SECTION 15500 – ICE THERMAL STORAGE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. General: Provide the installation of a thermal storage system shown on the drawings and specified herein.

1.2 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of ice tanks of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. The manufacturer shall have factory trained service technicians who will be responsible for the start-up.

1. Provide with bid a list of minimum five successful projects of similar size, with name and phone number of owner's representative. Verify with reference before submitting to ensure this person is available and willing to be contacted by the School District for a discussion of their system.

B. NEC Compliance: Comply with applicable NEC requirements pertaining to control wiring for construction and installation of ice tanks.

C. ASTM: D-4097

1.3 SUBMITTALS

A. General: Refer to paragraph entitled "SUBMITTAL" in Section 23. Include the following data:

1. Product Data: Submit manufacturers' technical product data, furnished specialties and accessories; and rigging, installation, start-up instructions, and copies of all base bid and alternate warranties.
2. Performance Data: Equipment performance curves (charge and discharge) with operational data such as, Delta Ts, charge time and discharge time according to the equipment schedule in the mechanical drawings. Submit computer selection program's output data, as well as, a completed table per AHRI Guideline T (Appendix E). The systems performance shall meet or exceed data specified in the mechanical drawings.
3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection. Include tank and piping layout if different than sample provided. Provide overall footprint required for entire number of tanks required for a complete system. Review proposed layout and confirm product submitted will fit in the space allocated.

4. Software: Provide two copies of the current version of selection software, complete with manual and license. One copy for Engineer of Record's evaluation, and the other for Owner for "what-if" optimization**.**
5. Provide templates for anchor bolt placement in concrete pad. Deliver templates to concrete installer so work by others is not delayed.
6. Wiring Diagrams: Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
7. Maintenance Data: Submit maintenance data and parts list for each tank, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual.

1.4 APPLICABLE STANDARDS

A. ASTM: ASTM-D-1004, and ASTM-D-4097.

B. AHRI:

1. 2013 Guideline for Specifying the Thermal Performance of Cool Storage Equipment (AHRI Guideline T).
2. 2010 Standard for Performance Rating of Thermal Storage Equipment Used for Cooling (ANSI/AHRI Standard 900)

1.5 WARRANTY

A. The manufacturer shall provide a full ten year parts and labor warranty on the entire tank assembly, containment vessel, all internal piping and internal heat exchanger. If any repair or replacement should become necessary during the ten year warranty period, all heat transfer fluid needed to complete repair and prepare system for operation is to be provided. All warranty repairs shall be performed by the manufacturer.

B. Provide an alternate to extend all conditions of the warranty for an additional 10 years.

C. The warranty shall include any damage from continuous over freezing.

PART 2 - PRODUCTS

2.1 ICE TANKS

A. The Ice Plant shall be modular in design so that its capacity can be increased in minimum increments as small as 85 usable latent ton-hours and maximum increments of no more than 600 latent ton-hours with no one tank being more than 25 percent of the usable stored capacity. Ice Plant shall contain the least amount of vessels possible to minimize the footprint. All storage vessels shall be of one module size to facilitate balancing and shall be filled with water as a freezing fluid, such that the ice tank heat exchanger is totally submerged. The ice tank heat exchanger, in all thermal storage

tank modules, shall be piped in parallel and a chilled solution (25% ethylene glycol) shall be circulated through the tubes. In the charging mode of operation, sub cooled ethylene glycol solution shall cause ice to form and build on the tube surfaces. Minimum charging temperature shall be 20 degrees F. In the load mode of operation, the melting ice from around the tube surfaces shall cool the glycol solution. Internal melt comes from the load mode of operation of the ice melting from the tube surface, inside the ice, out. Encapsulated and ice builder systems are not acceptable.

B. Ice Storage Vessel

1. The ice tanks and tank covers shall be suitable for installation outdoors, above ground, and shall produce a floor loading of no more than 400 pounds per square foot.
2. The ice tank farm shall be modular and have a maximum single tank capacity of no more than 600 usable ton-hours each, capable of being individually isolated so that each 600 ton-hour tank may be serviced without interrupting the operation of the total system for system reliability.
3. All Multiple tank installations must be capable of self-balancing, otherwise balancing valves shall be provided by the manufacturer and installed by contractor. If installation fails to provide a balanced charge/discharge, (+/- 5%) the total cost of adding balancing valves shall be the responsibility of the tank manufacturer.
4. Cylindrical ice tanks shall consist of a one-piece design manufactured with high-density rotationally molded, corrosion resistant, polyethylene with a minimum average thickness of 3/8 inch and a minimum average ultimate strength of 2,600 psi, per ASTM D 638-08. The tank shall include a factory assembled thermally isolated expansion chamber to help prevent expansion water from forming capacity reducing ice caps. 5. Galvanized steel vessels shall be constructed of 16-gauge structural quality, G-210, galvanized steel wall panels and thermal span roofing material fitted into a high-grade galvanized structural steel frame. The tank shall contain U-shaped heat exchangers each consisting of multiple parallel-path ¼-inch diameter tubes connected to supply and return headers 2-3/8 inches in diameter. The supply and return connections shall be 3” PVC. The container shall be insulated to an R-12 value.
6. The phase change water containment integrity shall be totally repairable without removing the internal ice tank heat exchanger. If removal of tank heat exchanger is required, tank manufacturer shall provide to owner at their option money or labor for heat exchanger removal, repair, and replacement during containment warranty period. Tank arrangements shall include enough room for rigging apparatus for a side or overhead removal of heat exchanger for tube repair.
7. If required by installation manual, manufacturers of thermal storage tank vessels shall provide, install, and warrant tank safety switches and temperature thermistors. Manufacturer shall notify control contractor of the quantity of safety BAS points required for the tank farm. Float switches and thermistors shall be included in the ice tank warranty.
8. All thermal storage tanks must be designed to withstand, without damage or distortion, repeated cycles of total freezing of all water within it due to control malfunctions or ambient temperatures for all extended warranty periods.
9. All thermal storage vessels must be capable of being re-deployed for use at other sites, in accordance with manufacturer’s instructions, without voiding the

remaining original warranty. Manufacturer shall provide any structural lifting devices, necessary to maintain the warranty.

10. Manufacturers of thermal storage tank vessels shall provide, install, and warrant all heat tracing tape if required for inventory meters, site glasses, and connections.

C. Ice Tank Heat Exchanger

1. The ice tank shall contain a spiral-wound, mat type heat exchanger consisting of translucent tubing with a of minimum 5/8 inch O.D. tubing arranged in multiple parallel circuits with opposite direction of flow in adjoining tubes for even ice making and melting. Tubes shall be connected to internal headers with all welded polyethylene construction, or equal.
2. Manufacturers of thermal energy storage heat exchangers using tubes less than ½ inch inside diameter must provide a 40-mesh strainer, or finer, according to manufacturers recommendations, to prevent tube blockages in heat exchanger tubes.
3. Steel heat exchanger tubes (1.05" O.D.) may be used provided steel framework is hot dip galvanized after fabrication and coated as directed above in tank specification with PLASITE 7122 HAR. All ice tank heat exchangers shall be warranted as specified elsewhere.
4. The heat exchanger designs must withstand 4X the maximum operating pressure and have a burst pressure rating of 300 psi.
5. To avoid capacity-reducing ice caps, heat exchanger tubes shall be totally submerged in the freezing liquid, and shall be kept evenly spaced by plastic spacer strips.
6. Heat transfer fluid temperature drops across the heat exchanger in the charging mode must be large enough to permit full fluid flow through the ice making ethylene glycol chiller. Bypass of fluid around the ice making ethylene glycol chiller in the charging mode is not acceptable.
7. Multiple modular thermal storage tank systems shall be piped parallel in a reverse-return configuration for self-balancing. At design conditions, the ice tank flow shall not change greater than 3% by varying the pressure across the tank farm by one foot (0.043psi). Manufacturers unable to meet this criterion must provide, install and warrant circuit setters and an inventory measuring device for each tank in the farm. Manufacturer must provide pressure drop curves of ice tank with submittal package. If the submitted equipment meets this criterion, only one ice inventory meter is required and balancing valves can be omitted.
8. Each ice tank heat exchanger and its associated piping shall be factory hydrostatically pressure tested.
9. If required by ice tank manufacturer, pressure relief valves between the tank and system must be provided and warranted.

D. Ice Tank Covers

1. Covers shall be provided for all ice modules and/or tanks. Covers shall also support the live weight of 250 pounds at any point on the tank.
2. Covers shall be in modular sections that can be readily lifted, removed, and replaced by two people. Each section shall weigh no more than 250 pounds, and shall have smoothed edges or handles for easy and safe gripping.

3. Each vessel shall have at least one inspection port in the cover, which can be used for visual inspection, determining liquid level, and for filling the vessel with water, without removing the cover(s).
4. Covers for steel vessels shall be a heavy gauge stainless or hot dipped galvanized steel of same type used on tank sides and bottom.

E. Ice Tank Insulation

1. The bottom, sides and cover(s) of each vessel shall be factory insulated. Insulation on the interior of the fluid containment vessel is unacceptable.
2. Manufacturer must provide adequate insulation to limit standby losses not to exceed one percent of the total stored capacity when in a 95 ºF environment for a period of twenty-four hours.
3. For plastic vessels that freeze solid the bottom and the sides of the tank shall be insulated externally with a minimum of two inches of extruded polystyrene or polyurethane applied in overlapping layers having a minimum R- factor of nine (9) Insulation of sides shall be covered with a 0.032-inch thick aluminum jacket for protection and reflectance.
4. The tops of all vessel types shall have a minimum R- factor of 24 for rectangular shaped tanks and R-16 for cylindrical shaped tanks. Insulation with direct access or contact with the storage fluid or ambient air is not acceptable.
5. For stainless steel or galvanized steel vessels that do not freeze solid, insulation meeting the standby loss criteria shall be applied between the exterior of the containment wall or pool type liner and the interior of the structural support system. Insulation of sides and bottom of vessel shall be covered with a minimum 30 mil thick PVC or EPDM impermeable liner, with all seams and joints double lapped and solvent welded. All fastening materials used to hold the liner in place shall be non-corrosive plastic, or stainless steel.

F. Installation instructions

1. Hydrostatically flush clean and field pressure test all piping external to thermal storage tanks prior to connecting the tanks and as specified elsewhere to remove welding slag, flux, and dirt. After successful completion of the test, drain the system and add premixed ethylene glycol to the system as described in another part of the specification. Upon completion of the filling and removal of air, pressure test the ice tanks in accordance with manufacturer's recommendations.
2. The system shall be filled with a pre-mixed ethylene glycol solution resulting in a minimum three parts de-ionized water to one part inhibited ethylene glycol (25% mixture or greater as specified elsewhere). Ethylene glycol shall be a premixed product called Wintrex, or approved equal. The solution shall be thoroughly mixed by the chemical supplier. Field mixed glycol, automotive glycol, and field inhibited glycol is not acceptable. The piping system shall contain a 2-inch fill port on the suction side of the system glycol pumps.
3. A lug type, full flow shut off valve shall be included for field installation and insulation in the supply and return lines of each tank on the system side of the removable flexible connector (if required).
4. Liquid level and/or pressure switches in the expansion tank shall provide glycol system leak protection.
5. Tank bottoms shall be level and supported over the entire area and insulated from their supporting surface with insulation supplied by the tank manufacturer.

If buried, the metal tank manufacturers must provide a factory applied mastic coating for corrosion protection and a field installed cathodic corrosion protection system for each tank.

G. Treatment of phase change water

1. The ice tank manufacturer shall supply one year of water treatment chemicals required for treatment of the phase change water against biological growth and tank corrosion.
2. The treatment must eliminate algae, bacteria, and metal corrosion (if metal tanks supplied). The submittal documents must contain the name(s), and quantities required for the ten-year chemical treatment. Rules for handling, storing, and amount of room required for storing, rules for handling, and rules for application must be provided. Manufacturer of ice tank must provide factory trained personnel annual inspection for heat exchanger and tank corrosion during warranty period shown above.

2.2 PERFORMANCE

A. Vendor shall provide tank performance and selection based on design day load profile, the current AHRI Guideline “T” calculations specified on the mechanical drawings, and factory published performance curves.

B. Ice tank performance less than scheduled is not acceptable.

2.3 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be delivered on the date required by the contractor.

2.4 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide ice storage tank(s) of one of the following:

1. Calmac Manufacturing Corporation
2. FAFCO Thermal Storage Systems, LLC
3. Baltimore Air Coil
4. Dunham Bush

PART 3 - EXECUTION

3.1 ICE STORAGE TANK

A. Placement: The location shall be as shown; however, actual placement shall be field verified in order to avoid conflict with the structure and the access to or location of other equipment.

B. Clearance: Layout and install units with sufficient overhead clearances to permit proper maintenance. The space required shall be a minimum of 36 inches, or greater if recommended by the manufacturer.

C. Piping: Connect the vessels in a reverse-return configuration for self-balancing. Isolation valves and flanges or unions shall be so arranged that the removal of the flexible hose piping shall provide an unobstructed access for the maintenance of each container.

D. Filling: The ice storage tanks shall be filled with water and provided with chemical treatment as directed by the manufacturer.

E. Coordination: Coordinate with piping and controls for a neat workmanlike installation.

3.2 HOUSEKEEPING PADS

A. Ice storage tanks shall be installed on housekeeping pads. Tank bottoms shall be level and supported over their entire area.

3.3 FIELD PIPING CONNECTIONS

A. Valves and Unions: A butterfly or full-port ball-type isolation valve shall be included in the supply line of each tank at the main header on multi module designs. The return line from each tank shall have a calibrated balancing and flow-measuring valve, if not configured as reverse-return.

B. Temperature/Pressure Test Plug: A temperature/pressure test plug shall be provided between the header and isolation valve on the inlet side of each tank.

C. Flow Measuring Station: If the system can't be installed in a reverse-return configuration or capable of self-balancing, provide a flow measuring station (flow venturi with butterfly valve) in the outlet piping from each tank to equally balance the flow through each tank at peak flow conditions.

D. Flexible Hose Connection (applies to steel tanks only): Connections to multi module designs from the main headers if utilized shall be with a 4-ply braided rubber hose having a burst pressure of 300 psi. The hose shall be a minimum of 36 inches long, connected on each end to male threaded hose adapters, secured with two stainless steel hose clamps. Flexible hose connectors on the supply and return connections to the tanks shall be installed with a minimum or 10º and a maximum of 90º bend to allow for a 1-inch movement in all directions. The system side header piping at each flexible connector shall be supported independently of the ice storage tank.

3.1 TRAINING AND START-UP

A. The manufacturer shall examine areas and conditions under which the ice tanks are to be installed and notify the contractor in writing of conditions detrimental to proper

completion of the work. Work is not to proceed until unsatisfactory conditions have been corrected in a manner acceptable to the manufacturer.

B. Provide services of manufacturer's factory-trained service representative to start-up ice system. Include in start-up procedures, testing controls, demonstration of compliance with requirements and replacement of damaged or malfunctioning controls and equipment. Cooperate with chiller manufacturer to ensure adequate operation of entire Ice Plant system.

C. Replace damaged or malfunctioning controls and equipment and retest.

D. Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of ice storage equipment.

E. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

END OF SECTION 15500