1 Specification and documents that apply to all work referred to in this section.

.2 Provide experienced management and supervision with the workmanship of skilled tradesmen. Provide quality materials, products, modern specialty tools and equipment to completely install refrigerated slab. All components including place, consolidate, finish and cure of concrete rink slab as required and/or indicated on drawings and specified within this section.

.3 Acceptable Contractors: Reward Construction Ltd. 1 877 725 8001
Global Sport Resources Ltd. 1 877 477 8007

1.2 REFERENCES

.1 ACI 311-4R-05 Guide for Concrete Inspection

.2 CAN/ULS S701-05 Thermal Insulation, Polystyrene, Boards and Pipe Covering

.3 CAN/CSA-A3001 Supplementary Cementitious Materials

.4 CAN/CSA-A23.1-14 Concrete Materials and Methods of Concrete Construction

.5 CAN/CSA-A23.2-14 Standard Test Method for Determining Average Elevation, Slope and Waviness

.6 CAN/CSA G30.5-M1983 (R1991) (R1998), Welded Steel Wire Fabric for Concrete Reinforcement.

.7 CAN/CSA G30.14-M1983 (R1991) (R1998), Deformed Steel Wire for Concrete Reinforcement.

.8 CAN/CSA G30.15-M1983 (R1991) (R1998), Welded Deformed Steel Wire Fabric for Concrete Reinforcement

.9 CAN/CGSB-51.34-M86 Vapor Barriers, Polyethylene Sheet for Use in Building Construction

.10 CAN/CSA-A23.3-04 Design of Concrete Structures

1.3 SUBMITTALS

.1 Product Data: Submit data for each accessory, admixture, and curing material proposed for the work.

.2 Shop Drawings:

.1 Submit Shop Drawings for concrete reinforcement, bar support and accessories for review by the Consultant at least 14 days prior to the placement of the rebar.

.2 Clearly indicate reinforcement sizes, spacing, locations and quantities of reinforcing, bending and cutting schedules, splicing, and supporting and spacing devices.

.3 Shop drawings should indicate procedures, equipment and all components pertinent to the refrigerated concrete floor including but not limited to insulation, piping, chairs, reinforcing steel, placing and finishing of concrete

.4 Quality Control Submittals:

.1 Concrete Mix Designs: Prior to starting work submit mix design for approval.

.2 Submit test results of proposed mix design performed locally less than six months prior to use for approval by Consultants- Engineer and Architect.

.3 Certifications: Submit certificates for cement, fly ash, and aggregates.

.5 Closeout Submittals:

.1 In accordance with Section 017700.

.2 Submit maintenance instructions for finishes within this section.

.3 Submit to Consultants slab floor tolerance report.

1.4 QUALITY ASSURANCE

.1 Perform concrete slab work in accordance with CAN/CSA-A23.1-14

.2 Initiate a pre pour conference a minimum of 2 weeks prior to the refrigerated concrete floor pour

.3 Notify Consultants at least 48 hours before concrete is scheduled to pour

.4 Concrete Ready-Mix Supplier: Member in good standing of the Ready Mix Concrete Association.

.5 Qualifications

.1 Work shall be performed by a company regularly engaged in the installation of refrigerated concrete floor and the application of concrete materials. Provide proof that the contractor has successfully completed at least three (3) projects of similar size and complexity in the past five (5) years.

.2 Concrete slab work shall be performed by an established concrete floor finishing contractor with a proven track record of satisfactory, consistent quality workmanship for a period of a minimum five years related to refrigerated floor slab and other stringent floor tolerance specified concrete floor slabs. Floor finishing contractor must have successfully performed a minimum of twenty-five refrigerated slabs utilizing specialized mechanical laser-guided power screed equipment. Approved contractor must show proof of this requirement to the consultant in advance of issuing contract.

.6 Warranty

.1 Provide written warranty against defects which appear in the finished work within a period of 1 year after acceptance of the building by the Owner, and which are judged by the Consultant to be the result of lack of bond, faulty workmanship or materials provided under this section.

.7 Coordination

.1 Coordinate the work of this section with the Ice Refrigeration Section.

.2 Coordinate the location of inserts for hockey goals, dasher boards and inserts for other events.

.3 Coordinate the work of this section with the Caulking and Sealant Section

.4 All sensors supplied and installed by others

1.5 SITE CONDITIONS

.1 Environmental Requirements:

.1 Perform all work of this section under conditions set forth within 033000.

.2 Perform Cold weather concreting to CSA Standard: ensure adequate and proper temporary heating is provided.

.3 Perform Hot weather concreting to CSA Standard: prevent rapid drying-evaporation of surface bleed water to reduce plastic shrinkage cracking.

.2 Protection

.1 Keep traffic which would affect or disturb the curing procedures off the surfaces for a period of 7 days minimum

.2 Protect exposed concrete finishes against damage until the building is accepted by the Owner.

.3 Protect items set into floors from damage; ensure that alignment is not disturbed

1.6 INSPECTION AND TESTING

.1 CONCRETE

.1 Slab concrete will be tested according to section 033000, by a testing firm retained by the Owner.

.2 Submit proposed mix design to testing firm.

.3 Obtain Consultants approval of reinforcing before placement of concrete commences.

.4 Advise testing firm in advance of concrete slab placement. Testing firm shall attend pre-pour conference.

.5 Testing firm will do the following:

.1 Take three test cylinders from each 40 m^3 of concrete, or fraction thereof, of each type of concrete placed in any one day.

.2 Take samples of concrete mix at point of discharge into the floor slab.

.3 Make at least one slump test and one air test for each set of test cylinders taken

.2 PIPING

.1 Brine piping pressure and leak testing

.1 Test all of the piping in the presence of the engineer or his representative.

.2 Test new piping with air to 210 kPa (30 psi).

.3 Protect accessories when performing test.

.4 Repair leaks and retest.

.2 Air pressure on the piping must stay constant during a period of 24 hrs prior to placing concrete and must remain constant during the concrete pour.

2. PART TWO. PRODUCTS

2.1 CONCRETE MATERIALS

.1 Produce, supply and deliver well proportioned ready-mix concrete specified in Concrete Mix Schedule under section 033000, unless otherwise specified within this section or established for approval before, during and after pre-slab pour meeting(s).

.2 Requirements not specified in Schedule shall conform to CAN/CSA A23.1-09

.3 Portland Cement: to CAN/CSA-A3000. Normal – Type 10.

.4 Fly Ash: Supplementary Cementing Materials (SCM): maximum 15% total Cementitious Content; type C or F; loss of ignition (LOI) not to exceed one percent. Use fly ash from one single source for entire slab installation.

.5 Total Cementitious Content shall be 320 kg/m3 for 32 MPa at 28 days.

.6 Maximum Water to Cementitious Material (W/CM) Ratio shall be 0.45 – 0.47

.7 Aggregates: normal weight fine and coarse aggregates to CAN/CSA A23.1-09, and shall be clean and properly graded (no gaps) with a maximum top size aggregate of 20mm (3/4")

2.2 ADMIXTURES

.1 Concrete shall contain the specified water reducing or high range water reducing admixture (Superplasticizer) complying with CAN/CSA A23.5-09

.2 Superplasticizer shall only be used to increase slump for flow-ability around refrigeration piping and reinforcing beyond maximum specified designed water slump while maintaining a maximum w/cm ratio of 0.45 – 0.47.

.3 Slab concrete placed in ambient temperatures less than 10C shall contain an approved compatible accelerator at the manufactures required dosage.

.4 Slab concrete placed in ambient temperatures at 30C or above shall contain an approved compatible set retarder at the manufactures required dosage.

.5 Air content shall be less than 2% and shall not be entrained air.

.6 Concrete for the refrigerated slab shall meet the following general requirements.

.1 Minimum 28-day strength:	32 MPa
.2 Maximum size of coarse aggregate:	20 mm
.3 Slump range before plasticizing	100 mm +- 20mm
.4 Slump range at discharge	180 mm +- 20mm

2.3 REINFORCING MATERIALS

.1 Reinforcing Steel: to CAN/CSA G30.18, [grade noted on drawings] [[300] [350] [400] [500] MPa]] yield grade deformed billet steel bars except for beam stirrups and column ties use only 300 MPa yield grade or 400 MPa yield grade to CAN/CSA G30.18.

.2 Reinforcing Steel: to CAN/CSA G30.18, 400 MPa yield grade special low alloy deformed billet steel for welding and/or bending.

.3 Welded Steel Wire Fabric: to CAN/CSA G30.5. Size of welded steel wire fabric shall be 152 x 152 x MW18.3/MW18.3 flat sheets.

.4 "M" style Pipe/Rebar Chairs shall have a spacing of no more than 600 mm to provide adequate support.

.5 Use intermediate grade, deformed steel, free from loose rust or scale, without sharp offsets or bends and conforming to CAN/CSA. Bar lengths shall not be less than 6m (20ft)

2.4 FORMWORK MATERIALS

.1 As per section 03 10 00 – Concrete Formwork

.2 Forms must be capable of the degree of adjustment necessary to achieve the construction tolerances specified herein.

2.5 SAND BED

.1 Clean coarse river sand, free from clay, shale, organic matter, complying with ASTM C136 and ASTM C117.

Aggregate Size	Percentage Passing (mm)
10 mm	100
4.75 mm	95 – 100
2.36 mm	80 – 100
1.18 mm	50 – 85
0.6 mm	25 – 60
0.30 mm	10 – 30
0.15 mm	2 - 10

2.6 INSULATION

.1 Rigid closed cell, board insulation under rink slab: Expanded polystyrene (EPS) board complying with CAN/ULC S701, Type 4 RSI-0.87 per 25mm (R-5) thickness and a minimum compressive strength of 210 kPa (30 psi) at 5% deformation or yield;
Acceptable materials:
.1 "SM" by Dow Industries
.2 "Foamular 300" by Owens Corning

2.7 RINK SLIP SHEET

.1 Slip Sheet: Minimum 0.15mm (6 mil) thick polyethylene sheet. Polyethylene film must not be bonded to the insulation.

2.8 RINK SLAB PIPING

.1 Cold Brine Headers

.1 Provide steel cooling headers for the ice surface.

.1 Header size: 6” SDR 11
.2 Header material: HDPE pipe
.3 Pipe nipples
.1 Size: 6”x1” HDPE saddles
.2 Spacing on header: 50mm in from outside edges of refrigerated slab and 100mm spacing on remainder of header.
.4 Provide NPS 6 butterfly valves to isolate the supply and return headers for each floor.
.5 Provide 1” drain and 1” purge valves at both ends of each header and at the inlet side of each floor isolation valve

.2 Cold floor piping

.1 Provide floor rink pipe running parallel to each other and connected to each header saddle.

.1 Material: Provide 25mm (1” ID) SDR 13.5 High Density Polyethylene rink pipe.
.2 Header connection: All nipple joints to be socket fused on to header saddles with appropriate socket fusing irons
.3 Return Bends: Pre manufactured SDR 13.5 HDPE U-bends.
.1 Joints to be socket fused with appropriate socket fusing irons

.3 Warm Brine Headers

.1 Provide steel warm headers for underside of ice surface.

.1 Header size: 4” SDR 11
.2 Header material: HDPE pipe
.3 Pipe nipples
.1 Size: 4”x1” HDPE saddles
.2 Spacing 300 mm
.4 Provide NPS 4 butterfly valves to isolate the supply and return headers for each floor.
.5 Provide 1” drain and 1” purge valves at both ends of each header and at the inlet side of each floor isolation valve

.4 Warm Floor Piping

.1 Provide floor rink pipe running parallel to each other and connected to each header saddle.

.1 Material: Provide 25mm (1” ID) SDR 13.5 High Density Polyethylene rink pipe.
.2 Header connection: All nipple joints to be socket fused on to header saddles with appropriate socket fusing irons

.3 Return Bends: Use continuous floor pipe at a minimum radius of 450 mm for the return bend

3. PART THREE. EXECUTION

3.1 INSPECTION

.1 Prior to starting work carefully examine installed work of other trades scope of work and verify that such is complete to the point where work of this section may properly commence. Notify Consultant in writing of conditions detrimental to the proper and timely completion of the work.

.2 Do not begin installation until all unsatisfactory conditions are resolved.

.3 Verify that sub-slab has been properly placed and levels are within acceptable tolerances.

3.2 INSTALLATION-SAND BED

.1 Provide a minimum 12” sand bed compacted to specified density.

.2 Install warm floor rink pipe in conjunction with the sand bed.

.3 Ensure that the sand is graded using a mechanically laser guided screed to the required tolerance:
- .1 6 mm variation within a 3000 mm straight edge.
- .2 Overall variation of +- 6 mm

3.3 INSTALLATION-UNDER SLAB INSULATION

.1 Install two layers of 38mm (1 1/2”) thick insulation under rink slab area.

.2 Lay insulation boards tightly butted with joints staggered, and secure such that insulation is not damaged or displaced when concrete is placed

.3 Install second layer of insulation ensuring that the joints do not line up with the joints in the first layer.

3.4 INSTALLATION-SLIP SHEET

.1 Install polyethylene sheet with 150 mm lapped joints to provide a surface effectively resistant to absorption or moisture transmission.

.2 Polyethylene sheets must be sealed at laps.

.3 Any damage to the slip sheet shall be effectively repaired to preserve the integrity of the moisture resistant surface prior to pouring the refrigerated slab.

.4 Maintain slip sheet surfaces clean and free of contaminates at all times.

3.5 INSTALLATION-EXPANSION JOINT

.1 Place closed cell expanded, polystyrene insulation 25 mm (wide), expansion strip around perimeter of the ice area. Joint material shall be properly set in place against concrete bulkhead and must run from top of insulation to finished elevation of rink slab.

.2 Expansion joint shall be sealed with premium-grade, polyurethane-based, elastomeric sealant.
Acceptable materials:
.1 SikaFlex 2C SL

3.6 INSTALLATION- CHAIRS, REINFORCING

.1 Place “M” style pipe chair supports of continuous metal base type at 600mm centers on the slip sheet.

.2 Slab Reinforcing shall be installed as indicated on reviewed shop drawings according to CAN/CSA Standard. Top reinforcing shall be laid and lapped in a manner as to not exceed 2 layers, and securely tied to pipe chair supports.

.3 Tie wires must be turned away from plastic pipe to avoid damage.

.4 Prior to placing concrete, obtain Consultants approval of reinforcing and placement.

3.7 INSTALLATION-RINK SLAB PIPING

.1 Install systems and related controls in accordance with reviewed shop drawings.

.2 Install new warm floor headers.

.3 Install new cold floor headers.

.4 Install new HDPE plastic pipe.

.5 Install new brine isolation valves.

.6 Run all connection piping as per drawings to minimize service conflicts.

.7 Supply all secondary support steel and hangers as required.

.8 All cutting and patching, including coring, is by others. Location of all wall penetrations must be approved by the site structural engineer prior to work beginning.

3.5 PLACING CONCRETE

.1 Perform concrete work in accordance with CAN/CSA-A23.1-14

.2 Place refrigerated concrete slab as one continuous operation to be completed within eight hours of commencement.

.3 Do not displace or damage reinforcing and piping during placing of concrete.

.4 Concrete shall be placed in 3m to 3.65m (10'-0" to 12'-0") lanes running transversely across the rink, starting at one side each time so that new concrete will be placed against the oldest concrete in the previous lane.

.5 The use of internal concrete vibrators will not be permitted on plastic pipe freezing system. Consolidation will be achieved by vibrating horizontal beam on laser guided equipment.

.6 Initial strike off concrete will be achieved by mechanically laser guided screed and then level and consolidate with a mechanically laser guided vibrating screed.

.7 Secondary back up equipment must be on site and in good working order in case of primary equipment failure.

.8 When concrete has stiffened sufficiently to sustain foot pressure and no bleed water is present, float concrete with minimum 60" pan floats to maintain floor flatness.

3.6 CONCRETE FINISHING FLATWORK

.1 Perform concrete work in accordance with CAN/CSA-A23.1-14

.2 Maximize the number of pan floating passes depending upon timing and stiffening characteristic of the concrete.

.3 Final machine steel troweling shall produce a surface that is hard, smooth, and densely troweled.

3.7 INSTALLATION-LIQUID CONCRETE HARDENER

.1 Apply liquid concrete hardener "Pentra-sil HD" by Convergent Concrete Technologies

.2 Install liquid concrete hardener according to manufactures recommendations

3.7 FLOOR SLAB TOLERANCE

.1 Refrigerated Ice Rink concrete floor slab tolerance classification in accordance with CAN/CSA A23.1-14 and CAN/CSA A23.2-10B

.1 CAN/CSA A23.1-14, Table 21, Classification D, "Extremely Flat"

.2 Floor slab tolerance measured using F-number method rather than using Straightedge method according to ASTM E 1155M

.3 Specified Overall Values (SOV)
Flatness: Ff 45
Levelness: Fl 30

.4 Minimum Local Values (MLV)
In accordance with CAN/CSA-A23.1-14 shall be 60% of the SOV

.4 Inspection and floor tolerance measurements shall be made within 72 hours after final troweling of floor slab.

.5 Specified floor tolerances that fall below the MLV shall be corrected by grinding

3.9 CURING AND PROTECTION

.1 Refrigerated slab shall be wet cured for a minimum of 7 days.

.2 Wet cure shall be accomplished by complete submersion of refrigerated slab, followed by covering with a layer of polyethylene or curing blankets to reduce evaporation. Maintain a sufficient depth of water to prevent formation of dry spots.

.3 Leave all formwork in place for the duration of the wet curing. Take special care to prevent water from seeping below refrigerated slab.

.4 After 28 days protect the finished concrete surface at all times from abrasion, concentrated construction point loads, and impact damage.

.5 After 28 days ramp construction traffic over all edges to protect exposed concrete from chipping.

END OF SECTION