ICE CHILLER® Thermal Storage Unit

Introduction

ICE CHILLER® Thermal Storage Units are designed for long, trouble free service when properly installed, operated, and maintained. This manual presents the procedures, precautions, and safeguards for rigging, installing, operating, and maintaining these units. These instructions, along with the certified drawing(s), should be thoroughly reviewed prior to receiving the equipment to ensure all personnel understand the requirements and all necessary equipment is available. All work should follow sound engineering practices and comply with federal, state, and local codes. If additional information is needed about installing, operating or maintaining this equipment, please contact the local BAC Representative whose name and telephone number are on a label at the connection end of the unit.

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NOTICE - Operation, maintenance and repair of this equipment must be undertaken only by qualified personnel. Proper care, procedures and tools must be used in handling, lifting, installing, operating, maintaining, and repairing this equipment to prevent personal injury and/or property damage.

SAFETY - Adequate precautions, appropriate for the installation and location of this product, must be taken to safeguard the public from possible injury and the premises from damage.

WARRANTIES - Please refer to the Limitation of Warranties applicable to and in effect at the time of sale/purchase of this product.

Receiving and Rigging

Inspection of Shipment

ICE CHILLER® Thermal Storage Units are factory assembled to assure uniform quality and minimize field installation requirements. Each unit is delivered to the jobsite on a wooden skid and should be thoroughly inspected for damage prior to unloading and signing the bill of lading. The inspection should include exterior panels, tank covers, sight-tube, controls, and if applicable, the ice inventory sensor. Any damage found must be noted on the bill of lading or the shipping agent may not honor the claim.

Temporary Storage

If the ICE CHILLER® Thermal Storage Unit is to be stored temporarily before being set in place, it must be stored on the shipping skid on a smooth, level site free of any bumps or irregularities that could penetrate or damage the bottom of the tank.

Rigging

Lifting devices have been provided for short lifts and final positioning. For extended lifts or where hazards exist, safety slings under the unit should be used. Spreader bars similar to those illustrated in Figures 1 and 2 must be used for all lifts to prevent damaging the unit.

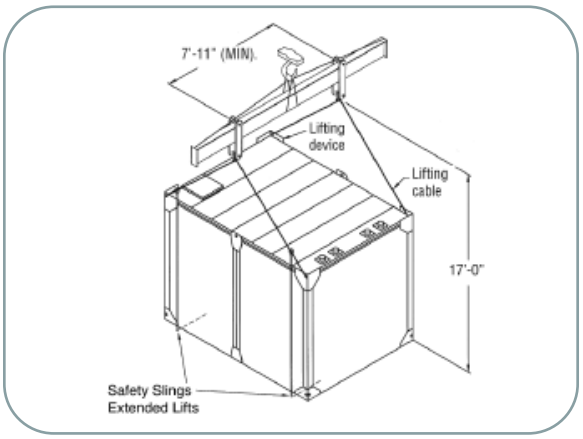

Figure 1 - Lifting: TSU-237M and TSU-L184M

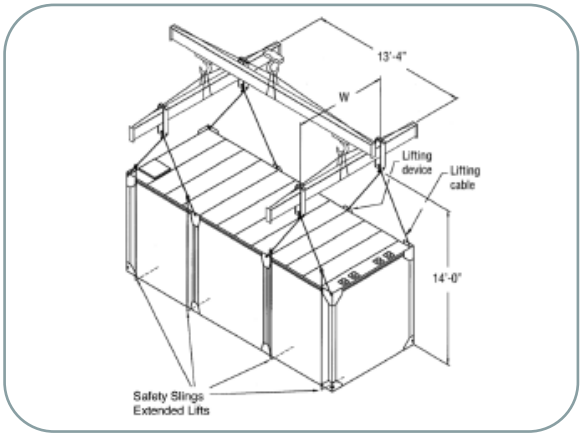

Figure 2 - Lifting: TSU-476M, 594M, 761M, L370M, L462M, and L592M

Caution: When planning the lift(s), use the unit shipping weight shown on the certified drawing. Do not use the dimensions in Figure 1 or 2 for construction. Refer to factory certified dimensions.

For Models TSU-237M and L184M, the proper lifting procedure is shown in Figure 1. For Models TSU-476M, 594M, 761M, L370M, L462M, and L592M refer to Figure 2.

Table 1: Lifting Dimension "W"

Model	Dimension "W"
TSU-476M	7' 11"
TSU-594M	9' 10"
TSU-761M	11' 10"
TSU-L370M	7' 11"
TSU-L462M	9' 10"
TSU-L592M	11' 10"

WARNING: Before lifting, ensure that no water, ice, or debris has collected in the unit or on the covers. Such accumulations will add substantially to the lifting weight and could damage the tank.

Before final placement of the thermal storage unit, remove the shipping skids, as illustrated in Figures 3a and 3b. If the thermal storage unit is to be rolled to its final position, the surface over which it is moved must be level and hard. Place the rollers under each corner as shown in Figure 4.

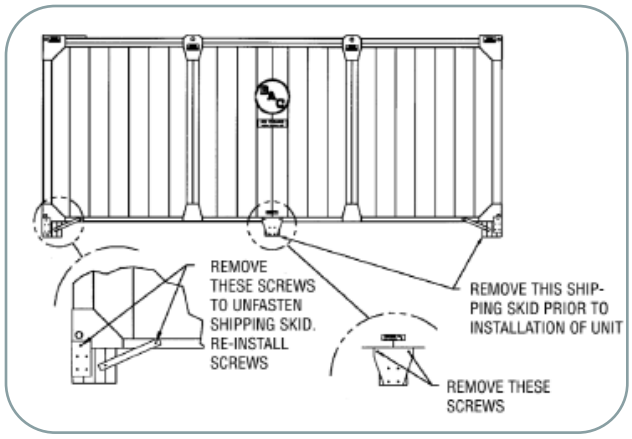

Figure 3a - Removal of Skids - Side View

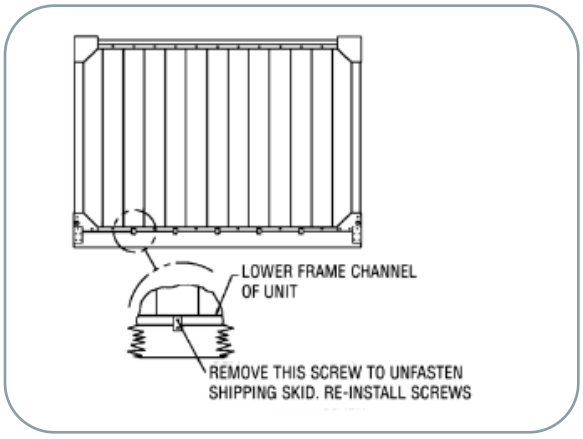

Figure 3b - Removal of Skids - End View

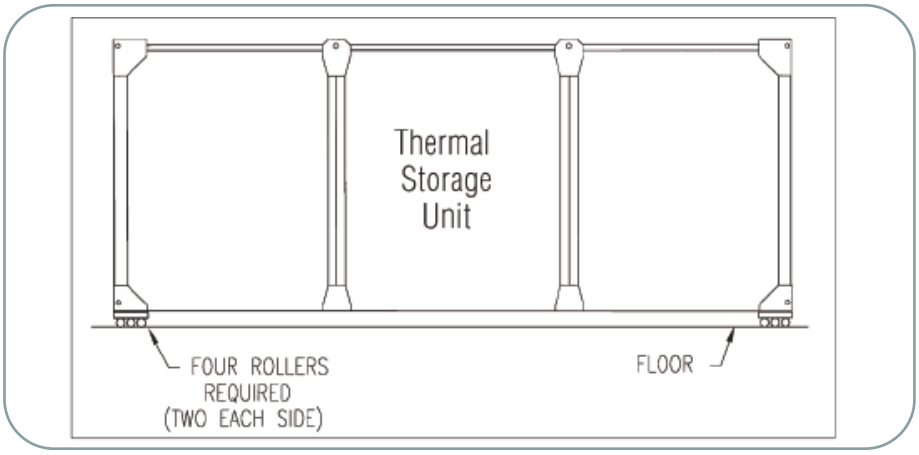

Figure 4 - Arrangement of Rollers - Side View

Installation

Site Requirements

ICE CHILLER® Thermal Storage Units are suitable for installation indoors or out. Units should be positioned with sufficient clearance between units and adjacent walls to provide easy access for inspection and maintenance. When multiple units are installed, provide a minimum of 18" side to side and 36" end to end and preferably more, particularly on the connection end with the control assembly. An overhead clearance of at least 3' should be provided for piping and access.

Support Requirements

ICE CHILLER® Thermal Storage Units must be continuously supported by a level concrete pad designed for the unit's operating weight (see certified drawing). The pitch of the concrete pad must not exceed 1/8" per 10'. Any variation over this amount must be corrected with high strength grout. Do not use shims to level the unit.

Piping

The design and installation of supply and return piping to ICE CHILLER® Thermal Storage Units should follow good practice and conform to applicable codes. Coil connections are grooved to suit a mechanical coupling.

Caution: DO NOT WELD THE COIL CONNECTIONS! This could damage the tank insulation and liner. Do not support piping from the walls of the Thermal Storage Unit or the coil connections.

For single unit applications, a shut-off valve should be installed for each pair of manifolded coil connections so the unit can be isolated from the system. Figure 5 illustrates the valving recommended for a single unit. These valves should offer little resistance to flow and provide tight shut-off. The piping should include a bypass circuit to permit continued system operation when the ICE CHILLER® Thermal Storage Unit is isolated from the system. This bypass can employ a three-way modulating valve to control the temperature of the glycol being supplied to the system. Temperature and pressure taps should be provided to simplify balancing the flow and system troubleshooting. A relief valve, set at a maximum of 150 psi, must be installed between the shut-off valves and the coil connections to protect the coils from excessive pressure due to hydraulic expansion, if and when both valves are closed. The relief valve should be vented to a portion of the system which can accommodate expansion or to an approved containment vessel.

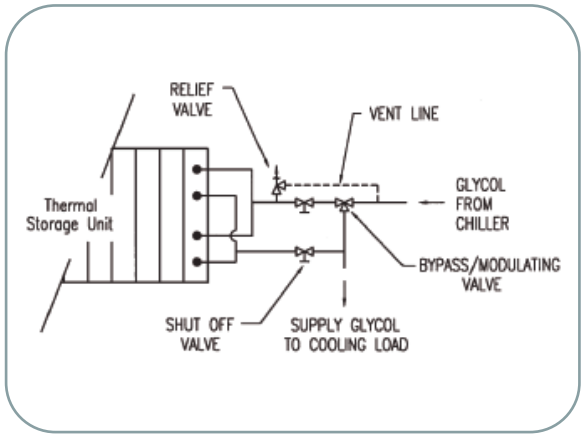

Figure 5 - Typical Glycol Piping for Single Unit

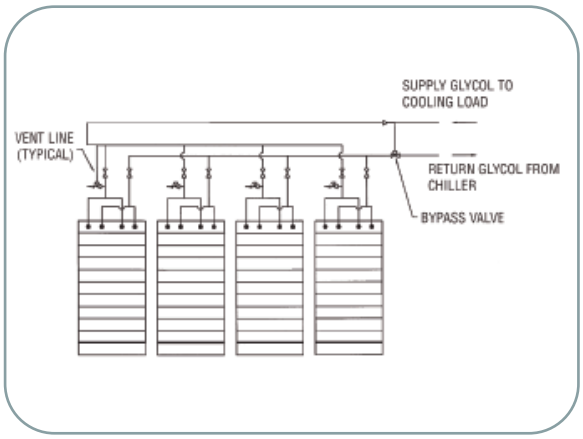

Figure 6 - Typical Reverse Return Piping for Multiple Units

When installing multiple units in parallel, a reverse return piping system must be used and provision made for balancing the flow rate to each unit (see Figure 6).

On installations with a large number of tanks, consider dividing them into groups with a common balancing valve for each group. In such an application, shut-off valves should still be installed on each tank to allow for isolating individual tanks. As with single unit installations, a relief valve should be installed between the shut-off valves and the ice coils to protect the coils from hydraulic expansion.

The system must include an expansion/compression tank to accommodate changes in fluid volume. Adequately sized air vents must be installed at the high points in the piping loop to remove trapped air from the system.

After the piping is installed, pressurize the system with air (but not to the point where the pressure relief valve(s) would be activated) and check the piping for leaks. Once the pressure test is complete, isolate the thermal storage unit(s) from the system before flushing and cleaning the system piping. Otherwise, some of the flushing chemicals, which may be detrimental to the glycol solution, could be trapped in the system. The thermal storage coils do not require flushing and are **NOT FREE DRAINING**. If the units are flushed with the system piping, the tube bundles cannot be readily drained and allowance must be made for the volume of water that remains in the coils when calculating the quantity and concentration of the glycol solution to be added to the system.

Tank Filling

After final placement and piping, verify the unit is uniformly supported on the concrete pad. Then, locate the tank fill connection (see Figure 7) and the Sight Tube showing the tank water level (see Figure 8).

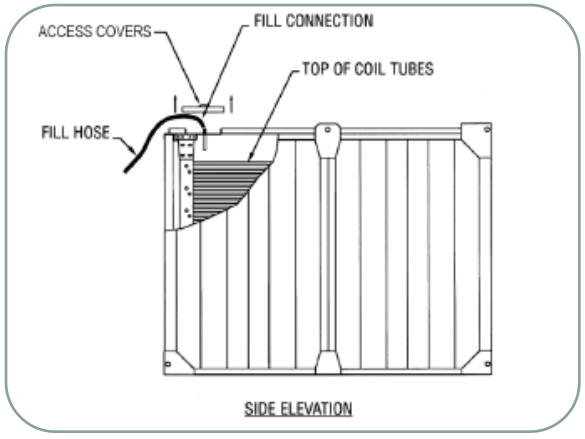

Figure 7 - Location of Fill Connection

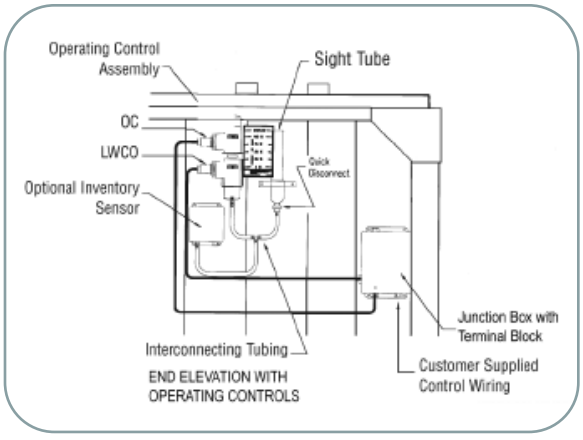

Figure 8 - Location of Sight Tube

Using good quality water (see quality guidelines in the “Water Quality and Treatment” section on Page N121), fill the tank following the steps outlined below. For proper, long-term operation of the thermal storage unit, the tank must be filled exactly to the prescribed level, (+1/4", -0").

1. Remove the access cover on the top of the unit, connect the fill hose to the tank fill connection and begin to fill the tank. See Table 2 for the approximate volume of water required.
2. Continue filling the tank until the water level in the clear sight tube reaches the "0% ice build" level (See Figure 9 below).

Table 2: Fluid Volumes

Model	Tank Volume (gallons of water)	Coil Volume (gallons of solution)
TSU-237M	2,990	260
TSU-476M	5,840	495
TSU-594M	7,460	610
TSU-761M	9,150	790
TSU-L184M	2,330	205
TSU-L370M	4,560	385
TSU-L462M	5,820	477
TSU-L592M	7,140	602

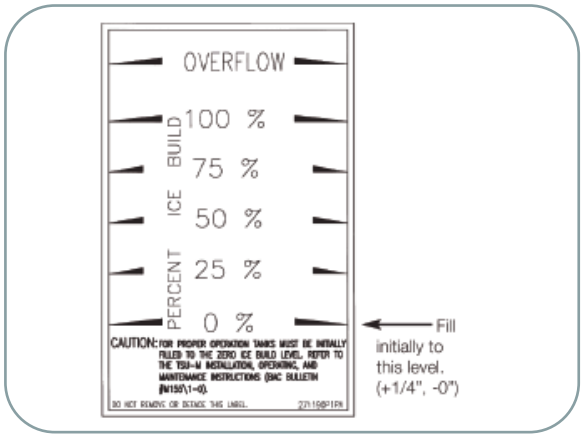

Figure 9 - Water Level in Sight Tube

3. When the tank is filled, disconnect the fill hose, then replace and tightly secure the access cover.

Caution: Do not overfill. Overflowing the tank may damage the insulation and/or cause the operating controls furnished with the unit to malfunction.

System Charging

Typically, a 25% solution (by weight) of ethylene or propylene glycol is specified for use with thermal storage systems.

However, project specifications vary and the type and concentration of solution to be used must be verified for each application. When ethylene glycol has been specified, two acceptable fluids are Dow's DOWTHERM® SR-1 and UCARTHERM®. If propylene glycol is required, Dow's DOWFROST® is suggested. BAC also recommends that premixed solutions be purchased, rather than mixing on site.

Caution: Do not use uninhibited glycols or antifreeze solutions intended for automotive use.

If the solution is to be mixed on site, be sure to use good quality dilution water (see Page N121) and follow the manufacturer's directions. Mix the solution thoroughly and test the concentration before it is introduced to the system. Use a refractometer specifically designed for heat transfer solutions to determine the glycol concentration. When calculating the total volume of solution required, see Table 2, Page N117, for the internal volume of the thermal storage coils.

To fill the system, open all valves and the air vent(s) at the system high point(s) to allow the glycol solution to flow freely throughout the system. Then, pump the premixed solution into the system. When the charging is almost complete, isolate the charging tank or tank truck from the glycol loop and turn on the system circulating pump to ensure the solution is circulated throughout the loop. Operate the pump for 24 hours and then check the system pressure and glycol concentration.

NOTE: The Model TSU-237M and TSU-L184M have two 1/2" MPT vent connections (see Figure 10) that must be bled during the charging process. The installing contractor is responsible for providing the vent valves and plugs.

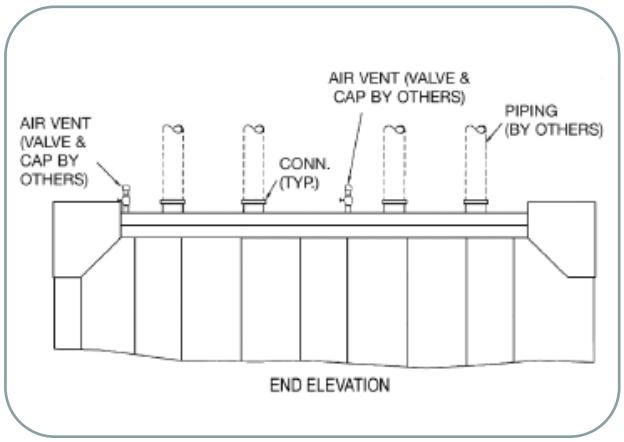

Figure 10 - Air Vents on TSU-237M and TSU-L184M

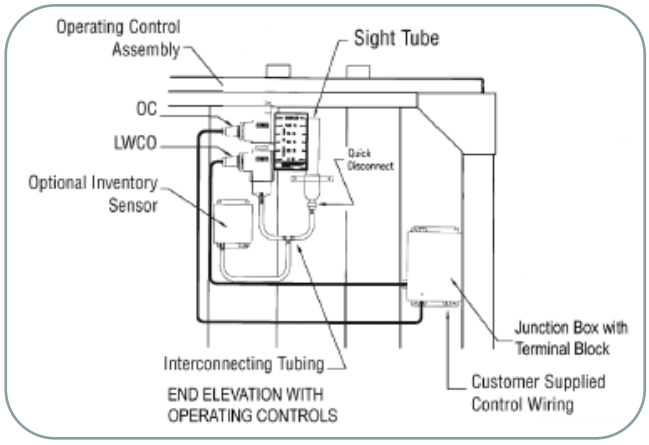

Figure 11 - Detail of Control Assembly

Operation and Control

General

To ensure dependable, trouble-free, efficient operation of the thermal storage units, each system is provided with factory-installed, preset operating control assemblies (see Figure 11). The operation of which is described below.

Build Cycle

For the most energy-efficient operation of the system, the controls should be designed to operate the build cycle as follows:

Once the ice build cycle has been initiated, the glycol chiller(s) should run at full capacity without cycling or unloading until the storage device is fully charged (recharged). At that point, the chiller and the glycol circulating pump should be turned off and not allowed to restart until the discharge (cooling) cycle is initiated. Additionally, a build cycle should not be re-initiated until approximately 15% of the ice has been melted.

To accomplish this control strategy simply and dependably, each ICE CHILLER® Thermal Storage System is furnished with at least one operating control assembly comprised of (See Figure 12):

1. A Low Water Cut-Out (LWCO), factory-set to lock-out the ice build cycle if there is insufficient water in the tank.
2. A Shut-Off Switch (OC), factory-set to terminate the ice build cycle when the thermal storage unit(s) are fully charged and to prevent the ice build cycle from being re-initiated until approximately 15% of the ice has been melted.

NOTE: On multiple tank installations, more than one operating control will be provided to ensure consistent operation of all thermal storage units.

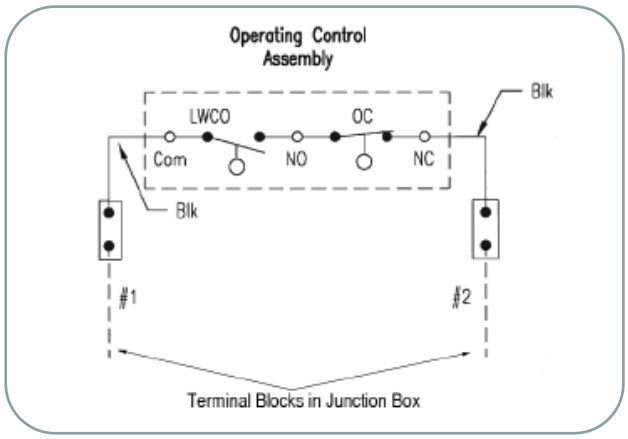

Figure 12 - Wiring for Operating Control Assembly

As illustrated in Figure 13, the operating controls must be connected in series to the chiller operating controls or the building energy management system to start and stop the ice build cycle on demand.

On systems with multiple operating controls, the ice build cycle for all units should be terminated when any one operating control is activated. Similarly, the ice build cycle should not be re-initiated until the contacts of all the operating controls are closed, signaling the inventory has been reduced to 85% of design or less.

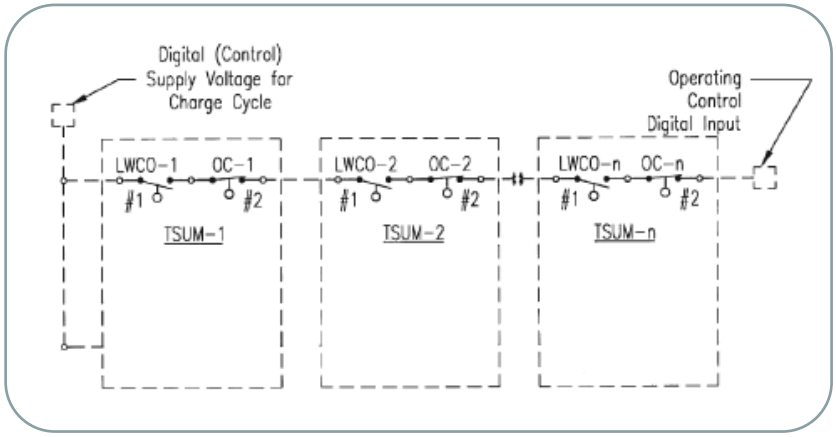

Figure 13 - Wiring Multiple Units

WARNING: Under no condition should the operating or safety controls furnished by BAC be bypassed or deactivated during the ice build cycle or the factory settings be changed. To do so will risk damaging the equipment.

Discharge (Cooling) Cycle

ICE CHILLER® Thermal Storage Units can be discharged in a variety of ways depending upon the system configuration and objectives of the system designer. Consult the project drawings and specifications for direction on how the system is to operate during the discharge (cooling) cycle. When the operating strategy calls for operation of the chiller at any time during the discharge cycle, the operating control(s) used to control the ice build cycle must be bypassed/deactivated when operating in the discharge cycle.

Outdoor Installations

Caution: When the thermal storage unit will be exposed to subfreezing ambient temperatures, the operating control assembly, the sight tube assembly, and, if so equipped, the Ice Inventory Sensor, (see Figures 14 and 15) must be protected. An enclosure with a thermostatically controlled, 100 Watt heater, is available from BAC.

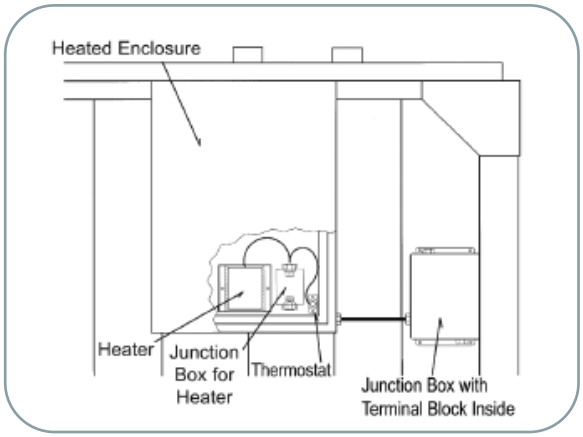

Figure 14 - Heated Enclosure for Controls

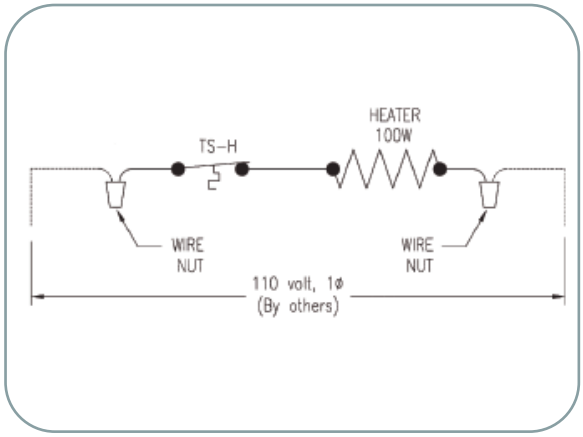

Figure 15 - Wiring for Enclosure Heater

Commissioning

General

Before initiating the first ice build cycle, check the following points:

1. Confirm all thermal storage units are filled with water to the 0% ice build level. (+1/4", -0")
2. Check the units with operating controls to ensure the contacts on the low water cutout are made and will allow the ice build cycle to be initiated.
3. Verify the system has been charged with a glycol solution of the type and concentration specified.
4. Confirm all circulating pumps are rotating in the proper direction.
5. Verify all operating controls have been wired correctly and set in accordance with the instructions in this manual.
6. Confirm there is sufficient load to discharge the tanks.
7. On systems equipped with an ice inventory sensor, check to insure the sensor has been wired, calibrated and purged of air by bleeding water through the bleed port.
8. If any of the units are equipped with a heated enclosure around the operating control and sight tube, check to ensure the heater and thermostat are wired and operational.

Once the checks are completed, start the initial ice build cycle and monitor the system throughout the cycle, recording glycol temperatures and noting the duration of the build. Confirm the operating controls function properly to terminate the build cycle and that once the build cycle is completed, the chiller is shut down and locked out until the cooling cycle is initiated.

On multiple unit installations, once the initial ice build cycle has been completed, check all the sight tubes to verify the water levels in each tank are equal. If the inventories are significantly out of balance, the flow rates of the glycol solution to each of the thermal storage units should be checked and balanced. Then, after the next ice build cycle, check the sight tubes once again to ensure balance has been achieved.

Maintenance

General

A program of regular inspection and maintenance is essential for optimum performance and maximum service life. The following information is provided as a guide to establishing such a maintenance program. If you have any specific questions, please contact your local BAC Representative whose name and address appear on a decal at the connection end of the unit, adjacent to the nameplate.

Unit Exterior

On a monthly basis, inspect the frame and exterior panels, for signs of corrosion or any unusual conditions. If corrosion is found, wire brush the area and treat with a cold galvanizing, zinc rich compound (ZRC).

Unit Interior

Quarterly, remove the access cover (see Figure 7) and inspect the interior of the unit for signs of scale formation, corrosion, or biological growth on the tube bundle. If present, initiate or modify the water treatment program (see the section on Water Treatment).

NOTE: Repeated freezing and thawing can cause some minerals dissolved in the water to precipitate. If observed, this is not cause for concern.

Water Level in Tank

To properly check the water level in the tank, **THE ICE MUST BE COMPLETELY MELTED.** At seasonal start-up, and at least once a quarter thereafter during the operating season, conduct a full melt-out and continue to add heat to the tank until the water temperature is approximately 40°F (4.4°C). Then check the water level in the sight tube. Add or remove water from the tank as necessary to restore the level to "0% Ice" in the sight tube (+1/4", -0").

Glycol Solution

Semi-annually, or at the seasonal start-up and shutdown, draw a sample of the glycol solution from the system and check the concentration using a refractometer. If necessary, adjust the concentration using the proper type of industrially inhibited ethylene or propylene glycol.

Annually, have your glycol supplier check samples of the glycol solution for the proper level of inhibitors and adjust if necessary.

Seasonal Shutdown

ICE CHILLER® Thermal Storage Units installed indoors in a heated space (or outdoors where subfreezing temperatures do not occur) do not require special attention or preparation for a seasonal or winter shutdown.

Caution: Where the thermal storage unit(s) will be exposed to subfreezing ambient temperatures, the ice inventory sensor, the operating control, and the sight tube assembly must be protected. An enclosure with a thermostatically controlled, 100 Watt heater is available from BAC.

Caution: The concentration of the glycol solution in the system should be verified to ensure it adequately protects the coils and system piping from freezing. See Table 4, Page N122, for a list of freeze point temperatures versus concentration for ethylene and propylene glycol solutions. Adjust the concentration if necessary.

Intermittent Winter Operation/Spring Start-up

ICE CHILLER® Thermal Storage Units that have been exposed to severe or sustained subfreezing ambient temperatures, should be checked before initiating an ice build cycle. Ice created by subfreezing ambient temperatures which accumulates at the top of the tank and around the walls must be melted out before initiating a build cycle. This ice can prevent normal water displacement during the build cycle, possibly leading to physical damage to the coil and tank walls.

Ice melt can be confirmed visually, but it is recommended the temperature of the water in the tank be raised to 40°F to ensure all ice is melted.

Water Quality and Treatment

Dilution Water Quality

The dilution water used to mix glycol-based heat transfer solutions must be of good quality, meeting certain minimum standards. Otherwise, the effectiveness of the corrosion inhibitors may be compromised and scale or other deposits may form on heat transfer surfaces. BAC recommends you consult the glycol supplier for their specific recommendation but, typically, distilled or deionized water with a total hardness of less than 100 ppm (expressed as ppm calcium carbonate) and less than 25 ppm each of chlorides and sulfates is recommended.

Water in Thermal Storage Tank

The constantly near or below freezing temperatures of the tank water tend to retard scale formation, corrosion, and biological growth. Therefore, little or no water treatment may be required unless the quality of the water used to charge the tank is extremely corrosive or scaling in nature. A biocide may be desirable, however, to control the growth of iron bacteria or other organisms, particularly during prolonged shutdowns.

Since water quality can vary widely from site to site, **a qualified water treatment specialist should be consulted for specific recommendations.** The water treatment program, whether simple or extensive, should be tailored to maintain the water quality within the guidelines listed in Table 3.

Table 3: Water Quality Guidelines

Property of Water	Range
pH	7.0 to 9.0*
Chlorides	≤ 125 ppm
Sulfates	≤ 125 ppm
Total Alkalinity as $CaCO_3$	≤ 500 ppm
Total Dissolved Solids	≤ 625 ppm

Caution: Do not treat the tank water with chemicals that alter the freeze point of water.

*Tank water pH of 8.3 or higher will require periodic passivation of the galvanized steel coils to prevent "white rust", the accumulation of white, waxy, non-protective zinc corrosion products on galvanized steel surfaces.

Table 4: Freezing Points of Aqueous Solutions of Ethylene and Propylene Glycol

Ethylene Glycol		Percent Solution by Weight	Propylene Glycol	
Freezing Point (°F)	% By Volume		% By Volume	Freezing Point (°F)
32.0	0.0	0.0	0.0	32.0
29.4	4.4	5.0	4.8	29.1
26.2	8.9	10.0	9.6	26.1
22.2	13.6	15.0	14.5	22.9
17.9	18.1	20.0	19.4	19.2
16.8	19.2	21.0	20.4	18.3
15.9	20.1	22.0	21.4	17.6
14.9	21.0	23.0	22.4	16.6
13.7	22.0	24.0	23.4	15.6
12.7	22.9	25.0	24.4	14.7
11.4	23.9	26.0	25.3	13.7
10.4	24.8	27.0	26.4	12.6
9.2	25.8	28.0	27.4	11.5
8.0	26.7	29.0	28.4	10.4
6.7	27.7	30.0	29.4	9.2

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