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Ice Bank® Energy Storage

INSTALLATION AND OPERATION MANUAL

IB-SVX186A-EN
June 6, 2019

CALMAC®

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This technical guide is written to provide a complete and comprehensive procedure for the installation of Ice Bank® Energy Storage tanks. It is not the intent of this guide to exclude sound and proven methods of installation by contractors who have, through experience, developed an efficient method of installation expertise.

All work must be performed in accordance with LOCAL, STATE and NATIONAL codes. After reading this manual, if any questions arise, please call your local representative or CALMAC® Applications Engineering Department at (201) 797-1511 or e-mail info@calmac.com.

I. GENERAL.

A. Module Description. The storage module consists of a plastic tank full of water (ice in the charged state) in which a specially designed heat exchanger is immersed. The heat exchanger consists of a coiled mat of plastic tubes, which are spaced evenly throughout the entire volume of water. The unique spiral counterflow configuration allows ice to build up evenly throughout the tank without tank damage. An empty space is provided above the heat exchanger for expansion of water during freezing.

B. Model Types. The tank model numbers are appended with suffixes to specify different configurations. The complete model number can be found on the rating plate located on the tank cover adjacent to the connections.

C. Damage in Transit. Upon receipt of the shipment of this equipment, inspect all tanks and packages for external damage. If external damage is noted, mark the number of damaged items and the nature of the damage on the delivering carrier's waybill and request the services of an inspector.

Since all materials are sold FOB factory, it is the responsibility of the consignee to file claims with the delivering carrier for equipment received in damaged condition. Normally, claims for any and all damages should be filed with the freight company within five working days of the receipt of shipment.

II. SITE LAYOUT.

A. **Floor Loading.** When filled with water the tanks are quite heavy. Consequently the structure supporting the tanks must be capable of bearing this weight. Refer to Table 1 for the filled weight of each tank model and required floor loading strength. The plastic bottom of the tank must be level (¼"/6 mm) over the tank diameter and supported over its entire area. For all "C" Model tanks (See Section III.B.2.) the adjoining tanks must be on a continuous level surface.

Table 1

Tank Model Number	Shipping Weight- Lbs. (kg)	Filled Weight- Lbs. (Kg)	Floor Loading- Lbs./Sq..Ft. (Kg/m²)	Overhead Clearance- inches (cm)	Fork Lift Slots	Required Coolant- gals. (liters)	Pure Glycol Added to HX- (Sec IV.D) gals. (liters)	Required Biocide- oz. (ml)
1045A	580 (265)	4380 (1986)	147 (718)	24 (61)	Yes	40 (152)	13 (49)	16 (475)
1082A	1025 (465)	8455 (3835)	283 (1382)	24 (61)	Yes	78 (295)	26 (98)	16 (475)
1098A	1225 (555)	10,100 (4580)	234 (1142)	24 (61)	Yes	90 (341)	30 (114)	16 (475)
1105A	1275 (580)	10,760 (4880)	360 (1758)	36 (91.5)	Yes	99 (375)	33 (125)	16 (475)
1190A	1950 (885)	16,765 (7605)	388 (1894)	36 (91.5)	Yes	148 (560)	50 (189)	16 (475)
1045C	620 (280)	4505 (2045)	151 (737)	24 (61)	Yes	47 (178)	16 (61)	16 (475)
1082C	1065 (485)	8580 (3890)	286 (1396)	24 (61)	No	86 (326)	29 (110)	16 (475)
1098C	1275 (580)	10,235 (4645)	237 (1157)	24 (61)	No	99 (375)	33 (125)	16 (475)
1105C	1315 (595)	10,760 (4880)	363 (1772)	36 (91.5)	No	107 (405)	36 (136)	16 (475)
1190C	2000 (910)	16,900 (7665)	391 (1909)	36 (91.5)	No	157 (594)	52 (197)	16 (475)
1220C	2625 (1190)	23,000 (10,433)	531 (2593)	36 (91.5)	No	210 (795)	70 (265)	16 (475)
1320C	4000 (1814)	34,000 (15,420)	391 (1909)	36 (91.5)	No	315 (1192)	105 (397)	2x16 (2x475)
1500C	6000 (2721)	50,600 (22,950)	391 (1909)	36 (91.5)	No	470 (1179)	155 (587)	3x16 (4x475)

B. **Partial Burial.** Partially burying the tanks in the ground is permissible as long as one foot of the tank protrudes above ground level. The tanks must be installed on a concrete pad which is level and completely supports the bottom of the tank. (See Specifications for Partially Buried Ice Bank® tanks, #CS-3).

C. **Full Burial.** Tanks sitting on a concrete pad may be placed in a pit. A layer of sand then wood chips or top soil may cover the tanks. (See the Installation Manual for Totally Buried Ice Bank Ice Storage Tanks, #IB-152 for more information).

D. **Outdoors.** Tanks are suitable for outdoor installation. They must be set on a surface that meets the specifications outlined in Section II. A. Settling or erosion of the surface may cause the tanks to shift. It is normal for the tank covers to show minor distortions when exposed to the sunlight. These minor distortions will not affect the operation of the tank.

E. **Roofs.** Tanks can be installed on roofs however they may need to be spaced apart so that maximum structural loading is not exceeded. Follow the instructions of a structural engineer regarding the distribution of the tank floor loading.

F. **Service Access.** Refer to Table 1 for the required overhead clearances for each model tank. No service access is required around the sides of the tank beyond what is needed for proper headering.

III. TANK INSTALLATION.

A. **Insulation.** All tank models are insulated at the factory and are shipped with integral insulated bases installed.

B. **Moving the Tanks.** The tanks are heavy even when empty and two people, with help of a forklift or crane, are generally required to move them. **All standard rigging procedures and safety rules for lifting heavy objects should be followed at all times even if not detailed in this manual.**

1. **"A" Model Tanks**. All have forklift slots incorporated into their bases to facilitate moving the tanks. Forklifts must have forks or extensions at least 72 inches (1830 mm) in length. Forklift operators must take care not to ram the tanks with their forks when picking the tanks up. This type of handling could puncture or otherwise damage the tanks.

When using a crane to move an "A" Model tank into position put two 30 foot (9 m) long, 3-inch (75 mm) wide "choker" straps — each 180° apart — around the midsection of the tanks. As the crane starts to lift, the straps will slide up about a foot (300 mm), tighten around the tank, grip and then hold the tank. The tank can then be maneuvered into position.

2. **"C" Model Tanks.** These tanks consist of one, two or three individual modules which have main headers built into the cover. Models 1320C and 1500C tanks must be rigged into position with a crane and a special rigging bar available from CALMAC®. (A standard spreader bar can be used on the Model 1190C and 1220C). When moved, they must be lifted as a single unit. Each module is equipped with 2 hoist rings. Normally, one rigging bar is shipped with each job. Lifting hooks are provided and packaged separately.

Insert the provided clevis pins through the appropriate holes in the rigging bar, capturing the hooks between the steel channels (Figures 2A, 2B & Table 2). Lock the clevis pins in place by inserting a cotter pin. Lifting cables should be attached to the rigging bar as shown in Figure 2A & 2B in accordance with Table 2.

The rigging bar should be placed on top of the ice tank unit and the lifting hooks secured to the tank hoist rings.

If either the Model 1320C or Model 1500C Ice Bank units must be temporarily set down, prior to its final placement, it should be placed on a clean, flat and reasonably level surface.

Note: Keeping the tanks level and preventing them from swinging will assist in maintaining the required uniform spacing between tanks.

IV. PLUMBING PROCEDURES.

A. General. There is no preferred inlet or outlet header connection to the tank.

Flange manufacturers recommend that the 4'' flange bolts with washers be torqued to no more than 60 ft. lbs (81.4 Nm) and standard tightening pattern be used to prevent leaks or damage to the flanges.

1. **"A" Model Tanks.** The connections on Model 'A' tanks are 2" flanges.

Table 2

LIFTING PIN DESIGNATIONS

MODEL	PIN # FOR TANKS	PIN # FOR LIFTING CABLE
1320	1,2,3,4	7,9
1500	1,2,3,4,5,6	8,10

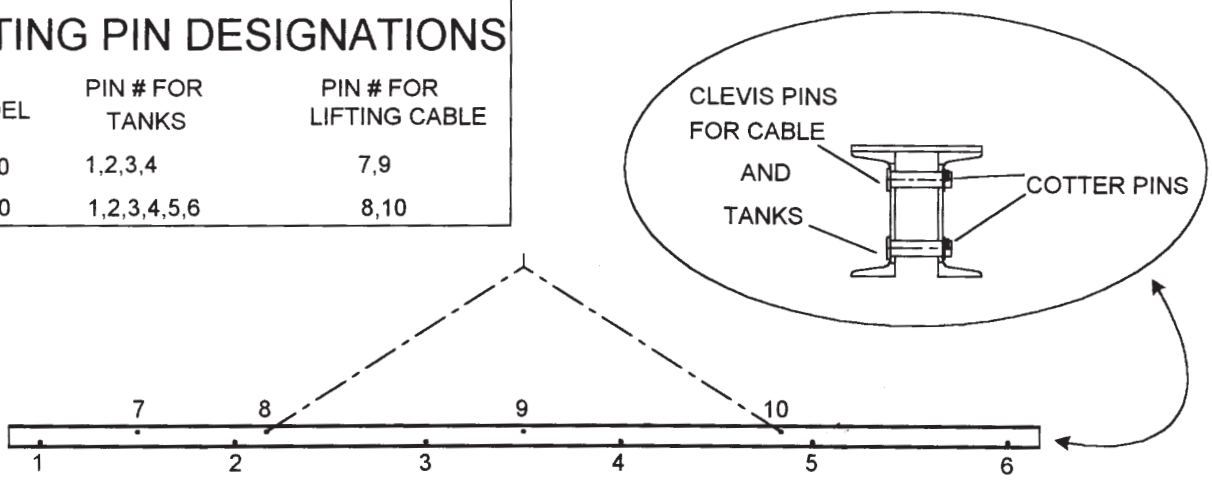


Figure 1

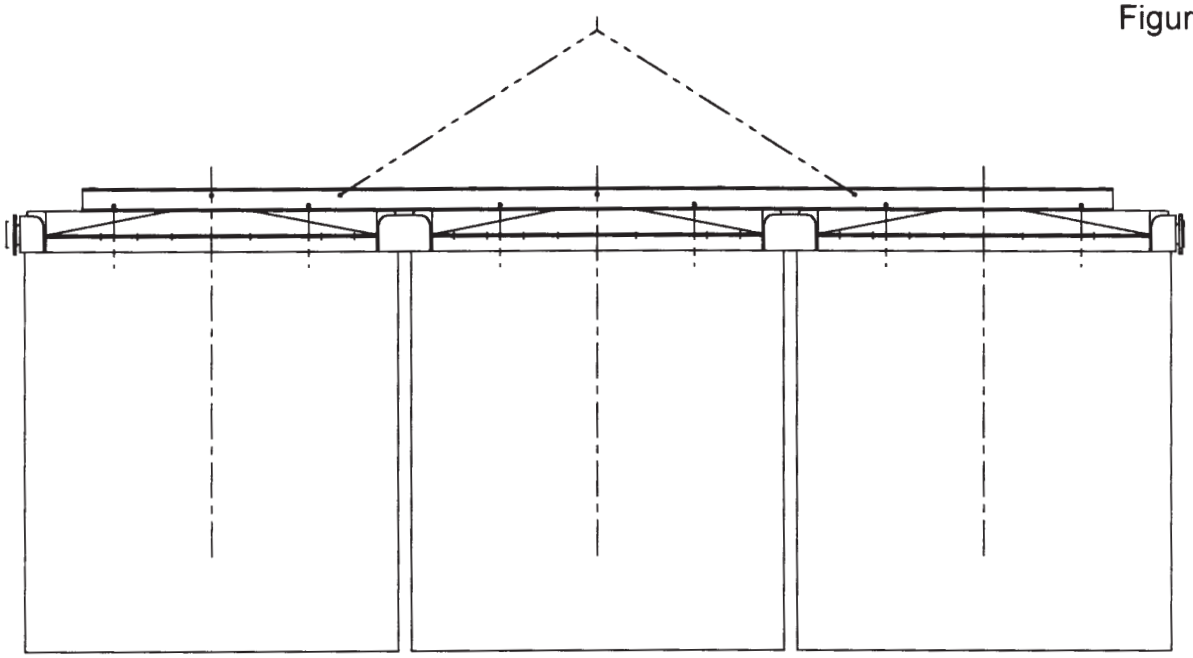


Figure 2A
Model
1500C

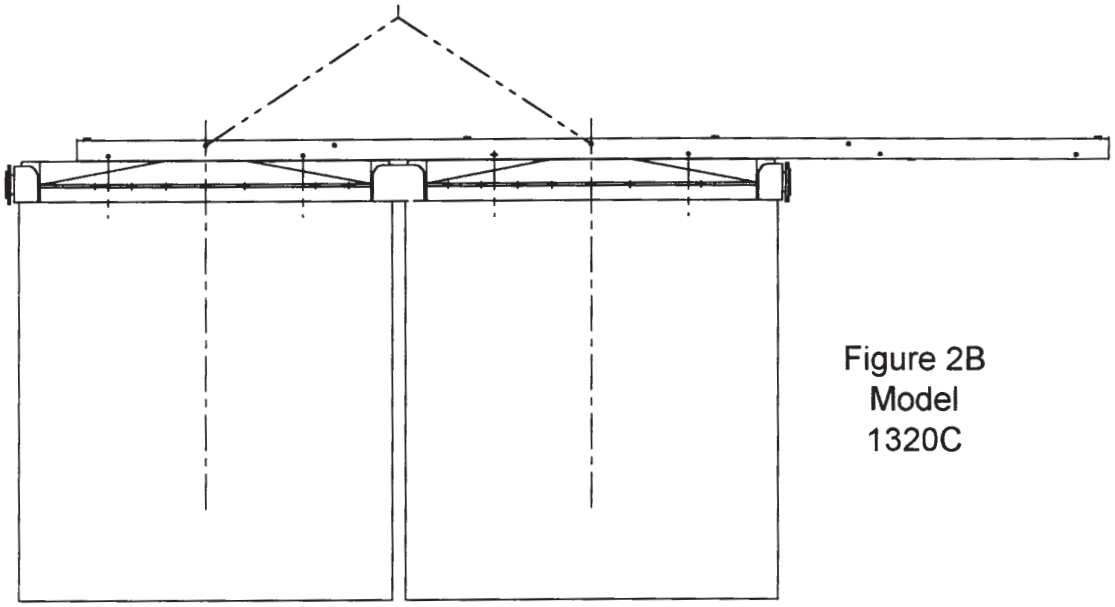
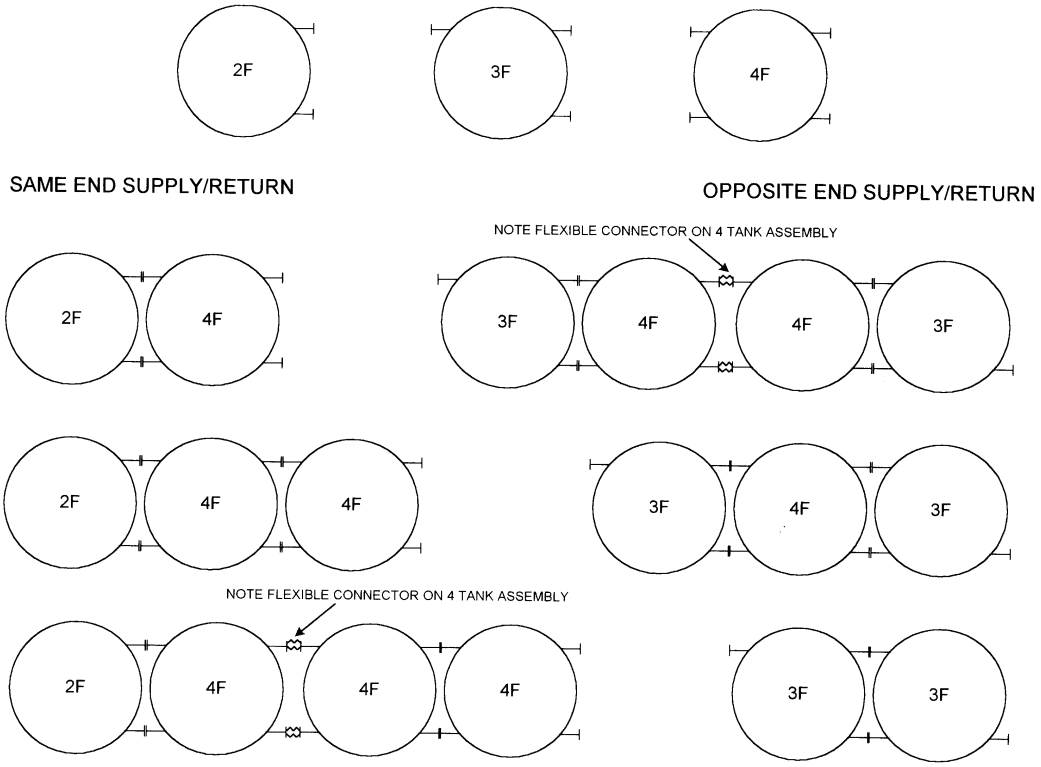


Figure 2B
Model
1320C

ASSEMBLY OPTIONS FOR "C" MODEL TANKS

Figure 3.



Note: The standard polyethylene heat exchanger is limited to 90 Psi (620 kPa) internal pressure. (Special orders to 125 Psi/862 kPa.) If system pressures exceed these limits, a heat exchanger must be used to isolate the storage tanks from the higher pressure. A pressure relief valve must also be installed in the system to assure that pressure does not exceed 90 Psi (620 kPa) for standard heat exchangers and 125 Psi (862 kPa) for special order heat exchangers.

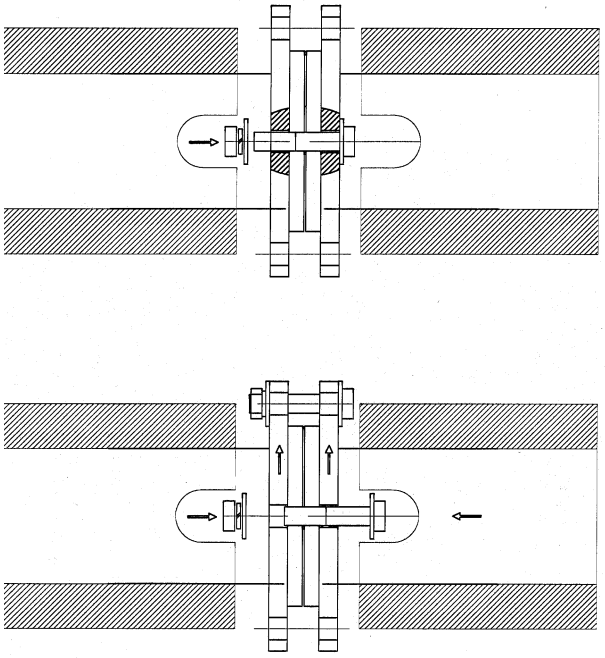
2. "C" Model Tanks. External pipes must be located in such a way that the internal header pipes are not pulled from their normal, at rest position. Using flange bolts to pull tank flanges to system piping may cause internal damage.

Models 1320C and 1500C have 4" flange connections. Model 1190C tanks can be bolted directly to each other at the 4" flange connection. See Figures 3 and 4. However, do not connect more than three Model 1190C tanks directly to each other without an intermediate flexible connection that will allow 3/4" to 1" (20 to 25mm) of axial motion.

B. Flushing. All field constructed piping systems should be flushed thoroughly, before filling with the coolant, to remove weld slag, flux, debris etc. from the piping. It is a good practice at this time to valve off all heat exchange devices that are not protected by a strainer so that small passages do not become plugged. The Ice Bank® tanks should also be valved off. It is a good practice to carefully monitor the amount of water needed to initially fill the system for flushing. This may be useful for determining the volume of coolant required to fill the system. Remember to add the Ice Bank heat exchanger, and any other piping volumes that were isolated from the system in the total system volume. Once the system has been thoroughly cleaned, the system should be totally drained of water.

C. Hydrostatic Testing. Hydrostatic tests are normally done on all piping systems. If a hydrostatic test is specified before coolant is put in the system, the tanks should not be part of this test and should be valved off. This is because if pure water is pumped into the heat exchanger it cannot be removed. After the successful completion of the test, drain the system and add premixed glycol to the system as described in Section IV.D.2.

If the specifications call for a complete hydrostatic pressure test of the entire system, including tank heat exchangers, completely fill system with glycol/water solution and remove air. Then increase air pressure in the expansion tank up to the hydrostatic test pressure



1. ALIGN HOLES IN THE FLANGES WITH RECESSES IN INSULATION. ASSEMBLE AND HAND TIGHTEN HARDWARE

2. ROTATE FLANGES AND REPEAT HARDWARE ASSEMBLY

Figure 4. Recesses in the header insulation facilitate the assembly of connecting hardware.

(maximum 150 Psi/1034 kPa). **After 30 minutes close off all valves on each tank and let sit for the prescribed period of time.** Monitor system pressure as tank valves are sequentially opened.

Liquid level and/or pressure switches in the expansion tank are recommended to alert operators of a shortage of liquid in the system. Since these systems contain a valuable heat transfer solution, steps should be taken to prevent the loss of the liquid. The tank farm as a whole should be capable of isolation by valves. A two-step alarm, triggered by either low liquid level in the expansion tank or low pressure at the high point of the building, should be installed. The first level of alarm is to alert the operator of routine requirements for the system's fluid. The second level would be for extremely low level/pressure indicating a major leak and should close automatic valves to isolate the tanks and other parts of the system.

Make-up systems using city water are not recommended because adding water alone will dilute the coolant. If an automatic coolant make-up system is required, CALMAC® GMS liquid pressurization system, which adds premixed solution is recommended. Indoor installations should have floor drains in accordance with local codes.

D. **Recommended Filling Sequence.**

1. **Add Water to Tank.** After the tanks are in final position and plumbed, CALMAC® recommends that tanks be initially filled with water to approximately 90% of final fill height, or about 6 tubes below the top HX tube. At this time the Biocide should be added to the water. See section IV.D.4. After the tank heat exchangers are filled with coolant, the water level would be brought to the final correct height, just covering the top heat exchanger (HX) tube, except for Model 1220, which is filled to the bottom of the top HX tube. **Partially or fully buried tanks should be filled with water as soon as practically possible to prevent tank flotation, should the burial pit accumulate with water.**

2**. Add Heat Transfer Fluid Solution to Heat Exchanger.** The system should be filled with a glycol/water mixture with a freezing point of about 12ºF (-11ºC)—approximately three parts water to one part ethylene glycol. Refer to Table 1 for amount of coolant required for each tank model. Houghton Chemical Wintrex, Dow SR-1 or equivalent are recommended; automotive anti-freeze is not recommended because it contains additives which reduce the life of internal surfaces.

If the tank heat exchangers have been filled with water, perhaps due to a hydrostatic test or system flush (Section IV.C.), an adjustment must be made to the concentration and/or quantity of coolant added to the remaining system. Pure glycol can be added to the

system to account for the water left in the tank heat exchangers. The required quantity can be found in Table 1, (Pure glycol added to water in HX, Gals. (liters). The remaining system volume would then be filled with coolant at the normal concentration. (e.g. Adding 50 gals./189 liters) of concentrated glycol to the 148 gals./560 liters of water in an 1190 HX would result in 198 gals./750 liters) of solution volume at 25.3% glycol concentration).

Alternatively, the concentration of all the coolant to be added to the system can be increased. This procedure may be simpler when coolant is ordered premixed, in bulk. The needed concentration can be calculated approximately from the following:

C = Concentration of added coolant

V_S = System volume, not including tank HX's

C_R = Final concentration needed by system

V_{IB} = Volume of tank HX's
(Required Coolant, Gals. (liters) from Table 1)

$$C = \frac{C_R\ (V_S+V_{IB})}{V_S}$$

In all large systems there should be a minimum two inch (50 mm) fill connection on the suction side of the pump. The premixed glycol solution should be pumped into this connection. Before starting the filling pump, high points of the system should have the vents open.

Note: Unlike when filling with water, these vent locations must be manned at all times during the filling process so that the heat transfer fluid is not inadvertently spilled.

When the coolant reaches the vent, manually close the vent and stop the fill pump. Care must be taken not to over-pressurize the system (maximum 90 psi/620 kPa at the tank inlet for standard tanks and 125 psi/862 kPa for special order tanks).

The system pump can now be turned on for a few minutes, preferably at low speed or valved back to half flow. Most air will quickly move to the high points. With the system pump off, the vents can be opened and the fill pump can be started again. After repeating this a few times and when most of the air is eliminated, open the valves and run the system pump at full flow. At this point the system's air eliminator should be able to remove the final amounts of air. When all of the air is out, run the fill pump until the system's expansion tank is at the proper level and the system is at its proper working pressure (usually 5 psi/35 kPa at the high point of the building).

Keep circulating coolant through the system at the design pressure. Make sure the system pressure doesn't drop. If it does, there is a leak in the system.

Use a refractometer or equivalent to test the solution's glycol concentration after the system has been filled and circulated for 24 hours. If the solution's glycol concentration is less than 25% or above 12°F (-11.1°C), draw off a sufficient amount of mixture and add pure glycol to achieve a 25% concentration.

3. **Finish Adding More Water to Tank.** At this time, after heat transfer fluid has been added to the heat exchanger, finish filling the tank with water to a height just covering the top heat exchanger (HX) tube, except for Model 1220, which is filled to the bottom of the top HX tube. For water level instructions in MIXAIR tanks, see Installation Manual for MIXAIR Ice Bank® tanks #IB-158.)

4. **Add Water Treatment. Pour in the initial treatment of biocide into the tank water upon filling**, into the inspection port. This will help to control biological growth. CALMAC® recommends a 20% Tetrakis hydroxymethyl phosphonium sulfate solution such as Aquacar PS20. All tank models require 16 oz. of biocide solution per tank.

The CAS number is 555-66-30-8

Note: The cover must always be in place whenever the tank is in operation in order to prevent floating of the heat exchanger. You are now ready to freeze the tank(s)!

E. **Insulation.** All piping must be insulated to prevent condensate dripping as well as exposure to sunlight (to prevent ultra-violet degradation). Since these liquid lines run cooler than most chilled water systems the thickness of the insulation may need to be slightly greater than normal to avoid condensation.

V. RECOMMENDED OPERATING TEMPERATURES.

The storage system will operate most efficiently if the chiller controls are set to terminate charging at the highest return temperature that will charge the tanks in the available hours. In most cases, with a 6ºF (-14.4°C) temperature difference across the chiller, the average leaving chilled coolant temperature will be approximately 25ºF (-3.9°C) with a 31ºF (-0.6°C) return. **Most commonly, if the chiller unit is set to turn off when the coolant temperature leaving the tank reaches 28ºF (-2.2°C) (See project engineers specification for exact temperature.) the tanks will be completely charged.** If the chiller is allowed to run at lower conditions than required the free water above the heat exchanger may freeze causing an "ice cap". This ice cap will in turn cause a shortage of water during discharge, thereby impairing the discharge performance and wasting energy.

VI. REPAIRS AND MAINTENANCE.

Note: The cover must always be in place whenever the tank contains ice in order to prevent floating of the heat exchanger.

A. Routine Maintenance.

1. **Annually.** The water/ice level in the tanks should be checked at least once a year. (Check Ice Bank® Ice Storage Operation & Maintenance Manual #IB-SVX147A-EN for complete details). When the tanks are 100% frozen, usually first thing in the morning, there should be approximately 4 to 7 inches (10 to 15 cm) of water above the submerged insulation depending on the tank model. The water level should be within ½ inch (1.27 cm) of the bottom of the tank covers. Add water if this is not the case. (If the tanks are not fully frozen, adding water may cause the tanks to overflow when fully charged, which will not hurt the tanks however, it may cause flooding of the area).

At the end of the cooling season, you should fully charge the tanks and leave them frozen until the start of your next air-conditioning season.

If the tank is equipped with an inventory meter sensor, altering the water level may require re-calibration of the meter. Refer to "Ice Inventory Meter Installation and Operation Manual", #IB-153.

The coolant should be checked annually for proper corrosion and freeze protection. This service should be available from the glycol manufacturer.

2. **Tank Water Treatment.** Generally, if tanks are kept at least partially frozen year round, provide retreatment with biocide as needed. However, if tanks are not kept frozen year round, retreatment may be required more often and the tanks should be checked for slime or odor seasonally.

B. Warranty Repairs. Authorization for in-warranty field repairs must be obtained in writing from CALMAC® before any repairs are attempted.

To find out more about Ice Bank® energy storage visit calmac.com or trane.com/energystorage

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