SECTION 13 18 00.20

ICE RINKS - CO2 STANDARD REFRIGERATION SYSTEMS

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\*\* NOTE TO SPECIFIER \*\* CIMCO Refrigeration, Inc.; recreational ice rinks  
.  
This section is based on the products of CIMCO Refrigeration, Inc., which is located at:  
1551 Corporate Dr,  
Burlington, ON L7L 6M3  
Toll Free: 800-267-1418  
Phone: 416-465-7581  
Fax: 416-465-8815  
Email: \_\_\_\_\_\_\_\_.  
Web: https://www.cimcorefrigeration.com/industries/recreational-ice-rinks/ice-rink-solutions  
[Click Here]  
Whether you are 10 years old or a 10-year pro hockey player, there is nothing like the feeling of skating on perfect ice. At CIMCO, we believe that everyone deserves the opportunity to enjoy that amazing experience - and that is why we work hard to make your perfect ice as affordable, efficient, and reliable as possible.  
From ultra-economical ice systems to environmentally-friendly alternatives to fully-integrated thermal solutions, CIMCO offers a wide range of Recreational Ice Solutions designed to meet and exceed the requirements of any arena facility. CIMCO solutions feature distinct cooling layouts, control simplicity, floor design and effective engineering - all brought together to ensure a reliable, low maintenance system.

1. GENERAL
   1. SECTION INCLUDES

\*\* NOTE TO SPECIFIER \*\* Delete items below not required for project.

* + 1. Ice Rink systems with CO2 refrigeration and related requirements:
  1. RELATED SECTIONS

\*\* NOTE TO SPECIFIER \*\* Delete any sections below not relevant to this project; add others as required.

* + 1. Division 22 PLUMBING, for plumbing requirements not specified in this section.
    2. DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING, for HVAC requirements not specified in this section.
    3. DIVISION 26 ELECTRICAL, for electrical requirements not specified in this section.
  1. REFERENCES

\*\* NOTE TO SPECIFIER \*\* Delete references from the list below that are not actually required by the text of the edited section.

* + 1. American National Standards Institute (ANSI):
       1. ANSI/IIAR Standard 2-1992.
       2. ANSI/ASME B31.1 - Power Piping.
       3. ANSI/ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
       4. ANSI/ASME - Boiler and Pressure Vessel Code.
    2. American Society of Heating Refrigeration and Air Conditioning Engineers.
       1. ASHRAE/ANSI - 15 Safety Code for Mechanical Refrigeration.
    3. International Building Code.
    4. International Fire Code.
    5. International Mechanical Code.
    6. International Institute of Ammonia Refrigeration:
       1. IIAR-2 Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems.
  1. DEFINITIONS
     1. Engineer: Ice Rink Systems Designer's Representative.
     2. Installer: The Contractor performing the work specified of this Specification and on the R-Drawing sheets.
     3. Ice Rink System: Equipment, piping, physical construction, and materials required to install a fully functional, code compliant ice rink, including refrigeration system, ice rink floor, ice rink piping, valves, controls, electrical, waste heat recovery, dasher boards, and accessories.
  2. UNIT PRICES
     1. Submit unit prices stating increase or decrease to Contract Price for additional or deleted work listed. This allows accurate comparison between base system bid prices. Unit prices to include labor, materials, products, equipment, services and respective overhead, profit, taxes, disbursements, and related charges, and represent the actual addition or credit to the Contract Price.
  3. SUBMITTALS
     1. Submit under provisions of Section 01 30 00 - Administrative Requirements.
        1. Submittals: On company letterhead, signed by authorized representative of company. Include project description, portion of project completed by the company, location, construction cost, completion date, Owner's name, Owner's Representative, phone number and completion date of work.
     2. Product Data:
        1. Manufacturer's data sheets on each product to be used.
        2. Preparation instructions and recommendations.
        3. Storage and handling requirements and recommendations.
        4. Typical installation methods.
        5. Spare Parts lists the different systems.
     3. Shop Drawings: Material details, construction, and finish. Relationship with adjacent construction.
     4. Motor Control Panel: Prior to ordering submit one copy of engineered panel drawings to Municipality for review.
        1. Drawings must indicate:
           1. All refrigeration equipment excluding electrical connections,
           2. Control panel electrical schematic.
           3. Control panel enclosure dimensions including location of all gauges, switches, lights, controls, and labels.
     5. Dasher Board Systems: To be of appropriate scale, dimensions, and details.
        1. Shop Drawings: Submitted by Manufacturer to Contractor for Engineer, Architect or Owner approval prior to fabrication. Include but not limited to the arena board system, glazing assemblies, and detail, and joining methods.
           1. Joining Methods: Fastening, joint locations, methods of anchoring, sizes of anchorage's, and hardware.
           2. Details of other pertinent components of the Work, and adjacent constructions to which work of this Section will be attached.
        2. Dimensioned layout and placement drawings for installation of floor anchors.
        3. Verification Samples. Materials, finishes and colors for review.
        4. Operation and Maintenance Data On completion of installation, supply three copies of instructions covering removal and replacement of panel system, reglazing, adjustments, and other relevant operating and maintenance data.
        5. Provide "As Built" drawings showing overall layout of the boards and glass.
     6. Ice Rink Control System:
        1. Network Diagrams: Supervisory devices, field level controllers, and point-to-point wiring diagrams. Detail diagrams down to a level acceptable for troubleshooting and problem analysis. Modify device templates to show how the device is wired.
        2. System and Process Flow Schematics: For control device and identification of points.
        3. Point Schedule: Minimum data for system points: Name, Type, Expanded Description, Display units, Controller Identification and Controller Address.
        4. Samples of graphics and screen menus.
        5. Point Schedule: Minimum data for system points: Name, Type, Expanded Description, Display units, Controller Identification and Controller Address.
        6. Samples of graphics and screen menus.
        7. Product Data Sheets: With identifying marks depicting the exact device or component used.
        8. Interconnections: Detailed wiring diagrams depicting connections and modifications made to motor control center, compressors, VFD's etc.
     7. Progress Schedule. Before the Project begins.
     8. Test Reports and Certifications. Electronic copies to Engineer when specified.
     9. Operation and Maintenance Manuals (O/M Manuals). Electronic soft copies for review. Final electronic copies to be available for owner to download.
        1. Include the following in addition to Division 1 requirements.
           1. Electronic Copy: Self-contained. Include software to access product data.
           2. System Description: Description of controls. Step by step written instructions on operating control system.
           3. Table of Contents: Dynamic links to view and print product data.
           4. Viewer Software: Ability to display, zoom, and search documents.
           5. As-Built System Record Drawings: Record Drawings representing as-built conditions. Incorporate information supplied with approved submittal.
           6. Manufacturer's Product Data Sheets: All products including software.
           7. System and Software Operator's manuals.
           8. Archive copy of site-specific databases and sequences.
           9. IRCS and BMS network diagrams.
           10. Interfaces to third-party products and work by other trades.
           11. Operating license for software.
           12. Start-Up and Shut-Down Procedures: Detailed instructions, system checks, safety device checks, valves number references, typical levels in vessels, etc.
           13. Equipment and Valve Data:

Approved shop Drawings.

Parts list.

Detailed Wiring Diagrams: Electrical and control systems and other electrical and control information.

Maintenance and operation.

Trouble shooting.

Address and contact information of manufacturers and service representatives for each piece of equipment.

Warranties: Including project, equipment, and material warranties.

Valve List: Valve number, description, manufacturer, and operation.

Schematics: Locations of valves, equipment, and controls.

* + - * 1. Test Records:

Material and fluid tests for concrete, sand, glycol, CaCl2, etc.

Pipe pressure tests for refrigeration system piping, rink floor piping, and transmission mains.

* + - * 1. Certifications of inspections by regulatory agencies.
        2. Record plan information of pipe routing, joint locations on underground transmission mains, wiring diagrams, equipment layout, valve locations, etc.
        3. Daily checklist form for recording operation of refrigeration system.
    1. Closeout Documents: Required by General Conditions and these specifications.
       1. Final Payment Request: Include the following.
          1. Insurance certificates for products and equipment where required.
          2. Proof that taxes, fees, and similar obligations are paid.
          3. Contractors Affidavit of Payment of Debts and Claims, AIA Document G706.
          4. Contractors Affidavit of Release of Liens, AIA Document G706A.
          5. Consent of Surety to Final Payment, AIA Document G707.
          6. Final pay request document accurately reflecting the contract amount.
          7. All outstanding shop Drawings.
          8. Final liquidated damages settlement statement.
  1. QUALITY ASSURANCE
     1. Any deviations from this specification, unless approved in writing by the owner, will be charged back to the supplier at the Owner's discretion.
     2. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with five years documented experience.
     3. Installer Qualifications: Company specializing in performing Work of this section with five years documented experience with projects of similar scope and complexity.
        1. Installer of Refrigeration Systems: Successfully installed similar systems for five construction projects completed in the past five years.
        2. Placing and Finishing Concrete: Placement and finishing of concrete on 8 concrete ice rink floor construction projects in the past 5 years.
        3. Controls Systems: Completed programming and installation of 2 ice rink projects in the past 5 years.
        4. Expansion Joint Systems: Completed twenty projects using the same type of joint.
        5. Motor Control Panel: Completed Five (5) - Refrigeration MCP installations within the last year. Provide references.
        6. Ice Rink Control Systems:
           1. As evidence and assurance of the Contractor's controls subcontractor's ability to construct the project, the control subcontractor must have successfully completed the design, programming, and installation of ten (10) ice rink control systems similar to this project within the past three (3) years.
           2. Experience in implementing Ice Rink Controller Systems framework, projects size and scope, specifically related to ice rink system.
     4. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.
  2. PRE-INSTALLATION CONFERENCE
     1. Convene a conference 2 weeks before scheduled commencement of Work. Attendees include Architect, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.
  3. DELIVERY, STORAGE, AND HANDLING
     1. Transport, store, and handle in strict compliance with manufacturer's written instructions and recommendations.
     2. Protect from damage due to weather, excessive temperature, and construction operations.
        1. Store products with seals and labels intact and legible.
  4. PROJECT CONDITIONS
     1. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
  5. WARRANTY
     1. In addition to the standard manufacturer's warranty on all equipment and materials, the contractor shall provide a standard one-year materials and labor warranty on all work performed for this project.
     2. Signage: Legible permanent signs on outside of ice rink equipment mechanical room doors as detailed on Drawings and as follows:
        1. Informative Signs, Emergency Signs, Charts, and Labels: Per NFPA 704, ANSI/IIAR, ANSI Z535.2 and International Mechanical Code.
           1. For Ammonia Refrigerant: NFPA 704 or Fire Diamond numbering to be 3-3-0-blank (blue- red-yellow-white) or per current code requirements.
           2. Provide other signs required by code even if not shown on Drawings.
           3. Next to strobe lights and audible alarms.
           4. Next to emergency stop buttons and ventilation, enable switches.
        2. Schematic Drawing or Panel: Operation directions per ASHRAE-15 paragraph 11.7.
        3. If the Owner requires format (font, size, colors, etc.) of signage to match signage in the facility, provide format required by Owner unless it does not meet code requirements.
     3. Motor Control Panel: One year parts and labor warranty from start-up date. Including 2 hour emergency response time in the event of failure of the system.
     4. Ice Rink Control System:
        1. One-year parts and labor warranty from start-up date.
        2. The refrigeration contractor shall carry the warranty for the control system as part of the total refrigeration installation. The owner shall have a single source of responsibility for both the refrigeration system and the control system.
        3. The refrigeration contractor shall provide 24/7 customer support services for the control system for the duration of the warranty period.

1. PRODUCTS
   1. MANUFACTURERS
      1. Acceptable Manufacturer: CIMCO Refrigeration, which is located at:  
         150 Parkway W.  
         Duncan, SC 29334  
         Toll Free Tel: 800-267-1418  
         Email: [request info (DFauser@Toromont.com)](https://arcat.com/rfi?action=email&company=CIMCO%252BRefrigeration&message=RE%253A%2520Spec%2520Question%2520(13177cim)%253A%2520&coid=53279&spec=13177cim&rep=&fax=);Web: <https://www.cimcorefrigeration.com/industries/recreational-ice-rinks> | <https://www.cimcorefrigeration.com/>
      2. Basis of Design: Ice Rinks with CO2 Refrigeration Systems.

\*\* NOTE TO SPECIFIER \*\* Delete one of the following two paragraphs; coordinate with requirements of Division 1 section on product options and substitutions.

* + 1. Substitutions: Not permitted.
    2. Requests for substitutions will be considered in accordance with the provisions of Section 01 60 00 - Product Requirements.
  1. PROJECT SCOPE DEFINITION
     1. Ice Rinks:

\*\* NOTE TO SPECIFIER \*\* Delete either "New Construction" or "Retrofit existing systems" option, whichever is not required. Delete the "Number of Skating Rinks" options that do not apply to the project

* + - 1. New construction.
      2. Retrofit existing systems.
      3. Number or Skating Rinks: One.
      4. Number or Skating Rinks: Two.
      5. Refrigeration Systems:

\*\* NOTE TO SPECIFIER \*\* New construction only uses a Glycol secondary refrigeration system. Retrofit systems may be Glycol or Brine.   
 New and retrofit systems may have an ammonia evaporative or adiabatic condenser. If sustainability is an issue the adiabatic condenser is the recommended choice for new and retrofit systems. Delete the condenser options not required.

* + - * 1. Secondary Refrigeration Systems: Glycol.
        2. Secondary Refrigeration Systems: Brine.
        3. Condenser: CO2 Adiabatic Gas Cooler.
        4. Condenser: Water Brazed Plate and Frame Gas Cooler.
        5. Condenser: Water Brazed Plate and Frame Gas Cooler replaces Adiabatic Gas Cooler.
      1. Piping, Valves, and Accessories:

\*\* NOTE TO SPECIFIER \*\* Delete the piping material option not required.

* + - * 1. Piping Material: Stainless Steel Sch 10 and Sch 40.
        2. Piping Material: High-density polyethylene.
      1. Equipment Redundancy:

\*\* NOTE TO SPECIFIER \*\* Delete the "Backup Cold Pumps"option not required.

* + - * 1. Backup Cold Pumps: Required.
        2. Backup Cold Pumps: Not required.
      1. Green Options:

\*\* NOTE TO SPECIFIER \*\* Delete the "Desuperheater" option not required.

* + - * 1. Desuperheater: Yes. Does not replace anything.
        2. Desuperheater: No.

\*\* NOTE TO SPECIFIER \*\* Delete any of the next six items that are not part of the project scope.

* + - 1. Motor control panels.
      2. CO2 140 degrees F Water heat exchangers.
      3. Dasher board systems.
      4. Control systems.
      5. CO2 95 degrees F Glycol Heat Recovery System: Underfloor and snow melt
  1. PERFORMANCE AND DESIGN REQUIREMENTS
     1. Standards Compliance:
        1. Selected Contractor must comply with all codes and standards (latest versions) applicable to this type of work, including:
           1. International Code.
           2. IIAR-2 CO2
           3. ASHRAE 15 Safety Code for Mechanical Refrigeration.
           4. ASME B31.5 Refrigeration Pressure Piping Code.
           5. WCB Regulations.
     2. Design Requirements for Refrigeration Capacity:
        1. Operating Season: 12 month.
        2. Rink Duty: Hockey Facility.
        3. Primary Refrigerant: Carbon Dioxide (R744).

\*\* NOTE TO SPECIFIER \*\* Delete system type options not required.

* + - 1. Secondary Refrigerant System Type: New glycol system.
      2. Secondary Refrigerant System Type: Retrofit glycol system.
      3. Secondary Refrigerant System Type: Retrofit brine system.

\*\* NOTE TO SPECIFIER \*\* Delete number of rinks options not required.

* + - 1. Plant Capacity for 1 Rink: Tons of Refrigeration (TR): 100
         1. Refrigerated Surface Arena: 1 sheet, a minimum of 85 x 200 ft; 17,000 to 20,000 sq ft.
      2. Plant Capacity for 2 Rinks: Tons of Refrigeration (TR): 200
         1. Refrigerated Surface Arena: 2 sheets, a minimum of 85 x 200 ft each; 34,000 to 40,000 sq ft.

\*\* NOTE TO SPECIFIER \*\* Delete if new rink floor is not required.

* + 1. Design Requirements: New rink floor system.
       1. Rink Cold Piping: High-density polyethylene (HDPE).
       2. Rink Cold Piping: Carbon Steel Schedule 40.
       3. Rink Floor Cold Pipe Spacing: 3 inches.
       4. Rink Floor Cold Pipe Spacing: 3.5 inches.
       5. Rink Floor Cold Pipe Spacing: 4 inches.
       6. Rink Floor Warm Pipe Spacing: N/A (outdoor)
       7. Rink Floor Warm Pipe Spacing: 18 inches.
       8. Rink Floor Warm Pipe Spacing: 20 inches.
       9. Rink Floor Warm Pipe Spacing: 24 inches.
       10. Concrete Floor Thickness / psi: 5 inches 4000 psi.
       11. Concrete Floor Thickness / psi: 5 inches 5000 psi.
       12. Concrete Floor Thickness / psi: 6 inches 4000 psi.
       13. Concrete Floor Thickness / psi: 6 inches 5000 psi.
       14. Rink Floor Insulation: 3 inches 25 psi.
       15. Rink Floor Insulation: 3 inches 40 psi.
       16. Rink Floor Insulation: 3 inches 60 psi.
       17. Rink Floor Insulation: 4 inches 25 psi.
       18. Rink Floor Insulation: 4 inches 40 psi.
       19. Rink Floor Insulation: 4 inches 60 psi.
       20. Cold Headers Type: HDPE DR11.
       21. Cold Headers Type: Steel Sch 40.
       22. Warm Header Type: HDPE DR11 Buried.
       23. Warm Header Type: Steel Sch 40 Buried.
       24. Warm Header Type: Steel Sch 40 Exposed.

\*\* NOTE TO SPECIFIER \*\* For new and existing systems, Delete the following paragraph if specifying Calcium Chloride or Brine.

* + 1. Additional Design Criteria: Ethylene Glycol
       1. Cold Floor Secondary Refrigerant: 40 percent by wt. Ethylene Glycol.
       2. Warm Floor Secondary Refrigerant: 40 percent by wt. Ethylene Glycol.
       3. Condenser Secondary Refrigerant: 40 percent by wt. Ethylene Glycol.
       4. Heat Reclaim Secondary Refrigerant: 40 percent by wt. Ethylene Glycol.
       5. Evaporative Temperature: 3.5 degrees F.
       6. Gas Cooler Leaving Temperature: 83.5 degrees F for Adiabatic Gas Cooler.
          1. Gas Cooler Leaving Temperature: 90 degrees F for Brazed Plates.
       7. Cold Floor Glycol Supply Temperature: 13.0 degrees F.
       8. Cold Floor Glycol Return Temperature: 16.0 degrees F.
       9. Power: 3/60/460 Volt.
       10. Control: 1/60/120 Volt.

\*\* NOTE TO SPECIFIER \*\* For new and existing systems, Delete the following paragraph is specifying Ethylene Glycol.

* + 1. Additional Design Criteria: Calcium Chloride or Brine
       1. Cold Floor Secondary Refrigerant: 21 percent Calcium Chloride or Brine.
       2. Warm Floor Secondary Refrigerant: 21 percent Calcium Chloride or Brine.
       3. Condenser Secondary Refrigerant: 21 percent Calcium Chloride or Brine.
       4. Heat Reclaim Secondary Refrigerant: 21 percent Calcium Chloride or Brine.
       5. Evaporative Temperature: 3.5 degrees F.
       6. Gas Cooler Leaving Temperature: 83.5 degrees F for Adiabatic Gas Cooler.
          1. Gas Cooler Leaving Temperature: 90 degrees F for Brazed Plates. Cold Floor.
       7. Calcium Chloride or Brine Supply Temperature: 13.0 degrees F.
       8. Cold Floor Calcium Chloride or Brine Temperature: 16.0 degrees F.
       9. Power: 3/60/460 Volt.
       10. Control: 1/60/120 Volt.

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. REFRIGERATION SYSTEM
     1. Scope of Work:
        1. Ice Rink Equipment work called for, or implied, together with necessary incidentals, whether referred to or not, as will be required to complete the Work to the full intent and meaning of the specifications.
        2. The Work includes, but is not limited to the following:
           1. A central ice rink refrigeration package to serve the arena ice sheet. The package will consist of reciprocating compressors, evaporators, gas coolers, cold glycol pumps, heat reclaim system, starter, and control panel.
           2. Heat Rejection Equipment: Along with power wiring between Heat Rejection Equipment and refrigeration control panel. Include field mounted disconnect switch.
           3. CO2 leak detector.
           4. Initial charge of CO2 Refrigerant, Oil and Ethylene Glycol for rinks and Refrigeration Package.
           5. Necessary power and control wiring between starter panel and refrigeration equipment.
           6. Necessary Glycol and Water piping between refrigeration package, cooling tower and rink floor.
           7. Necessary CO2 and glycol insulation.
           8. One year warranty.
           9. Start up and commissioning.
           10. Training.
     2. Related Work by Other Divisions:
        1. Cutting, patching, sleeving, sealing, and fireproofing of floor, wall and ceiling openings for all refrigeration system piping and related electrical conduits.
        2. Direct outside wall opening and interior passageways for rigging of the refrigeration package into the ice plant room.
        3. Temporary lighting, heating, 120 V power and water. Should refrigeration contractor require additional light, heat, or power, he shall provide it to complete his work.
        4. Refrigeration Room to be constructed in accordance with current edition of the International Mechanical Refrigeration Code.
        5. Refrigeration Room exhaust and fresh air make-up to meet the current international Mechanical Refrigeration Code.
        6. Heat for Refrigeration Room to maintain minimum 65 degrees F room temperature. Open flame heater is not acceptable.
        7. Forming, steel re-enforcing and pouring of level concrete housekeeping pads for refrigeration package.
        8. 1-1/2 inch cold water service with valved back flow preventer inside the ice pant room for initial system filling.
        9. Floor drain in ice plant room.
        10. One 800 amp, 460 V/3 Ph/60 Hz electrical power supply and conductors terminated at refrigeration package starter panel disconnect switch lugs.
        11. 120 V power to the refrigeration package DDC control panel.
        12. 120 V power to the Ammonia leak detector and run control wiring from the Ammonia leak detector to exhaust fans and dampers.
        13. Necessary partitions around construction areas for dust control.
        14. Supply structural concrete isolation/inertia pads for refrigeration equipment.
        15. Supply pads and counterflashing for roof supported pipe supports, etc.
        16. Supply and install necessary level support or platforms for the cooling tower.
        17. Specialty valves such as a back flow preventer required by the local Public Utilities.
        18. Subgrade prepared per recommendations of soils engineer and structural engineer.
        19. Excavation and back filling for placement of four (4) access vent boxes, concrete slab box- outs and pouring of box-outs. Box-outs shall be poured after valve boxes installed mains and rink headers tied into buried.
        20. Cleaning of concrete surface prior to commissioning of ice rink system.
        21. A permanent water supply shall be available for the rink floor piping system pressure test, concrete rink floor pour, and flushing.
        22. Excavation and forming of trenches, including backfilling and compaction for any buried portions of refrigeration system piping.
     3. Refrigeration Package: Field built systems are not allowed.
        1. Approved Manufacturer: CIMCO CO2 Standard Package or approved equal.
           1. Services ice rink floor cooling with heat reclaim capabilities.
        2. Equipment: Factory packaged, prewired and pre-piped including valves, controls, insulation, and wiring on a structural steel skid. Package Mounted Motors: Factory aligned. Package Piping Systems: Factory pressure tested. Factory painted with manufacturer's standard color.
        3. Includes but not limited to the following equipment.
           1. Reciprocating Compressors: Bitzer 6 CTC series or approved equal. C/w unloading steps/ Semi-hermetic reciprocating compressors c/w 50 HP, ODP, 1800 rpm, 460/3/60 soft starter motors, 40 percent glycol to oil heat exchanger, manual oil return system, relief valves, safety cut outs, service shut off valves, and thermometers.

One Rink: Four Compressors. 98 TR c/w One (1) 4CTE-30K at 30HP and Three (3) 6CTC-50K at 50 HP, automatic oil return

Two Rinks: Seven Compressors. 187 TR c/w Seven (7) 6CTC-50K, automatic oil return

* + - 1. Chiller Assembly: A series of soldered plate and frame heat exchanger arranged for direct expansion CO2 operation.
         1. Approved Manufacturer: Alfa Laval CBXP model or approved equal.
         2. Design Capacity: See Equipment Schedule on Drawings.
         3. Constructed to ASME code requirements.
         4. Registered by the National Board.
         5. Design Working Pressures: CO2 Side: 1,160 psig. Glycol Side: 1,160 psig.
         6. Chiller Plates: CO2 Side: Soldering Alloy 304. Glycol Side: Soldering Alloy 304.
         7. Chiller is Shell and Tube when Brine (CaCl) is selected.
      2. Dual refrigerant pressure relief valves. Two reflex type level sight glasses. Heat Reclaim System for Underfloor and Snow Melt Pit
         1. Heat Exchanger

Model Alfa Laval AXP112 or Approved Equal

Countercurrent Plate and Frame CO2 / 40 percent Ethylene Glycol

Dimensions (LxWxH): 19.3 x 9.9 x 27 inches.

Capacity: 460 MBH

40 percent Glycol Temperatures: 85 degrees F in / 95 degrees F out

* + - * 1. Pump

Bronze fitted construction with mechanical shaft seal, stainless steel shaft sleeve, non-overloading impeller, flex coupling, coupling guard and steel base.

Approved Manufacturer: S.A. Armstrong 4300 or approved equal.

Design Capacity: Flow rate, pump head, horsepower, and starter method; see Equipment Schedule on Drawings

Glycol System Flow Rate: 150 GPM. 45 ft (for 1 Rink), 250 GPM for 2 Rinks,

Pump Motor: WEG, or approved equal, 3/60/460V, 1800 RPM, Class B insulation, open drip proof with 1.15 SF, meeting Federal Efficiency requirements.

Suction and discharge butterfly valves, discharge check valves and pressure gauges

Side Stream Glycol Filter: Replaceable 25 micron bags to allow system filtration. A pressure gauge is connected across filter to indicate differential pressure.

\*\* NOTE TO SPECIFIER \*\* Delete one of the two following condenser paragraphs. Water Plate and Frame Condensers are to be used when using Water Plates and Frame Gas Coolers instead of an Adiabatic Condenser.

* + 1. CO2 Adiabatic Gas Cooler:
       1. Model Guntner hydroBLU Adiabatic Cooler or approved equal. An Adiabatic Cooling System, a heat exchanger, powder coated galvanized steel casing, and one or more low noise axial fans with maintenance-free motors with Guntner Motor Management (GMM) for fan speed control.
          1. Adiabatic Cooling System: Evaporative cooling pads, humidity, and ambient temperature sensor, GHM water metering controller, a water distribution and collection system with flow control valve, flow meter, strainer, and solenoid drain valve.
          2. Heat Exchanger: Coils fitted with fins; stainless steel pipe, aluminum fins, distribution, and header pipes; stainless steel, and pipe connections to the pipeline system/
       2. Dry Cooler Coil: An ETL listed floating coil design. Prevents contact of refrigerant and fluid carrying tubes with the supporting frame allowing thermal expansion and contraction of the tubes without risk of tube damage at the tube sheet.
          1. Expanded Support Tubes: Minimize flexing during installation.
          2. Coil Tube Construction: 0.47 inch diameter stainless steel tubes.
          3. Fin Construction: Aluminum, full drawn collar with tubes expanded into collar.
          4. Coil tubes are connected to stainless steel headers.
          5. Coil Pressure: Tested to 2262 psia (156 bar) with dry air underwater. Shipped with a 25 psig (1.7 bar) dry air holding charge.
       3. Cooler Casing: Self-supporting construction of galvanized steel, powder coated with RAL 7035 (light grey).
          1. Casing Fan Chambers: To be separated by an internal baffle to prevent windmilling during off-cycle.
       4. Fan Sets: Utilize external rotor motors, die cast aluminum sickle bladed impellers, and fan guards. Supplied with full bell mouth fan plates, optimized for highest efficiency.
          1. Wire Fan Guards: Welded construction. Coating: Weather proof synthetic finish for maximum corrosion protection. Complies with safety standard EN294.
          2. Impeller and Rotor: Form one complete item for proper balancing.
          3. Fans Balance Quality: Q6.3 according to VDI 2060.
       5. Fan Motors: Electronically Commutated (EC), maintenance free, with inherent ability to control fan speeds without auxiliary components.
          1. Alternating Current (AC) Motors: Not acceptable without variable frequency drives (VFD) and sine filters.
          2. Fan Motor Operation Power Supply: \_\_\_\_ volt, a \_\_\_ phase, a \_\_\_\_ hertz.
          3. Periodic Motors Lubrication: Is not acceptable.
          4. Labyrinth Seals: To impede ingress of splash water.
          5. Drain Holes: Included for condensation water drainage.
          6. Thermal Contacts: Integrated into the motor windings.
          7. Protection Class: IP 54 and windings with thermal class F according to DIN EN 60 034-1.
       6. Indirect Adiabatic Cooling System: Pre-cools the entering air stream prior to the finned coil heat transfer surface:
          1. Wetted Pads: Specially designed cellulose paper chemically treated to resist deterioration and bacterial growth.
          2. Guntner Hydro Management (GHM) Controller: Regulates water flow rate based on ambient conditions, fan speed and process conditions. Varying water flow rate is crucial to minimize water consumption.

Not Acceptable: Systems not modulating water flow.

* + - * 1. Controls: Determine water usage requirement.

If external temperature or the fans' speed are above the set start value for the wetting, the wetting is activated.

If the speed or the external temperature fall below the set value, the wetting is deactivated.

* + - * 1. Water Distribution System: Includes flow control valve, high pulse rate flow meter, strainer, piping, and solenoid drain valve.
        2. Water Collection System: Welded 304 type stainless steel. Allows free drainage of excess water.

Not Acceptable: Water basins or collection devices that allow stagnant water.

* + - * 1. Humidity and Ambient Temperature Sensor: Included.
      1. Guntner Motor Management (GMM): Creates an intelligent fan motor system that optimizes cooler operation and simplifies maintenance.
         1. Controller: Adjusts fan motor speed based on temperature and regulating processes to provide reliability and information for the system.

Not Acceptable: Systems that only allow steps of motors control or only motor cycling.

* + - * 1. Reduces sound emission due to no control-induced noise, especially in part-load operation.
        2. Various modes of operation for flexibility to meet system demands.

Modes of Operation Include:

Auto Internal automatic control of fan speed based on factory supplied sensor.

Auto External Analog for automatic control of fan speed based on externally supplied setpoint provided via analog input.

Auto External BUS for automatic control of fan speed based on externally supplied setpoint provided via Modbus RTU communication.

Slave External Analog for external control of fan speed sent via analog input.

Slave External BUS for external control of fan speed sent via Modbus RTU communication.

Ethernet IP is also an available communication.

* + - * 1. Motors Bypass Mode: In the event of sensor fault, or loss of communication with control signal or fault in GMM, fan motors will initiate emergency mode and run at a configurable fan speed.

Factory Default Bypass Mode Fan Speed: 100 percent.

* + - * 1. Low-Capacity Motor Management (LCMM): Provides more precise control during extreme low ambient or low load conditions.

The GMM utilizes LCMM to cycle fans while maintaining capacity and minimizing fan energy consumption.

* + - * 1. Cleaning Function: To help remove dirt and debris from coil by running fans in reverse at configurable intervals.
        2. Maintenance Run Function: To activate fan motors after configurable time of unit non-operation. Occasional use of fan motors is recommended during prolonged periods of non-operation.
        3. Digital Outputs for Alarms: Operational signal and threshold met.
        4. Analog Output: 0 to 10V signal, to indicate fan speed.
        5. Digital Inputs: For enabling of unit.

Night Limit Activation Signal: Limits fan speed and hence noise during configurable times.

Secondary set point.

* + - * 1. Optional Communication Modes with GMM: shall be available including Wi-Fi, Modbus RTU, Modbus TCP/IP, BACnet IP or BACnet MSTP.
    1. Water Plate and Frame Condensers: CO2 Plate and Frame Gas Coolers manufactured by Alfa Laval Model AXP112or approved equal.
       1. Thermal Performance:
          1. Reject 869 MBH of CO2 in countercurrent mode.
          2. Hot Side: CO2 Transcritical Stage.

Temperature in/out of Heat Exchanger: 250 degrees F / 90 degrees F

Inlet Pressure: 1,159 psi.

Pressure Drop: 0.4 psi.

* + - * 1. Cold Side: Cooling Tower Water:

Temperature in/out of Heat Exchanger: 85 degrees F / 95 degrees F.

Water Required flow: 175 gpm.

Pressure Drop: 13.3 psi.

\*\* NOTE TO SPECIFIER \*\* Delete rink sizes not required.

* + - 1. Total Heat Rejection Requirements for One Rink: 1,936 MBH.
      2. Total Heat Rejection Requirements for Two Rinks: 3,872 MBH.
    1. Pumps: Either end suction base mounted or vertical inline. Capable of continuous operation without fault and rated at 175 psi.
       1. Bronze fitted construction with mechanical shaft seal, stainless steel shaft sleeve, non-overloading impeller, flex coupling, coupling guard and steel base.
       2. Approved Manufacturer: S.A. Armstrong 4030/4300 or approved equal.
       3. Design Capacity: Flow rate, pump head, horsepower, and starter method; see Equipment Schedule on Drawings.
          1. Brine System Flow Rate: 900 gpm. 55 ft
          2. Glycol System Flow Rate: 1000 gpm. 65 ft
       4. Pump Motor: WEG, or approved equal, 3/60/460V, 1800 RPM, Class B insulation, open drip proof with 1.15 SF, meeting Federal Efficiency requirements.
       5. Suction and discharge butterfly valves, discharge check valves and pressure gauges.
       6. Side Stream Glycol Filter: Replaceable 25 micron bags to allow system filtration. A pressure gauge is connected across filter to indicate differential pressure.
    2. Starter Panel: Includes main disconnect, phase failure protection, starters, fuses, overload relays with reset buttons in panel door and control transformer, housed in NEMA 12 enclosure.
       1. Mounted on refrigeration package. Power and control wiring for equipment within refrigeration package to be pre-wired at the factory.
       2. Refer to Article, "Dasher Board Systems" in this specification.
    3. Refrigeration Control System:
       1. DDC Control Panel: Includes necessary hardware, software and interface device for a complete microprocessor based DDC control system.
       2. Mounted on refrigeration package. Sensor and control wiring for transducer within refrigeration package to be pre-wired at factory.
    4. Remote Sump Tanks:
       1. High grade polyethylene. A seamless one-piece vertical tank.
       2. Manufacturers: ACO CONTRAINER or approved equal.
       3. Dimensions: See Equipment Schedule on Drawings.
       4. Sump Tank shall be constructed of high grade polyethylene.
    5. Evaporative Condenser Water Pumps:
       1. Either end suction base mounted or vertical inline. Capable of continuous operation without fault. Rated at 175 psi.
       2. Bronze fitted construction with mechanical shaft seal, stainless steel shaft sleeve, non-overloading impeller, flex coupling, coupling guard and steel base.
       3. Approved Manufacturer: S.A. Armstrong 4030/4300 or approved equal.
       4. Design Capacity; Flow Rate, Pump Head, Horsepower and Starter Method: See Equipment Schedule on Drawings.
       5. Pump Motor: WEG, or approved equal, 3/60/460V, 1800 RPM, Class B insulation, open drip proof with 1.15 SF, meeting Federal Efficiency requirements.
       6. Suction and discharge butterfly valves, discharge check valves, and pressure gauges.
    6. Snow Melt Pit Coil: All stainless steel tube bundle, encased in stainless steel framework with pipe connections above the water line. Factory tested to 400 psig air pressure under water. Sized to melt ice resurfacer based on one flood per hour per ice sheet.
    7. Expansion and Overflow Tanks:
       1. Separate expansion tanks for cold and warm systems to allow for expansion and contraction of system charges. Tanks to be closed to minimize air contact with heat transfer fluid. Tanks will require level indication if tanks are not translucent. Glycol Tanks: Have overflow lines piped to overflow tank.
       2. One overflow tank.
    8. Pipe and Fittings:
       1. Refrigerant Piping to Conform to the Following:
          1. Latest edition of ASME B31.5 Refrigeration Pressure Piping Code and ASHRAE 15.
          2. 2 inch and Larger: Sch 40S, ASTM A312, Type 304 or 316 Seamless Stainless Steel.
          3. 1-1/2 inch and Smaller: Sch 10S, ASTM A312 Type 304 or 312, Seamless Stainless Steel.
       2. Refrigerant Pipe Fittings to Conform to the Following:
          1. 2 inch and Larger: 3000 lbs, ASTM A182 Type 304 or 316 SS, Socket Weld
          2. 1-1/2 inch and Smaller: 3000 lbs, ASTM A182 type 304 or 316 stainless steel socket weld . 3000 lbs ASTM A182 Type 304 or 316 stainless steel threaded only on 3/4 inch and smaller.
       3. Secondary Refrigerant Pipe and Fittings: Supply and install secondary refrigerant piping as indicated on Drawings.
          1. Secondary Refrigerant Piping, Above Ground: Conform to ASTM A53, Grade B, ERW, Schedule 40, carbon steel.
          2. Secondary Refrigerant Piping Below Ground: Confirm to PE4710, DR17, High Density Polyethylene.
          3. Secondary Refrigerant Fittings Above Ground: Conform to the following:

2-1/2 inch and Larger: ASTM 105-N, 3000 lbs, socket weld, forged steel.

2 inch and Smaller: ASTM 197, 150 lbs, threaded, Malleable Iron.

* + - * 1. Secondary Refrigerant Fittings Below Ground: Conform to PE4710, DR17, Butt weld, High Density Polyethylene.
      1. Valves:
         1. CO2 Valves and Controls: As indicated on Drawings. Valves Manufacturer: Danfoss Farris, Henry, Hansen, Phillips, R/S, or approved equal.
         2. CO2 Relief Valves: Sized and piped to suitable location as defined in ASHRAE 15 Safety Code/IIAR-2 for Mechanical Refrigeration. Valves to be manufactured by Farris 2700 series or approved equal.
         3. Secondary Refrigerant and Water Valves and Controls: For safe, convenient operation and maintenance.
         4. Butterfly Valves: Full lug type with trim selection compatible with fluid being handled. Valves 10 inches and larger to be gear operated.

Manufacturer: Challenger, Bray, or approved equal.

* + - * 1. Lines 2 inch and Smaller: May use ball valves manufactured by Flow+ or approved equal.
      1. Gauges and Thermometers:
         1. Main Refrigerant Gauges: Minimum 4 inch diameter.
         2. Component Gauges: May be 2-1/2 inch diameter.
         3. Gauge Manufacturer: Weiss or approved equal.
         4. Gauges: Constructed of material compatible with fluid being measured.

Liquid filled and with gauge valves.

* + - * 1. Heat Exchanger Thermometers: Solar powered digital display. Adjustable stem angle and separable wells. Manufacturer: Weiss or approved equal.
        2. Compressor Thermometers: Supplied by compressor manufacturer.
      1. Insulation: Install per manufacturer's recommendations.
         1. Low Temperature Line Insulation: Thick enough to prevent surface condensation.
         2. Package Insulation: Foam-in-place urethane with fiberglass jacket installed at factory.
         3. Field Insulation Above Ground: Polyisocyanurate rigid insulation with tongue and groove horizontal joints and ship lap end joints. Insulation to be complete with vapor barrier and white PVC jacket.
         4. Field Insulation Below Ground: Polyurethane foam pre-insulated insulation with high density polyethylene jacket or approved equal.
      2. Refrigerant Charge:
         1. Refrigerant System: To be thoroughly evacuated prior to charging.
         2. Supply and install a complete operating charge of ammonia refrigerant. The system is considered fully charged when the system is operating, and the chiller lower sight glass is half full.
      3. Oil Charge: Initial charge of oil for compressors and one 50 gallon drum. System is fully charged when oil return system is fully operational and replenishing compressor crankcases as required.
      4. Glycol Charge: Initial charge of 40 percent by weight inhibited ethylene glycol. Dilute glycol only with de-ionized water. System is fully charged when all air is purged from piping.

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. FLOORS, PIPING, VALVES, AND ACCESSORIES
     1. Scope: Ice Rink Contractor will be responsible for proper supervision and installation of the rink structural slab including underfloor sand, insulation, vapor barrier, rink pipe, rink chairs, reinforcing, concrete, and floor inserts for hockey and the circus; as required.
     2. Warranties: Flooring contractor will guarantee floor for a two year period after the successful completion and approval by the Owner's representative. The guarantee is to cover dusting, disintegration or any other defects of surface coming within control of the Contractor.
     3. Performance and Design Requirements for Rink Floor System
        1. Add decision questionnaire for Rink Floor System
     4. Rink Floor Headers:

\*\* NOTE TO SPECIFIER \*\* Delete one of the two piping options.

* + - 1. Piping: Carbon Steel Sch 40.
         1. Cold Header Pipe: 8 inch carbon steel sch 40
         2. Warm Header Pipe: 3 inch carbon steel sch 40
      2. Piping: High-density polyethylene complying with requirements of ASTM D3350 cell classification and have a Plastic Pipe Institute (PPI) designation of PE4710.
         1. Minimum Density: 58 lbs per cu ft (0.957 gm per cu cm).
         2. Cold Header Pipe: 8 inch SDR11. Pressure Rating: 200 psi.
         3. Warm Header Pipe: 3 inch SDR11. Pressure Rating: 200 psi.
         4. Joints and Connections: Fusion welded by personnel fully trained in the fusion welding process.
      3. Location: Inside the rink, across full width of rink, at end nearest refrigeration room.
      4. Fittings: High-density polyethylene complying with requirements of ASTM D3350 cell classification and have a Plastic Pipe Institute (PPI) designation of PE4710.
         1. Minimum Density: 58 lbs per cu ft (0.957 gm per cu cm).
         2. Fittings 2-1/2 inch and Above: Molded butt weld conforming to ASTM F714.
         3. Fittings 2 inch and Under: Socket type conforming to ASTM 2683.
      5. Approved manufacturers: ISCO, Integrity, GFPS or approved equal.
    1. Rink Floor Piping:
       1. Carbon Steel Sch 40: 1 inch.
       2. Polyethylene or Poly Pipe: 1 inch SDR11 high-density complying with ASTM D3350 cell classification and have a Plastic Pipe Institute (PPI) designation of PE4710.
          1. Minimum Density: 58 lbs/cf (0.957 gm/cc) or CSA B137.1 approved pipe manufactured for rink use.
       3. Floor Cooling Piping: The only permitted connections or joints in cold floor piping, except as noted in the Paragraph "Rink Cooling Floor Chairs" in this specification Article, are to be at the headers and at the180 degree return bends. Fusion weld pipes to headers. Install on 3, 3-1/2, or 4 inch centers.
       4. Underfloor Heating Piping: The only permitted connections or joints in the underfloor piping, except as noted in the Paragraph "Rink Cooling Floor Chairs" in this specification Article, to be at the headers. Pipes to be fusion welded. Installed on 18, 20, or 24 inch centers.
       5. Rink Cooling Floor and Header System: Test with air pressure at 50 psig for 48 hours, prior to pouring concrete. Maintain pressure on system during the rink pour.
       6. Rink Underfloor and Header System: Test with air pressure at 50 psig for 48 hours, prior to placement of top lift of sand. Maintain pressure on system during sand placement and compaction.
       7. Rink Return Bend: High-density polyethylene fabricated as one piece molded socket weld U-Bend. U-Bends fabricated from 90 degree elbows is not allowed.
          1. Manufacturers: ISCO, GES or approved equal.
       8. To Repair a Polyethylene Pipe Leak; Damaged after Welded Wire Mesh is Placed in the Cold Floor or after the Sand is Placed in the Underfloor:
          1. Cut pipe at the leak. Install a 1 inch plastic insert coupling and re-test.
          2. Brine piping leaks found prior to pouring of the floor slab, while the pipe circuit is accessible will be repaired by replacing the entire brine pipe circuit.
       9. Return Bend Wire Ties: To be cut two days after the concrete floor pour, through the perimeter side of the expansion joint before the compression seal is installed, to permit the floor slab to contract during operation.
    2. Rink Cooling Floor Chairs: Top loaded pipe supporting chairs made of steel rod fabricated with 3 inch wide, 24 gauge steel plate on the bottom. Pipe lift to allow 1-3/4 inch concrete over top of rink piping. Top loaded feature will allow ease of reinforcing bar installation.
       1. Pipe chairs space cooling rink floor piping on 3, 3-1/2, or 4 inch centers and placed in rows on 2 ft centers down length of rink. Overlap chairs by one pipe at end of each chair.
    3. Rink Floor Valve Boxes: Two high density polymer concrete valve boxes, flush mounted with removable cover in perimeter slab edge. One adjacent to each end of rink headers. One vent valve per header in each valve box.
       1. Valve boxes to be provided by the general contractor. The same division providing the openings shall backfill and compact clean sand to underside of valve boxes and place and finish concrete in the box-outs after boxes are installed and rink floor is poured.
    4. Rink Underfloor Sand: Clean and free of clay and organic material. 90 percent of sand must pass US sieve size No. 12; 0.0681 inch opening size.
       1. Place a bed of under floor sand to thickness specified in the schedule of values, in one 2 inch and one 5 inch lift compacted to 95 percent standard density and level to plus or minus 3/16 inches.
       2. When completing second lift of sand, do not damage the subfloor heating pipes.
    5. Rink Floor Insulation: Insulation: DOW HI4, DOW HI25, or DOW HI60 Styrofoam extruded polystyrene. Insulation Sheets: 4 x 8 ft.
       1. Layers: Two, 2 or 1-1/2 inch layers. Place with a minimum of 24 inch staggered and overlapped joints.
       2. Polyethylene 6 mil Sheeting: 20 x 100 ft rolls. Cover top and bottom of insulation with one layer. Seams to overlap a minimum of 12 inches.
    6. Rink Floor Concrete Re-enforcement:
       1. No rebar below the pipes with 12 inch centers parallel to pipe chairs and at the spacing listed in the schedule of values for rebar parallel to rink pipe.
          1. Bars to be intermediate grade deformed steel, rust, and scale free without sharp offsets or bends.
          2. Longitudinal bars for bottom reinforcing to be 20 ft lengths minimum.
          3. Bars to be placed beginning 4 inches clear of the bulkhead on each side and ends of the rink.
       2. Welded wire mesh above the pipes: 6x6 - W2.9xW2.9.
    7. Rink Floor Concrete:
       1. Mix Design: Submitted to Contractor one month prior to the rink pour and must be approved by the Owner's representative.
          1. Designed with admixtures to produce the specified compressive strength in 28 days. Any concrete admixtures must be compatible with the specified ice rink floor piping. Aggregate: Clean and properly graded with a maximum size of 3/4 inches. Slump: Maintained at 3-1/2 to 4-1/2 inches at end of pump hose to allow for complete flow around the piping system.
       2. Concrete Floor Thickness and Strength: 5 inches and 4000 psi
       3. Concrete Floor Thickness and Strength: 5 inches and 5000 psi
       4. Concrete Floor Thickness and Strength: 6 inches and 4000 psi
       5. Concrete Floor Thickness and Strength: 6 inches and 5000 psi.

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. MOTOR CONTROL PANELS
     1. Refrigeration Control Panel: Provides for operation of refrigeration equipment.
        1. One Rink: Four compressors. One Cold pump. One Adiabatic Gas Cooler fans. One Warm pump.
        2. Two Rinks: Eight compressors. One Adiabatic Gas Cooler fans. One Warm pump. Two Cold Pumps.
     2. Standards Compliance: Refer to most recent editions in all instances.
        1. IIAR 2 latest edition and/or Local Mechanical Code.
        2. National Electrical Code and/or Local Code.
        3. ANSI/ASME Boiler and Pressure Vessel Code.
     3. Materials: All new factory wired refrigeration control panel to ESA code compliance. Panel includes:
        1. NEMA 12 enclosure panel.
        2. IEC rated starters, contactors, relays, selector switches and push buttons.
        3. Adjustable overloads with external manual reset buttons.
        4. Soft Starters for compressors and brine pump (WEG).
        5. GREEN Indicator Lights: For brine pump1, compressor 1, compressor 2, condenser pump, condenser fan, and compressor jacket cooling pump.
        6. RED Indicator Lights: For High ammonia liquid level, Compressor 1 failure and Compressor 2 failure, Compressor 1 high ammonia pressure, Compressor 2 high ammonia pressure, Compressor 1 low ammonia pressure, Compressor 2 low ammonia pressure.
        7. BLUE Indicator Light: For alarm silenced.
        8. YELLOW Indicator: For compressor anti short cycle.
        9. Disconnect Switch: 200 Amp non-fused.
        10. Transformer: 2 KVA.
        11. Lead/Lag selector switch for two compressors.
        12. Hour meters for compressors.
        13. Alarm horn, silence push button, and high liquid level reset.
        14. One 4-1/2 inch panel mounted high pressure gauge c/w top mounted gauge board.
        15. One 4-1/2 inch panel mounted low pressure gauge c/w top mounted gauge board.
        16. One reverse acting high pressure control for the condenser fan.
        17. One reverse acting high pressure control for the condenser pump.
        18. ON/OFF/AUTO switches for all motors.
        19. Honeywell T775 digital readout electronic thermostat c/w new sensor
        20. Lamacoid name plates for switches, buttons, controls, and indicator lights. Black with white letters.
        21. Selector switch for back up and future DDC (Direct Digital Control) rink control system
     4. Equipment:
        1. Compressor 1.
        2. Compressor 2.
        3. Compressor 3.
        4. Compressor 4.
        5. Cold Glycol Pump.
        6. Warm Glycol Pump
        7. Adiabatic Gas Cooler

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. CO2 High Grade Heat Exchanger
     1. Manufacturer: SWEP International AB, model BDW16DWHx100/1P
     2. Design Parameters:
        1. Fluids: Side 1 is R744 (Carbon Diaoxide); Side 2 is Water.
        2. Flow type: Conter-surrent
        3. Heat Load: 975MBH
        4. Temperatures:
           1. R744 in/out: 228 degrees F / 108.7 degrees F
           2. Water in/out: 50 degrees F / 140 degrees F
        5. Flow Rate:
           1. R744: 24000 lb/hr
           2. Water: 21 to 81 GPM
     3. Physical Characteristics
        1. Total Heat Transfer Area: 43.2 sq ft
        2. Pressure Drop total:
           1. R744: 53.5 psi
           2. Water: 1.79 psi
        3. Connection Diameter:
           1. R744: 1.06 in
           2. Water: 1.06 in
        4. Number of plates: 100
        5. Fouling factor: 0.000 sqft,h, degrees F/Btu
        6. Total weight: 51.92 lbs (shipping), 169.33 lbs (operating)
        7. Volume: 0.11 cu ft (R744 and Water)
        8. Dimensions (WxHxD): 6.5 x 13 x 12 inches.

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. DASHER BOARD SYSTEMS
     1. Complete factory prefabricated, arena board system with spectator shielding, including team, penalty and officials' boxes as indicated on Drawings and specified herein.
     2. Acceptable Manufacturers:
        1. Athletica Sport Systems: 554 Parkside Drive, Waterloo, Ontario, Canada N2L 5Z4; Phone: 519.747.1856; Toll-Free: 1.877.778.5911; Fax: 519.747.3659. Web: www.Athletica.com
        2. Athletica Sport Systems: 17200 Medina Rd., Suite 600, Minneapolis, Minnesota, USA 55447; Phone: 763.249.7465; Toll-free 1.800.809.7465; Fax: 763.249.7475; Web: [www.Athletica.com](http://www.Athletica.com)
     3. Dasher Board Systems:
        1. Manufacturer to provide materials and labor for a dasher board system and installation. Shop fabricated as much as possible prior to delivering to job site.
        2. Frames: Aluminum or steel. Not a combination of the two.
           1. Aluminum: Alloy 6005A-T6. Meet STM B221 and Federal Specifications QQA200-9.
           2. Steel: Hot dip galvanized after fabrication.
        3. Dasher Panels: Straight, curved or gated, similar design and all welded construction.
           1. Sizes of Panel Sections: Heights may be modified if ice retainers are used.

Straight (HxLxW): 41 x 96 x 6 inches.

Curved (HxLxW): 41 x 88 x 6 inches.

Back of Players Boxes (LxW): 96 x 6 inches. Height: See plan.

* + - * 1. Components: See Drawings.
        2. Panel Connections: With end plates at 3 or more locations. Bolts: 1/2 inch diameter.
        3. Additional Supports: Quick release backer panels, gap closures, taller panels, etc.
        4. Framing System Holes: Pre-punched and slotted for expansion and contraction in polyethylene materials.
        5. External Support Posts on Back Side of Dasher Panels: Not acceptable unless noted on Drawings.
      1. Shielding: As specified herein and shown on Drawings.
         1. Clear Float Tempered Glass. CAN2-12.1- M79, Type 2. Edges ground or beveled.

Height of Shielding: See Drawings. From top of top sill to top of shielding.

Thickness of Shielding: Dimensions: Inches. Nominal Dimensions: ():

Acrylic: Sides: 0.545 to 0.620. Ends: 0.545 to 0.620. Radius: 0.545 to 0.620.

Glass: Sides: 0.472 (1/2). Ends: 0.591 (5/8). Radius: 0.591 (5/8).

Interchangeable equal panel widths wherever possible.

Top Two Corners of Shielding: Rounded to 1/2 inch radius.

Speaker Holes: 2.5 inch diameter in shielding in front of scorer's box. Hole Edges: Routed smooth.

Transitions: Angled top edge matching height of adjacent shielding pieces of shielding. Where two different height shielding meet as shown on the Drawings.

Extra Pieces of Shielding: Match specified area thickness. Height: 72 inches.

Seamless System. Material: Tempered Glass. Qty: \_\_\_.

Supported System. Material: Tempered Glass. Qty: \_\_\_.

4 ft Access gate. Material: Tempered Glass. Qty: \_\_\_.

3 ft Access gate. Material: Tempered Glass. Qty: \_\_\_.

2.5 ft Access gate. Material: Tempered Glass. Qty: \_\_\_.

Equipment gate. Material: Tempered Glass. Qty: \_\_\_.

Emergency Repair. Material: Tempered Glass. Qty: \_\_\_.

* + - 1. Shielding Supports: Structural alloy 6005A-T6 conforming to ASTM B221 and Federal Specifications QQA200-9 or architectural alloy 6061-T6. Finish: Mill finish.
         1. Supports Between Shielding: Two-piece design. Ice Side Piece: Flat faced. Screwed assembly. Not Acceptable: Round construction on ice side.

Ends and Terminations: One-piece channel design for glazing terminations, gates, and 90 degree corners.

Fit snug through top sill. Secure at bottom of middle stringer. See Drawings.

* + - * 1. Gaskets: Continuous polyethylene holding shielding in place. Gasket Thickness: Dependent on shielding thickness. Provide snug fit between shielding and support.
        2. Hardware: Aluminum 6005A or 6351-T-6. Fasteners: Recessed flush with support surface. Removable for shielding replacement, disassembling, and reinstallation.
        3. Height: 1 inch below top of shielding if not indicated on Drawings.
        4. Spacing: 4 ft on center.
        5. Eye Bolts: On each support on ends and radius for connection of netting.
        6. Polycarbonate H sleeves for each different height of shielding: Quantity: 3 each.
      1. Supportless Shielding Support Aluminum Channel: ASTM B221, Federal Specification QQA200-9. Alloy: 6005A or 6351-T-6. Continuous aluminum channels supporting glass welded into frame. Bottom 3-1/2 inch of tempered glass to be covered with U-shaped gaskets inserted in channels.
         1. Polyethylene Channel: See "Polyethylene" Paragraph in this article.

Continuous block of polyethylene supporting glass welded into frame. Bottom 3-1/2 inch of tempered glass to be covered with U-shaped gaskets inserted in polyethylene channels.

* + - * 1. Gaskets: Continuous polyethylene or approved equal gasket to hold shield in place. Mounted to glass with adhesive tape.
        2. Hardware: Aluminum alloy 6005A or 6351-T-6. Fasteners: Recessed flush with support surface. Removable for replacement, disassembling, and reinstallation.
        3. System to support netting below top of shielding.
        4. Gap between Glass Shields: Where there are no gates; 1/4 to 3/8 inches.
        5. Spring-Loaded Lexan Clip Assemblies: Connect shielding sections together at tops of shielding.

Protection Covers: For each bolt on back of each assembly.

Provide 8 extra clips and 20 extra covers for Owner's use.

* + - * 1. Plastic Spacers between shielding panels for proper spacing.
      1. Polyethylene: High impact, high density, stress relieved, virgin polyethylene.
         1. Dimensions: See Drawings.
         2. Colors: See material schedules on Drawings. Like colors to match.

Standard Colors: White, black, royal blue, red, gold, and yellow.

White: Bright white in color. Natural white is not acceptable.

Premium Colors: Light blue, green, navy blue, shades of grey, custom colors.

* + - * 1. Fasteners: For fastening polyethylene components to aluminum and steel.

Aluminum Framing: 1/4 Type F Zinc, self-tapping. Color: Match poly material.

Steel Framing: 1/4-20 Phillips flat head machine screw, flat washers, nylon insert lock nuts.

* + - * 1. Top Sill: Dimensions: See Drawings.

Supported Acrylic Shielding System: 3/8 inch deep continuous channel routed in top sill to support shielding.

* + - * 1. Kick Plate: Fastened to facing of dasher board system.
        2. Facing Panels: One piece, cut to match dimension of frame.

Line Markings: Locations shown on Drawings. Flush with dasher board facing.

Facing: Routed 1/4 inch deep so colored line marking material can be inserted into facing panel.

* + - 1. Backer Panels: One piece, cut to match frame dimensions.
         1. In Player's Boxes: Backer panels cover exposed framing.
         2. Trim: Polyethylene pieces between back panel sections.
      2. Thresholds for Equipment Gates: Metal frame and polyethylene top piece.
         1. Frame Height: As required providing overall height shown in table on Drawings. See Drawings also for thickness of polyethylene.
         2. Frame: As specified in this Article.
         3. Polyethylene: As specified in this Article.
         4. Equipment Gate Thresholds: Removable for dry floor event access and replacement.
      3. Fasteners for Polyethylene Material: Secure facing, backing, top sill and kick plate materials.
         1. Aluminum Framing: 1/4 Type F Zinc, self-tapping, color to match poly material.
         2. Steel Framing: 1/4-20 Phillips flat head machine screw, flat washers, nylon insert lock nuts.
         3. Construction:

Outdoor Rinks: Fasteners to be stainless steel.

Screw Heads: Painted to match facing color.

Fasteners for Bottom Row of Kick Plate: Stainless steel.

Spacing: 10 inches maximum on center.

Screw Holes in Poly Material: Large enough to allow expansion and contraction.

Thresholds: Counter-sunk 1/2 inch.

* + - 1. Players, Penalty, Scorer, and Camera Boxes: Dimensions: As shown on Drawings.
         1. Framing Systems: Same material as dasher frame.

Components: See Drawings.

Benches: Easily removeable including supports built into flooring.

* + - * 1. Flooring. 3/4 inch fire treated plywood screwed to framing.

Coaches Walk: As shown on Drawings. Full length of player's benches.

Exposed Surfaces: Cover with 1/2 inch black resilient flooring material.

* + - * 1. Scorers Box Tables and Benches: Dimensions as shown on Drawings.

Framing: As specified in this Article.

Bench Material: \_\_\_\_\_\_\_\_. Thickness as specified on the Drawings.

* + - * 1. Fasteners: Plain finish.
        2. Fasteners In Contact with Pressure or Fire Retardant Treated Wood as required by the International Building Code Section 2303.1.8.5:

Hot-dipped galvanized steel. Minimum rating of G-185 (1.85 oz. of zinc/sq ft of metal) meeting ASTM A153, stainless steel, or silicon bronze.

* + - * 1. Electroplated Galvanized Fasteners: Not acceptable for exterior use.
        2. Bench Fasteners: 3/8 inch carriage bolts.
        3. Backing: Specified in Article 2.07 of these specifications.
        4. Other: Water bottle shelf in player's boxes as shown on Drawings. Full length of player's box. Material Thickness: As shown on Drawings. Color: White or match backer color.
      1. Players and Access Gates with Openings: As shown on Drawings.
         1. Gates: Integrate into 8 ft panel sections. Gate Swing Direction: As directed by Owner.
         2. Gate Panel Framing: Similar to dasher framing.
         3. Gate Gravity Latches: Welded, 2 x 3/8 inch steel flat bar. Opens with gloved hand.

Fastened with 3/8 x 1-1/4 hex head bold and 3/8 inch nylon locking nut.

Latch automatically via gravity when closed.

* + - * 1. Gate Hinges: Two lift off type hinges. Grease fittings or nylon bushings.

Piano Type Hinges: 10 GA, non-greaseable, adjustable, and bolted to frame, is acceptable where shielding is not used.

* + - * 1. Doorstop: Welded to frame. 3/8 x 3-1/2 x 4-1/2 inches long.
        2. Ice Side Release Devices for Player and Access Gates with Shielding: Push button releases located in top sill, on ice side, to open from ice side.
        3. Finger Hold: 3/8 x 3/4 inch wide groove in top sill for access gates with glass shielding to close doors from ice side of board system.
        4. Construct gate so top of threshold is located as follows:

Players Gate Distance Above Finished Floor: 9 inches.

Access Gates Distance Above Finished Floor: 3 inches.

Equipment Gates Distance Above Finished Floor: 2 inches.

* + - * 1. Casters For Gates 42 inches wide or larger: On each leaf; 5 inch diameter polyurethane tires, spring loaded, and adjustable with zinc plated framing.
      1. Equipment Gates: Double leaf. Opening sizes as shown on Drawings.
         1. Framing Materials: Meet dasher board framing requirements as specified.
         2. Latch: Zinc plated components. Two latches per gate.

Sliding steel tube with minimum dimensions of 2-1/4 x 2-1/4 inch x 12 gauge.

Solid Steel Rod: 2 inch diameter with large push down handle.

* + - * 1. Lock For Each Gate Leaf: Cane Bolts 3/4 inch diameter by 12 inch long steel, zinc plated. Lock into concrete perimeter slab.
        2. Hinges: Two per door. Lift off adjustable type. Welded to frame. Grease fittings. Zinc plated, 3/8 inch thick steel, 3/4 inch diameter hinge pins.
        3. On each leaf, 5 inch diameter polyurethane tires, spring loaded, and adjustable with zinc plated framing.
        4. Fasteners: Zinc plated and color to match where necessary.
      1. Gap Closures: Material to fill gap between back of dasher board panel bleachers, stairs, ramps, and other raised structures.
         1. Aluminum Angle: 1/4 inch thick. Piece Lengths: 8 ft or longer, as needed. Other dimensions as shown on Drawings.
         2. Fasteners: 1/4 Type F Zinc, self-tapping, color to match poly material.
         3. Construction: Mount gap closures to dasher boards and not adjacent structure.
      2. Floor Anchors and Inserts:
         1. Anchor Components: Bolts, inserts, washers, threaded rod, and hold down plate as follows and as detailed on Drawings.

Dasher Board System Located on Perimeter Concrete:

Drill holes for anchors.

Anchors: 5/8 x 3 inch zinc plated inserts by Hilti-HFA 200, Hilti HY 150, or approved equal. Expansion anchors are not acceptable.

Dasher Board System Located on Ice Rink Slab:

Anchor Assembly: As detailed on Drawings or approved equal and cast in place in concrete ice rink floor. If not designated on Drawings:

Permanent Panels: Materials to be zinc plated.

Removable Panels: Anchor Inserts and Washers: 303 stainless steel. Base Plate: 303 stainless steel or carbon steel. Bolts: Zinc plated material.

Dasher Board System Replacing Existing System: Replace existing anchor assembly. Secure dasher board system as specified.

Dasher Board System Located Outside for Outdoor Rink: Anchor inserts: 303 stainless steel. Base Plate and Washers: 303 stainless steel. Bolts: Zinc plated material.

Where ice retainer is used, provide 5 inch anchors.

* + - * 1. Hold Down Plates: Size as shown on Drawings.
        2. Anchoring Adhesive: For drilled in anchors.

Approved Manufacturers: Hilti HIT Doweling Adhesive HIT HY-150 MAX, Red Head A7 Adhesive, Simpson Strong-Tie AT-High Strength or approved equal.

Properties: ASTM C881 Type IV, Grade 3, Class A, B, C.

Bond Strength: ASTM C882: 2900 psi minimum at 2 days.

Compressive Strength: ASTM D695: 9200 psi at 7 days.

Water Absorption: ASTM D570: 0.23 percent (24 hours).

* + - * 1. Plug Materials: Threaded for each insert. Stainless steel for circus inserts. Brass for dasher board inserts.
      1. Ramps: Same materials as Player's, Penalty and Scorer's boxes. Cover with rubber flooring as specified for Player's Penalty and Scorer's boxes.
      2. Advertisement Panels: On entire face and perimeter of dasher board system.
         1. Material: Lexan: 1/8 inch thick sheets. Pre-drilled and countersunk. Bevel edges with 1/2 inch radius corners.
         2. Straight Panels 96 inch: 33 x 94 inches. Radius Panels: 33 x 86 inches.
         3. Panel Attachment: Special 1/4 inch Hi-Lo screws with undercut heads.
         4. Printed Messages: Adhered to backside of Lexan.
         5. Refrigeration must be turned on for ad panel installation per manufacturers recommendations.
      3. Protective Spectator Netting System: Size and Location as shown on Drawings.
         1. Netting: Extends 6 inches below top of shielding supports to height specified on Drawings. Custom made to fit length and height required.
         2. Material: Nylon. No. 420 knotless High Tenacity Polypropylene (HTPP) Pylon, 1-1/2 inch square mesh x 1.8 mm twine. UV and weather resistant. Fire retardant coating.

Break Strength: 125 lbs.

Perimeter Edging: Reinforced vinyl, double sewn with No. 2 brass grommets. Grommet Locations: 24 inches on center. Color: Black or white as selected by Owner.

* + - * 1. Support System:

Top of Netting: Support with continuous rigid conduit or rigid bar system. Section Lengths: 10 ft minimum formed to radius of rink.

Rigid Supports: Installed at bottom of netting at equipment and access gates and across bench areas without shielding.

Conduit Supports: Galvanized steel.

Support Cables: 3/16 inch galvanized steel cable to roof structure.

Fasteners: Attach netting to top of shielding with cable system and metal clips or nylon ties every 4 ft on center, centered on each shielding sheet.

Cable: Attached to shielding with suction cups if supportless shielding. Fasteners to be attached to poly clips at top of shielding.

Nylon Ties: 1/8 inch wide. UL recognized. Tensile Strength: 100 lbs.

Cables, clamps, turnbuckles, eyebolts, suction cups, plastic ties, as required.

* + - 1. Accessories:
         1. Glass Handler Suction Cups: One pair of suction cup devices for glass handling for removal of tempered glass or acrylic shielding.

Diameter: 8 inches with Lexan handle. Capacity: 125 lbs.

Wood's Power Grip or approved equal.

* + - * 1. Glass and Acrylic Cleaning Kits as manufactured by Novus or approved equal:

Cleaning Kit:

One 8 oz. Bottle of Polish 1: Clean and Shine.

One 8 oz. Bottle of Polish 2: Fine Scratch Remover.

One 8 oz. Bottle of Polish 3: Heavy Scratch Remover.

Two NOVUS Polish Mates

One Package of Ten Polish Mates: Microfilament, highly absorbent, extra durable, soft, and abrasion resistant. Re-usable and washable.

Size: 13 x 13 inch each.

Buffing Kit:

One wool applicator pad.

One wool buffing pad.

One back plate adapter.

One 1/4 inch spindle adapter.

One Instruction sheet.

* + - * 1. Shielding Pads: At exposed ends of shielding or supports, corners, and terminations.

Full length of shielding or supports.

Heavy duty 18 oz. reinforced fabric sleeve with impact-absorbing foam core.

Secure in place with 2 inch wide Velcro fastening system.

Color: Owners to select color from Manufacturer's standard colors of red, navy, orange, gray, tan, green, burgundy, yellow or black.

* + - 1. Ice Marking Set for Rink. Includes but not limited to:
         1. Paint: Approved Manufacturers: Lumin' Ice Pro, Crystal-Ice, Jet Ice, or approved equal.

Entire Ice Surface: White in color

Ice Markings: Circles, lines, dots, and goal crease per USA hockey requirements.

Ice Logos: By Owner.

* + - 1. Poly Electrical Enclosures: Cover electrical outlets, wiring and other devices located beneath scorer's table. Size: Full height of space beneath table and as narrow as possible maximizing leg room.
         1. Latched Hinged Door: Size so electrical outlets are unobstructed when open.

\*\* NOTE TO SPECIFIER \*\* Delete article if not required.

* 1. CONTROL SYSTEMS
     1. Summary: Specification Article includes Ice Rink Equipment work called for, or implied, together with necessary incidentals, whether referred to or not, required to complete the Work to the full intent and meaning of the specifications.
        1. Work Includes, but is not Limited to the Following:
           1. Work under this Contract covers the upgrade and/or replacement of the Refrigeration Plant Control System. This includes but is not limited to the reinstatement of all connections to the panel in accordance with the specifications. Also additional new equipment may be provided as noted in the specification. It is the responsibility of the refrigeration Contractor to coordinate all components of the project as defined herein.
           2. The specification is not intended as a detailed description of installation methods but serves to indicate the quality and requirements of the completed Work Result.
           3. Any items omitted which are clearly necessary for completion of the Work or its appurtenances is to be considered as part of the work result.
           4. Refrigeration Contractor: Responsible to review existing system and equipment within refrigeration plant and including all necessary devices to complete the installation. Coordinate requirements with electrical Contractor.

Provide a fully functional control system to safely operate the refrigeration plant condenser system based on a floating head pressure design.

Any ministry Inspections.

Start-up and testing.

Training.

Manuals and as-built drawings (2 electronic copies).

* + 1. Basis of Design: SMART Hub IRC Ice Rink Controller using distech platform by CIMCO Refrigeration Inc.
    2. Standards Compliance: Selected Contractor must comply with all codes and standards; latest editions, as applicable to the work, including:
       - 1. CAN/CSA-B52-99 Mechanical Refrigeration Code, latest revision.
         2. ANSI B31.5
         3. ASHRAE 15 Safety Code for Mechanical Refrigeration.
         4. ASME B31.5 Refrigeration Pressure Piping Code.
         5. Boiler and Pressure Vessels Act.
         6. WCB Regulations.
         7. Register the Design with TSSA.
    3. Minimum System Requirements: Design, provide and commission the necessary accessories, software, human machine interfaces, relays, transmitters, control panels, etc. for the complete operation of a DDC based centralized control system following refrigeration equipment where applicable:
       - 1. Cold glycol / brine pump.
         2. Warm glycol / brine pump.
         3. Refrigeration compressors.
         4. Evaporative Condenser/Cooling tower pumps.
         5. Underfloor heating.
         6. Evaporative Condenser/Cooling tower fans.
         7. The condenser is floating head pressure ready.
         8. Machine room ventilation system.
    4. Infrared Temperature Control of Refrigeration System:
       1. Refrigeration Contractor: Supply a complete microprocessor based automatic control system to achieve the performance specified in the following clauses.
       2. Refrigeration Management System: To be Cimco Hub. To be part of the refrigeration control system forming a single physical network so data can be directly shared.
       3. Controllers: Distech Controls; Eclypse hardware version 1.10.18199.491 or newer.
       4. All Control Products: To be comprised of a BACnet internetwork. Communication involving control components; i.e., all types of controllers and Operator Workstations, must conform to ANSI/ASHRAE Standard 135-2001, BACnet.
       5. Each Building Controller: Support BACnet over IP. Building Controller to be connected to BACnet network using the BACnet IP.
       6. Building Controller secondary communication network, if applicable, must support BACnet MS/TP.
    5. Control System Equipment:
       1. Controls will be assembled in an appropriate enclosure.
       2. Control Elements: Identified by P-TOUCH type ribbon inside enclosure.
          1. Elements in Front of Enclosure: Will be indicated by means of engraved plate.
       3. Wiring Inside the Panel: Routed inside appropriate wire duct. Each wire will carry a number at each end. These numbers are to correspond to electric Drawings.
       4. Control Panels: Manufactured in a factory. Certified CSA. Panels will have a clear indication they conform with CSA standards.
       5. Control Panel Characteristics: Hinged doors. Electrostatic factory paint of gray color. Interior components such as transformer, fuses relays, programmable controllers, will be assembled on a dismountable back plate. Installation of components directly on panel is not acceptable.
       6. Panel Power Supply: 120 VAC, 15 amps maximum, protected by an integrated circuit breaker and having a double service socket to power 115 volt laptop and router.
       7. Wiring Connection of Cables Coming from Outside the Enclosure: Will have connections to a terminal block with the exception of the wires connecting to the Input side of the programmable controllers.
    6. Sensors:
       1. Transmitters: Electronic type with 4 to 20 mA control signal.
       2. Control System: Controls refrigeration equipment based on information received from the following field sensors.
          1. Infrared camera mounted above the ice surface.
          2. Cold glycol / brine supply temperature.
          3. Cold glycol / brine return temperature.
          4. Compressors discharge pressure.
          5. Compressors suction pressure.
          6. Sub-slab temperature.
          7. Outdoor air temperature and relative humidity.
          8. Condenser condensate temperature.
          9. Rink space temperature and relative humidity.
          10. Status inputs from pumps, compressors, and fans.
          11. Individual safety status from each compressor.
    7. Operator Workstation:

\*\* NOTE TO SPECIFIER \*\* A system can have both or either of the following two workstations. Delete a workstation if one of them is not required.

* + - 1. Provide the following minimum configuration for a panel mounted touchscreen operator station:
         1. Intel Core i5 Processor or higher.
         2. 4GB RAM Memory or more.
         3. 250GB hard drive or larger.
         4. 19 inch Panel mount touchscreen display.
         5. USB ports: Two.
         6. Network Interface Cards: Two.
         7. Windows 10 Professional operating system.
         8. HTML5 compatible web browser.
      2. Provide the following minimum configuration for a desktop operator workstation:
         1. Intel Core i5 Processor or higher.
         2. 4GB RAM Memory or more.
         3. 250GB hard drive or larger.
         4. 27 inch LCD Flat screen Monitor.
         5. USB ports: Two.
         6. Network Interface Cards: Two.
         7. USB Optical mouse.
         8. Windows 10 Professional operating system.
         9. HTML5 compatible web browser.
    1. DDC Controller:
       1. DDC System: Must utilize high-speed networks using Ethernet between the major controllers and the HMI. Between major and secondary controllers, the DDC system must use BACnet/MSTP.
          1. Must be able to communicate with other peripheral controllers using Modbus.
       2. BACnet DDC Controllers: To be mounted in CSA certified control panel installed locally in building as close as possible of controlled equipment.
       3. The DDC HMI: Must be capable of communicating with other HVAC manufacturer's equipment using industry standard BACnet protocol.
       4. DDC Controllers: Peer-to-peer data communication between BACnet/IP, and BACnet MS/TP networks.
          1. BACnet system with inputs, outputs, and variables available as standard BACnet AI, BI, AO, BO, AV, and BV objects.
          2. Controllers when connected can have their firmware upgraded without disconnecting them from an active network.
          3. Each controller must have a specific network address.
       5. DDC Controller Functions:
          1. Control refrigeration equipment and associated components directly.

Must not depend on any other CPU or computer to perform this function.

* + - * 1. Loss or failure of an operator workstation must in no way affect the refrigeration equipment operation.
        2. Provide scheduling for temperature setpoints.

Schedules to include, day mode, night mode and game mode settings. Capable of scheduling at four different on/off periods per day for each 7 day schedule.

* + - * 1. Each Ice Surface: Must have its own unique set of schedules.

A trend log. As a minimum, the DDC system HMI must store to hard drive, all input readings and control outputs from control system.

* + - * 1. Compressors, Pumps and Fans: Will have their own individual trend logs.

Trends will show readings of equipment status, i.e. on/off or fail, and associate control variable relevant to that equipment, i.e. temperature, pressure etc.

* + - * 1. Log run hours and number of starts for each pump, compressor, and fan.
        2. Monitor temperatures, pressures, and equipment status for alarm conditions.

Alarm Setpoints: Adjustable by operator with appropriate password.

* + - * 1. Upon an Alarm Condition: Message appears on operator interface indicating what alarm condition is and time it occurred. Alarms to be documented in the trend logs.
        2. Acknowledgment of alarm will clear the alarm.
        3. Ability to send an alarm message via email to an email recipient or to a cell phone equipped with text-messaging capability. It will generate a specific alarm message for each alarm incident including date and time stamp.
        4. Capable of being monitored remotely from any location via Internet. Remote diagnostics, software maintenance, graphics updates and setpoint adjustments to be possible with remote communications.
        5. Password protected: Minimum of four password levels: Programmer/engineer, service technician, supervisor/operator, and view only.
    1. Graphic Interface Software:
       1. Graphical operator interface software viewable via an HTML5 supported web browser.
       2. Operator Software: Allow navigation through screens by using a mouse. Other than entering numerical values, key entries are to be kept to a minimum.
          1. Allow for restricted access to setpoints and selected information depending on operator password level.
          2. Allow for editing of setpoints, alarms, and schedules.
          3. Allow the display of trends, equipment screens, run-hours, flow screens, sensor values etc.
          4. A screen specific help icon is to be available on each screen providing user with relevant information.
       3. Minimum Graphic Requirements:
          1. Logon graphic.
          2. Main project graphic.
          3. Flow graphic.
          4. One schedule graphic per ice surface.
          5. One graphic for each trend log.
          6. Setpoint graphics.
          7. Alarm graphics.
          8. Runtime data graphics.
    2. Remote Communications Software: Achieve by installing remote viewing software on the local workstation. Refrigeration contractor is to install remote access software to remotely support and monitor the system if required.
    3. Variable Frequency Drives:
       1. Manufacturer: ABB Inc., Model No. ACH550-VDR or approved equivalent.
       2. Line Reactor and Enclosure: Manufacturer: ABB Inc. or approved equivalent.
       3. Engineered Wiring Drawings: Must be complete by the selected contractor.
       4. Programming of VFDs: Must be completed by the selected contractor.
    4. Condenser Fan Motor:
       1. Manufacturer: WEG or approved equivalent.
       2. Condenser Fan Motor: Open Drip Proof NEMA Premium Motor.

1. EXECUTION
   1. EXAMINATION
      1. Do not begin installation until substrates have been properly constructed and prepared.
      2. If substrate preparation is the responsibility of another installer, notify Architect in writing of unsatisfactory preparation before proceeding.
   2. PREPARATION
      1. Clean surfaces thoroughly prior to installation.
      2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
   3. INSTALLATION
      1. Install in accordance with manufacturer's instructions, approved submittals, and in proper relationship with adjacent construction.
      2. Ice Rink Refrigeration System:
         1. Field-Fabricated Steel: Painted with primer, ready to receive final coat as indicated by owner/consultant.
         2. Identification: Primary and secondary refrigerant lines and water lines pertaining to ice rink refrigeration system will be identified after painting and insulation as to substance in the pipe, and direction of flow. Lines penetrating wall sections must be immediately identified on either side of wall. Markers to be Brady as per ASHRAE.
         3. Testing and Instruction:
            1. Refrigeration Contractor: Provide a licensed refrigeration mechanic to operate refrigeration plant during commissioning and training period.
            2. After concrete is cured and rink slab pull down procedure is completed, the owner's personnel will install the first sheet of ice on each new rink floor per Manufacturer's instruction and under Manufacturer's supervision.
            3. Refrigeration Contractor: Provide three (3) days of training minimum, on refrigeration system, for owner's representatives. One day constitutes 8 hours.
      3. Ice Rink Floor Systems:
         1. Ice Rink Contractor: Responsible for supervision and installation of rink floor:
            1. Underfloor sand with heating piping system.
            2. Insulation, slip sheet and vapour barrier.
            3. Reinforced concrete rink slab with refrigeration piping system.
            4. Floor inserts.
            5. Rink perimeter expansion joint.
         2. Rink will be handed over to the Ice Rink Contractor when the following is complete:

Drained subgrade, level to plus or minus 1 inch at elevation 15 inch below finished floor including depressed section at rink headers.

Rink perimeter slab is installed providing an 86 ft 2 inch wide x 201 ft 2 inch long x 28 ft 7 inch opening, level to plus or minus 1 inch within 15 inches of rink edge.

* + - 1. Rink Underfloor Sand: 6 inch thick underfloor stone dust sand in two (2) lifts compacted to 95 percent Proctor standard density and level to plus or minus 3/16 inches. Sand: Clean and free of clay and organic material. Screenings can be provided in lieu of clean sand at the rink contractor's discretion.
      2. Rink Insulation, Slip Sheet, and Vapor Barrier:
         1. Rink Insulation: DOW SE Styrofoam extruded polystyrene insulation.

Supplied in 4 x 8 ft sheets. Compression Strength: 25 psi

* + - * 1. Place In multiple layers, with minimum 24 inch staggered and overlapped joints.
        2. Slip Sheet on Top of Insulation: 6 mil polyethylene vapor barrier.

Supplied in 20 x 100 ft sheets and placed with seams overlapped a minimum of 12 inches.

* + - * 1. Vapor Barrier on Top of Sand: 6 mil polyethylene vapor barrier.

Supplied in 20 x 100 ft sheets and placed with seams overlapped a minimum of 12 inches.

* + - 1. Rink Reinforced Concrete Floor:
         1. Thickness: 5 or 6 inches minimum. Total thickness of concrete over freezing pipes to be a nominal 1-3/4 inch.
         2. Reinforcing: No. 4 bars at 12 inch centers perpendicular to rink pipes, and at 14 inch centers parallel to rink pipes, below the pipes and with 6 x 6 W2.9 x W2.9 welded wire mesh above the pipes. Bars to be intermediate grade deformed steel rust and scale free without sharp offsets or bends. Longitudinal bars for bottom reinforcing to be 20 ft lengths minimum and the minimum overlap to be 24 inches. Place bars beginning 4 inch clear of bulkhead on each side and ends of rink.
         3. Rebar Placement: First layer of No. 4 reinforcing to be laid parallel to rink pipe supports at 12 inch centers and installed before the rink piping. The second layer of No. 4 reinforcing to be laid parallel to rink pipe at 14 inch centers and installed into top loaded pipe chairs after rink piping. The two layers of reinforcing are to be tied together with loop type wire ties at every intersection along diagonal, starting at every third rebar intersection along the rink length.
         4. Mesh Placement: One layer of 6 x 6 W2.9 x W2.9 wire mesh laid on top of rink pipe with 6 inch overlap at seams. Tie mesh with loop type wire ties to pipe chairs every 12 inches and around perimeter of each mesh sheet as required to hold mesh securely in place.
         5. Concrete Mix: Compressive strength of 4000 psi in 28 days. Use any concrete admixtures compatible with specified ice rink floor piping. Submit mix design to be reviewed and approved by structural engineer and Owner's representative. Aggregate: Clean and graded with a maximum size of 3/4 inch. Slump must be maintained at 3-1/2 to 4-1/2 inch at end of pump hose allowing for complete flow around piping system.
         6. Concrete Pump: Concrete slab to be poured in place using a concrete pump with minimum output of 50 cubic yards per hour. No trucks are allowed in floor area and the use of power operated buggies will not be permitted. A standby concrete pump is to be provided.
         7. Runways: 4 x 8 ft, 3/4 inch thick plywood in good structural condition laid on pipe chair supports.
         8. Concrete Placement: In 10 to 12 ft lanes running across width of rink starting in one corner. Vibrators are not permitted in placing concrete. Care must be exercised to prevent damage to piping systems.
         9. Concrete Pour: After concrete placing commences, it must be carried on continuously until completion. Changing of shifts must be done so there is no delay in pouring and meal hours for the crew must be staggered to avoid any stoppage of pouring. Concrete is to be struck off at the exact 6 inch thickness and finished with rotary steel floats until latency has disappeared.
         10. Testing: Testing of concrete mix and test cylinders to be performed by Owner's testing services consultant. Six test cylinders will be taken throughout the pour and tested for a compressive strength at 7 days and 28 days. Cylinders are to be stored at the Project site, under the same conditions of temperature and moisture as the floor, until tested.
         11. Surface Tolerance: Lace concrete to achieve Floor Flatness of FF 45, and Floor Levelness of FL35 (ASTM E1115). Minimum local values for FF/FL to be at least 60 percent of specified overall values.
         12. Finishing: Slab surface to be finished with power driven rotary trowels following immediately behind the pouring crew.
         13. Floor Hardener: BASF Masterkure HD 300WB 55 gallon drum. Disposal of drum after use is by Owner.
         14. Curing and Protection: Continuous moist cure to be maintained for a period of 7 days after the finishing process. The entire slab area is to be covered with polyethylene sheets with care being taken to overlap joints. Polyethylene is to remain in place free of traffic during the wet cure.
      2. Rink Floor Inserts:
         1. Hockey goal post inserts with plugs. To accept Marsh flexible pegs. Qty: 8.
         2. Insert shafts and plugs to be stainless steel. Refer to tender drawings for general details, installation notes and locations.
         3. Supply and placement of Dasher Board inserts are not part of the rink floor insert scope. See Paragraph "Dasher Board System" in this Article. Coordinate installation of rink floor materials and dash board inserts with the dasher board Contractor.
      3. Rink Perimeter Expansion Joint:
         1. A 1 inch expansion joint around the rink perimeter as detailed on the tender Drawings. Expansion joint is to incorporate a Watson Bowman Acme WE-225, or approved equal, black Santoprene compression seal acceptable for use in pedestrian and vehicular traffic areas with ADA requirements.
         2. Install compression seal per manufacturer's recommendations.
    1. Ice Rink Motor Control Panel:
       1. Disconnect and remove Existing Control Panel and related ammonia tubing and dispose in environmentally sound manner.
       2. Supply and Install New NEMA Enclosure Factory built Panel c/w 6 inch panel fan.
       3. Supply and install new cold floor slab temperature sensor and connect to new Honeywell T775 Panel mount controller.
       4. Supply and install new power feeds to all motors.
       5. All control is to be 120 V.
       6. Supply and install new emergency stop button inside vestibule or outside refrigeration room main entrance.
       7. Supply and install 2 x RAHP switches and ammonia tubing to new panel location.
       8. Configure RAHP cut outs with new panel to ensure efficient operation of condenser water pump and fan for condenser.
       9. Test and Tag all plant safeties after panel is installation.
       10. Calibrate ammonia leak detection system.
       11. Check all motor/compressor/pump/fan rotation.
       12. ESA inspections.
    2. Dasher Board System:
       1. Prior to Beginning Installation: Verify rink floor has been released for lift access and expansion joint is installed, inspected, and approved.
       2. Complete installation under direct supervision of experienced Manufacturer Representative.
       3. Install per manufacturers recommended requirements and instructions. Anchor system in place. Provide trim, shims, and accessories for a complete, level, and plumb, installation.
       4. Replace any material scratched, marked up, chipped, dented, or damaged in any way.
       5. Test all parts of system and adjust, as necessary. Walk through system with Owner and make adjustments necessary for Owner's satisfaction.
       6. Nylon ties used to attach netting at top of shielding and elsewhere to be cut off or trimmed in such a manner, and with appropriate tools, to eliminate sharp edges.
       7. Supportless Shielding Systems: Install with 3/8 inch gap between pieces of shielding.
       8. Anchors and Inserts: When dasher board system is installed on the rink floor.
       9. Dasher Board Manufacturer: To be on-site prior to and during concrete rink floor pour to install, protect, and adjust anchors and inserts.
       10. Field verify goal insert locations in concrete floor. Assure alignment with goal line markings on dasher board system.
       11. Resilient Flooring in Boxes: Loose laid over plywood substrate on main box level. Securely fastened on coaches raised platform and raised floor levels within box areas. Cut flooring to fit neatly and tightly around fixed objects and perimeter. Flush surfaces at sills and gates.
       12. Other exposed aluminum or steel horizontal surfaces: Cover with rubber flooring.
       13. Other exposed aluminum or steel vertical surfaces: Cover with poly.
       14. Advertisement Panels: Install per manufacturer's recommendations. Typically, cool rink floor to operating temperature prior to installing advertisement panels.
       15. Ice Markings: Dasher board manufacturer to supply and install paint and ice markings as shown on Drawings and/or as specified.
       16. Coordinate with Installer and/or Owner when making the ice sheet.
       17. Apply paint as recommended by paint manufacturer and supplier; 3 coats minimum for white paint and to achieve uniform coverage of ice surface, marking areas, etc.
       18. Painting shall be performed by a company or crew that has painted a complete set of ice markings for a minimum of ten (10) ice rinks.
       19. Logos: Furnished and installed by Owner.
    3. Ice Rink Control System:
       1. Commissioning: Refrigeration contractor is to provide a competent experienced technician for control system commissioning. Refrigeration contractor employees will accomplish commissioning.
       2. Drawings and Post Install Inspection:
          1. A complete as-built drawing of the new installation is to accompany the final installation inspection report, including piping changes and form part of the tender and construction documents.
          2. Relevant documentation from the Technical Standards and Safety Authority, verifying pressure tests of new piping has been undertaken and inspected by the local Safety Authority representative.
          3. Documentation pertaining to acquisition of a new Provincial Registration number is to accompany the final installation.
          4. Equipment drawings and details to be reviewed and stamped by a professional engineer accredited in the State where the ice rink is located.
       3. Manuals: Three copies of operating and maintenance manuals for equipment covered under this contract, including as-built Drawings. Equipment, drawings, and details to be reviewed and stamped by a professional engineer accredited in the State where the ice rink is located.
       4. Coordination: Ice rink control system contractor is to closely coordinate interactions with other contractors and trades. Specifically mark and identify exact locations for thermowells, transducers and other devices installed by others. Provide specific installation directions and conduct jobsite meetings to make sure devices others are installing are installed properly.
       5. Installation: Work to be in a quality workmanship fashion.
          1. Conduit and Raceways: Routed in a perpendicular fashion with 90 degree and 45 degree bends.
          2. Fire Rated Assemblies Penetrations: Fire stopped or fireproofed conforming to local and national codes.
          3. Weather Station: In open equipment well in a location providing the most accurate outdoor ambient weather information.
       6. Points List: Provide the following system points necessary for a complete properly functioning control system. Provide 10 percent excess hardware points on each controller for future expansion.
       7. Inputs:
          1. Type AI:

Rink 1 Infrared Temperature: IRC.

Return Temperature: TT4WellLo.

Supply Temperature: TT4WellLo.

Suction Pressure: PT100.

Discharge Pressure: PT300.

Outside Air Temperature: ATRHCombo.

Outside Air Humidity: ATRHCombo.

Rink 1 Underfloor Temperature: TTSubSlab.

Rink 1 Slab Temperature: TTSlab.

Snow Pit Temperature: TT4WellLo.

CF1 Actual Speed: (from VFD).

CF2 Actual Speed: (from VFD).

* + - * 1. Type DI:

E-Stop Alarm.

DDC Mode.

Rink 1 Pump Run.

Rink Backup Pump run.

Compressor 1 Run.

Compressor 2 Run.

Compressor 3 Run.

Condenser Pump Run.

Condenser Fan 1 Run.

Condenser Fan 2 Run.

Underfloor Rink No. 1 Pump Run.

Snow Melt Pit Pump Run.

High Level.

Refrigerant Detection.

* + - 1. Outputs:
         1. Type DO:

General Alarm.

Remote Alarm Contact.

Rink 1 Main Pump.

Rink backup Pump Start.

Compressor 1 Start.

Compressor 2 Start.

Compressor 3 Start.

Compressor 4 Start.

Condenser Pump Start.

Condenser Fan 1.

Condenser Fan 2.

Underfloor Rink No.1 Pump Start.

Snow Melt Pit Pump Start.

* + - * 1. Type AO:

Condenser Fan CF1 VFD Reference.

Condenser Fan CF2 VFD Reference.

* 1. FIELD QUALITY CONTROL
     1. Notify Engineer 7 Business Days Prior to the Following Work Phases:
        1. Completion of subgrade preparation.
        2. Start of sub-floor heating system piping.
        3. Completion of transmission main installation.
        4. Start of floor insulation.
        5. Completion of floor insulation.
        6. Start of rink piping and header piping.
        7. Completion of rink piping and header piping.
        8. Final flushing of all piping systems.
        9. Start of concrete placement.
        10. Start of refrigeration piping insulation installation.
        11. Start and completion of all pressure tests.
        12. Start up and Training.
     2. Field Inspection: Coordinate with appropriate sections in Division 01.
        1. Engineer will be on-site at the end of project to generate the final Punch List.
        2. Punch list of uncompleted, or unsatisfactorily completed items, (i.e., punch list) after the project is reported complete by the Contractor and prior to the project's required completion date. If the items are not satisfactorily completed and should additional site visits be required to follow up on uncompleted items, the Engineer shall be compensated at the typically hourly rate for each person involved in the re-inspection. The Contractor will be back charged the amount of the additional inspections.
     3. Testing of Piping Systems: To be witnessed by Engineer. Notify Engineer 10 business days prior to testing.
        1. Test piping prior to backfilling. Isolate equipment and other devices that may be damaged by pressure test. Testing procedures must meet all code requirements.
        2. Testing Requirements:
           1. Polyethylene Pipe: Tested as specified in the "Ice Rink Floor System" Article.
           2. Stainless Steel and Carbon Steel Refrigerant Pipe: Tested as specified in the "Ice Rink Floor System" Article.
           3. Gauges for pressure tests must be for pressures greater than test pressure.

\*\* NOTE TO SPECIFIER \*\* Include if manufacturer provides field quality control with onsite personnel for instruction or supervision of product installation, application, erection, or construction. Delete if not required.

* + 1. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.
  1. SYSTEM STARTUP

\*\* NOTE TO SPECIFIER \*\* Delete the two following paragraphs if CO2 refrigeration is not required.

* + 1. Notify NH3 refrigeration package manufacturer three weeks in advance of refrigeration system startup. Prior to NH3 refrigeration arrival to site:
       1. An NH3 must be approved.
       2. Complete and test ice rink bowl, emergency ventilation, egress lighting, gas monitoring and FA systems.
       3. Facility must be safe for construction personnel and staff occupancy for making ice.
       4. Data cables are run to refrigeration package control panel.
    2. Do not start refrigeration system until local and state Authorities Having Jurisdiction have inspected and provided written approval for systems including refrigeration, piping, controls, ventilation, NH3 gas detection, ice equipment room and related systems; and alarms and controls are tested for all conditions and modes of operations.
    3. Prior to final inspections of Owner, demonstrate control and alarm systems are working as required by code and specified. Make necessary adjustments, additions, and electrical modifications to provide systems. Document procedures were witnessed by Owner. Document piping pressures tests and vacuum tests on systems.
    4. After testing piping systems according to specifications and current codes, clean and fill piping systems with a complete charge of specified refrigerant.
    5. Provide refrigerant as necessary to maintain fully charged systems during project warranty period. Test refrigerants at 3, 12, and 16 months after startup, provide final test reports of each refrigerant; including moisture content, etc.
    6. Concrete Ice Rink Floors: Cure 28 days prior to lowering temperature of ice rink floor. After curing, lower the temperature of the ice rink floor at a maximum rate of 1 degree F per hour until slab temperature reaches 34 degrees F. Then 1 degree F every 2 hours until slab temperature reaches 16 to 18 degrees F before applying water. Provide documentation procedure was witnessed by Owner or Owner representative.
    7. Demonstrate control and alarm systems are working as required by code and as specified. Make adjustments, additions, and electrical modifications to provide these systems. Provide documentation procedure was witnessed by Owner or Owner representative.
    8. The Installer will provide these follow-up services, at no additional cost to Owner:
       1. Forty-Eight hours after operating system, shut down the system, remove construction bags from compressor, and clean strainers and screens on compressor that has been operating. Clean strainers and screens on other valves and equipment. Start operation of other compressors that were not operating previously.
       2. Forty-Eight hours after operating the next group of compressors, shut down the system, remove construction bags from compressor, and clean strainers and screens on operating compressor. Repeat this step for additional equipment. Provide documentation of work performed and observations.
       3. Thirty days after startup, change filter dryer cores. Provide documentation of work performed and observations.
       4. One complete oil change of compressors at runtime recommended by manufacturer. Provide documentation of work.
    9. Variable Frequency Drives: Provide startup services by certified manufacturer's representative to provide an additional 1 year warranty. Provide field report and documentation of all work performed and observations.
  1. STARTUP TRAINING AND SITE SUPPORT
     1. Up to eight days on-site by direct employee of Manufacturer and/or Controls Manufacturer for programming and startup of system.
     2. Five days minimum on-site by a direct employee of Manufacturer for receiving refrigeration package on-site and reviewing installation by Installer.
     3. Fifteen days minimum on-site by a direct employee of the Manufacturer for system startup.

\*\* NOTE TO SPECIFIER \*\* Delete if CO2 refrigeration system is not required.

* + 1. Four days minimum on-site by a direct employee of Manufacturer for hands-on instructions of Owner's operating staff for a total of thirty two hours of training on startup procedures of the NH3 refrigeration system during initial startup of refrigeration system.
    2. Two days minimum on-site for commissioning system. Verify design and operational parameters of refrigeration system. Provide a full, detailed report of findings.
    3. Refrigeration System: Is not to be started until local and state governing authorities have inspected and provided written approval for systems related to, and including refrigeration, piping, controls, ventilation, ice equipment room, building and other related systems. Alarms and controls must have been tested for all conditions and modes of operations.
    4. Documentation of piping pressures and vacuum tests on systems. The owner or Owner's representatives must witness test.
    5. After testing and cleaning piping systems per specifications and codes, fill piping systems with a complete charge of primary and secondary refrigerants. Remove free air from the systems. Contractor is responsible for removing air from system throughout project warranty period. Fill piping system in a manner that avoids trapping air in the system. If air becomes trapped, Contractor must remove fluid and refill system as required until air is removed. Provide field report for each site visit where air is removed, or systems checked clearly detailing processes and observations.
    6. Provide primary and secondary refrigerants needed to maintain fully charged systems throughout project warranty period. Test refrigerants 3 and 11 months after start up. Provide test reports of each refrigerant, including moisture content, inhibitor concentration, solids, refrigerant content, etc.
    7. Provide a factory trained technician for 30 hours to check operation of refrigeration system and equipment and associated systems and equipment during start up. Provide documentation and certification from technician with completed, detailed, check list.
    8. Concrete Ice Rink Floors: Cure for 28 days prior to lowering floor temperature. After curing, lower the temperature of ice rink floor at a maximum rate of 1 degree F per hour until slab is 34 degrees F. Then 1 degree F every 2 hours until slab temperature is 16 to 18 degrees F. Apply water after desired operating temperature is reached. Provide documentation procedure was witnessed by Owner or Owner representative.
    9. Provide Owner's operating staff with 14 hours of hands-on instructions on safe operation of entire ice system. A minimum of two separate days. Include detailed instructions on how to build the first ice sheets. Operation and Maintenance Manuals must be completed and approved at by this time so they can be reviewed during training sessions. Provide 14 days notice for training sessions. Coordinate with Owner's schedule.
    10. Demonstrate control and alarm systems are working as required by code and specified in contract documents and necessary adjustments, additions, and electrical modifications have been made. Document that Owner or Owner representative witnessed procedure.
    11. Provide these follow-up services, at a minimum. Cost of services to be incidental.
        1. After forty-eight hours of operation, shutdown system and remove construction bags from the compressor. Clean strainers and screens on compressor, rink pump and on other valves and equipment. Start operation of second compressor and rink pump.
        2. Forty-eight hours after second compressor and rink pump start up, shutdown system and remove construction bags from compressor, clean screens on compressor and rink pump and on other valves and equipment operating during this period. Provide field report and documentation of work performed and observations.
        3. Thirty days after start-up change filter dryer cores. Provide field report and documentation of work performed and observations.
        4. Provide one complete oil change of compressors at runtime recommended by manufacturer. Provide documentation of work.
        5. Site Visits During Warranty Period: A required to adjust to control settings, equipment functions, and other parts of system as required to optimize operation.
    12. Variable Frequency Drives: Provide start up services by a certified manufacturer's representative to provide additional 1-year warranty. Provide field report and documentation of work performed and observations.
    13. Build the first ice sheet on ice rink floors. Build in thin layers of water in accordance with industry standard practices.
        1. Build a black ice layer of ice. Ice layer prior to painting.
        2. Furnish and install white paint on entire ice rink floors and ice markings as shown on Drawings and/or specified. Apply paint at rates recommended by paint manufacturer; 3 coats minimum for the white paint, and to achieve full uniform coverage of the ice surface, marking areas, etc. Logos: Furnished and installed by Owner.
        3. Build ice over the ice markings to thickness desired by Owner.
        4. Train Owner's staff in building the ice sheet.
    14. Assist Owner in preparing an Emergency Preparedness Plan, Process Hazard Assessment, or related documents by providing Owner's planning consultant with required information on the ice system as requested. Take part in planning session with Owner, Owner's planning consultant and others to assist Owner's planning consultant in developing this plan.
  1. SHUTDOWN TRAINING
     1. Eight hours of hands-on instructions for Owner's operating staff, on shutdown procedures of ice and related systems after the first ice season has expired.
  2. CLEANING AND PROTECTION
     1. Ice Rink Refrigeration System: On completion of the work, all protection erected under this section shall be removed, all damage to this work and to the work of other trades resulting from the execution of the work of this section shall be made good, and all surplus materials, debris, tools, plant, and equipment shall be removed from the premises, and the buildings and site left in a condition satisfactory to the owner/consultant.
     2. Installer must keep premises clean and free of unnecessary materials and debris. On direction at any time from the Owner, clear any designated areas or area of materials and debris. On completion of any portion of the work, remove from premises tools and machinery and debris occasioned by the work, leaving premises free of obstructions and hindrances.
     3. Installer: Responsible for cleaning immediate construction area including rink floor, perimeter concrete, and mechanical rooms where work is performed. Specific requirements:
        1. Patch and paint holes caused or left by construction and demolition work. Match adjacent textures and colors.
        2. Clean equipment and piping to original condition after project has been completed.
        3. Touch up equipment paint, using paint provided by manufacturer, after installation.
        4. Clean out ice re-surfacer snow melt pits.

END OF SECTION