ICE-CEL®

Tube-in-Tank / Packaged Systems Ice Thermal Storage Modules

FEATURES

- Tough, one piece tank construction with integral insulation
- Super efficient heat exchanger yields top performance
- Pre-engineered matched components
- Integration minimizes field labor
- All welded coil construction
- Pumps and piping included
- Controls included
- Easy to install

DUNHAM-BUSH®

Form No. 6074D

Why thermal storage?

Thermal storage is a technology that has come of age. It meets today's need for flexible energy management. Whether you're the owner of a large building, a school executive, a hospital administrator or a manufacturer, you realize that energy costs are a major part of your annual budget, and a somewhat uncontrollable one. Today, you can do something about that. You can begin to manage your energy usage.

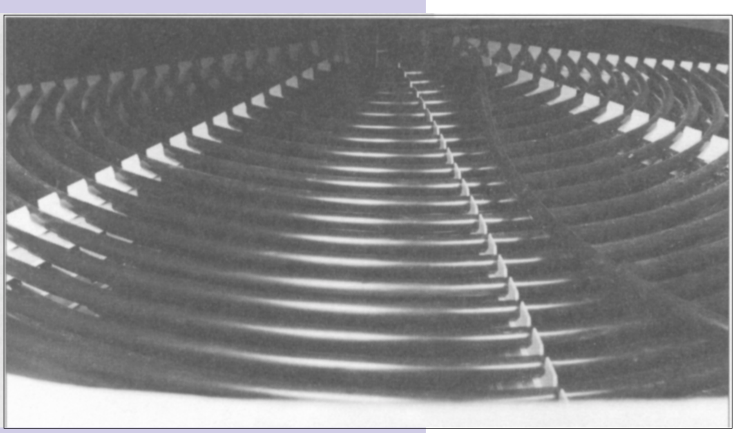
Thermal storage allows you to produce cooling when most convenient, or least costly, and use it for air conditioning or process cooling when needed. You'll find that thermal storage is remarkably economical. In many cases, the equipment is no more costly than conventional, inflexible cooling systems. If you're adding cooling capacity to a given building or process, thermal storage can often provide the needed cooling with no additional electric-driven refrigeration equipment.

Ice-Cel is used primarily to store cooling capacity for air conditioning. Many central air conditioning systems serving both large and small buildings use electrically-driven liquid chillers. Chillers are often idle at night because little, if any, cooling is required at that time. When Ice-Cel thermal storage tanks are added to the system, the chiller operates at night to store cooling capacity within the Ice-Cels. When cooling is required during the day, it can then be supplied by the Ice-Cels. This cooling can either supplement or replace the electrically-driven chiller during daytime operation.

Most building air conditioning systems using Ice-Cel thermal storage can be designed to cost no more than conventional chiller-only systems.

What is an Ice-Cel?

Ice-Cel is a modular ice thermal storage tank. The tank is filled with water, in which is submerged a polyethylene tube heat exchanger. A glycol solution cooled to about 25°F by an air conditioning liquid chiller is pumped through the tubes, causing the surrounding water to freeze. When fully frozen, the TS240 will store 240 ton-hours (844 kWh) of cooling capacity, so, for example, it would require 10 hours operation of a 24 ton (84 kW) chiller to fully freeze the water in the tank. Ice-Cel tanks come in three convenient sizes shown in Table #4 on page 6.



To serve a cooling load, the ice can then be melted at a rate ranging from 0 to 40 tons (0 to 140 kW). For example, the TS240 Ice-Cel could serve a steady load of 20 tons (70 kW) for 12 hours. In providing cooling, the glycol solution flows from the Ice-Cel to the load device (such as an air handler) at a temperature of typically 34-38°F (1-4°C).

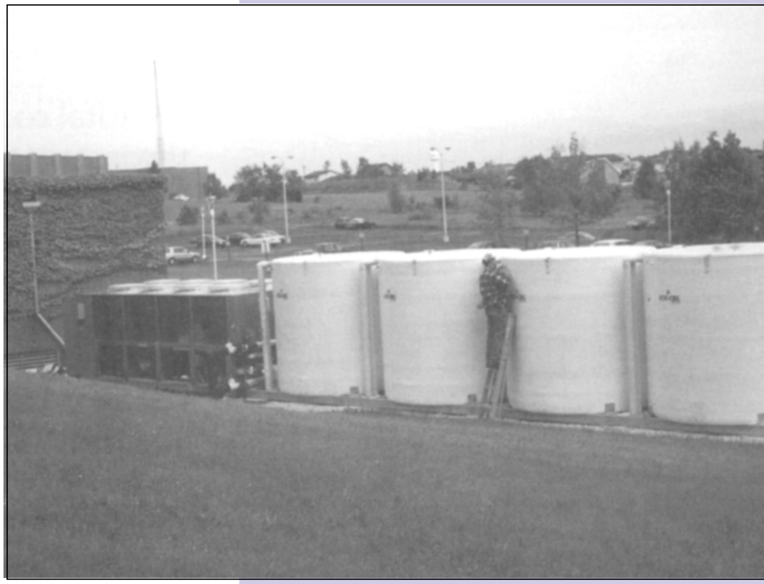
Introducing A New Concept in Packaged Air Conditioning!

Integrated ice storage systems by Dunham-Bush combine:

- The benefits of economy, flexibility and compactness offered by Ice-Cel tube-in-tank frozen storage modules and
- The convenience, reliability and low cost of pre-engineered and factory-packaged chiller systems.

Ice-Cel integrated systems are offered in two forms:

Packaged Systems in the range of 25 to 100 tons (88 to 352 kW) which include a chiller and up to 4 Ice-Cel tanks mounted on a skid with integral microcomputer controls, glycol pump, control valve(s) and interconnecting piping. They are available with either air- or water-cooled heat rejection and use either reciprocating or screw compressors. Larger systems with simple cross connections can be offered by Dunham-Bush. Contact your local Dunham-Bush representative.



Engineered Systems in the range from 100 to 550 tons (352 to 1934 kW) which consist of a chiller, multiple Ice-Cels, pump and microcomputer controls shipped separately for field assembly into an integrated system. These systems are also available with either air or water cooled heat rejection.

How does an Integrated System Work?

Advantages to a building owner of ice thermal storage

The most common application of an Ice-Cel Integrated System is in big building air conditioning, where it is used to store cooling effect during the night. This cooling effect is later used for air conditioning during the day. It can also be used to serve an intermittent process, where cooling is stored over a long period, to be used in a short period.

Demand Charge: Most big building utility rates include a heavy demand charge based on peak demand, which is usually experienced in summer daytime. Ice-Cel allows some or all of this peak demand to be shifted to low-demand nighttime periods, thus reducing demand charges for the entire year.

Energy Cost: Many electric utilities offer time-of-day or time-of-use electric rates, where each kWh of electric energy used at night costs less than in the daytime. In some cases, the nighttime rate is less than half the daytime rate. Ice-Cel, by utilizing the chiller at night, takes advantage of this incentive.

Rebates: Some electric utilities offer up-front rebates for equipment that will shift peak loads to off-peak hours. Thermal storage usually qualifies. In some cases, the rebate is large enough to pay for the purchase of Ice-Cel tanks.

Colder Air: With Ice-Cel thermal storage, chilled liquid is available at temperatures of 38°F (+3.3°C) or less, rather than the 44°F or 45°F (6.6°C or 7.2°C) commonly available from liquid chillers. This lower temperature allows air handling units and ducts to be downsized and air handler fan power to be reduced. The result is the distribution of cooler air, and lower room humidity. With lower humidity, a room's thermostat can be set slightly higher for the same comfort level, thus reducing air conditioning load. The net result is reduced installed cost and operating cost.

Standby Cooling Capacity: With Ice-Cel thermal storage, standby cooling capacity is available for peak load periods, since the total cooling capacity exceeds the instantaneous capacity of the installed chillers. This can be valuable for batch process cooling, where high short-term loads are encountered.

Deregulation of Electric Utilities: With Ice-Cel thermal storage, the building operator will be able to deal with changing electric rates due to deregulation. Although some utilities will do away with special incentive programs, most utilities will still have high demand charges during peak periods and will have real time pricing. Real time pricing means the utility will charge more for electric at noon than it will at night because it will be cheaper for the utility to make electric during off-peak periods. Ice-Cel will allow the owner to take advantage of this changing structure and reduce operating costs for the future.

Installing an Ice-Cel Packaged System

Since the Ice-Cel Packaged System is mounted on a single skid, all it needs is a flat concrete slab capable of carrying the unit operating weight (see Table 2).

Water cooled packages should be installed in an indoor equipment room. The only connections needed are:

1. Piping from unit to building chilled glycol loop.

   If the owner prefers to run chilled water to air conditioning loads, a plate heat exchanger can be provided as a special option, to isolate glycol within the package.
2. Three phase electrical connection to unit terminal block.
3. Condensing water piping connection to cooling tower.

   Condensing water pump can be provided in the Integrated Package as a special option.

Air Cooled Integrated Package Systems should be installed on a slab outdoors. The only connections needed are:

1. Piping from unit to building chilled glycol loop.

   If the owner prefers to run chilled water to air conditioning loads, a plate heat exchanger can be provided as a special option, to isolate glycol within the package.
2. Three phase electrical connection to unit terminal block.

Packaged System Advantages

Ice-Cel Packaged Systems offer the following advantages over field-installed equipment:

1. Pre-engineered matched components assure reliable operation.
2. Control of thermal storage sequencing is included in the chiller microcomputer. No need for separate controller.
3. Cost of separate equipment pads and field labor for mounting chiller, pump(s) and ice tanks is eliminated.
4. Cost of separate wiring to chiller and pumps is reduced, since there is one common connection. Pump starter(s) are included in package.
5. No field control wiring to install between components.
6. Cost of field piping between chiller, pump(s) and ice tanks is eliminated.
7. Single source support for all major air conditioning equipment.

Installing Ice-Cel Engineered Systems

Ice-Cel Engineered Systems: Since these systems are shipped as separate components, they must be field installed, using the following guidelines:

Ice-Cel tanks should be installed on a concrete slab capable of supporting the operating weight. They may be installed indoors, outdoors on a slab, buried in the ground, or supported on steel structural support. (See Ice-Cel instructions for tank burial.)

Water cooled chillers should be installed in an indoor equipment room.

Air cooled chillers should be installed outdoors on a slab.

Pumps should be mounted in an indoor equipment room.

All interconnecting piping and wiring must be field installed.

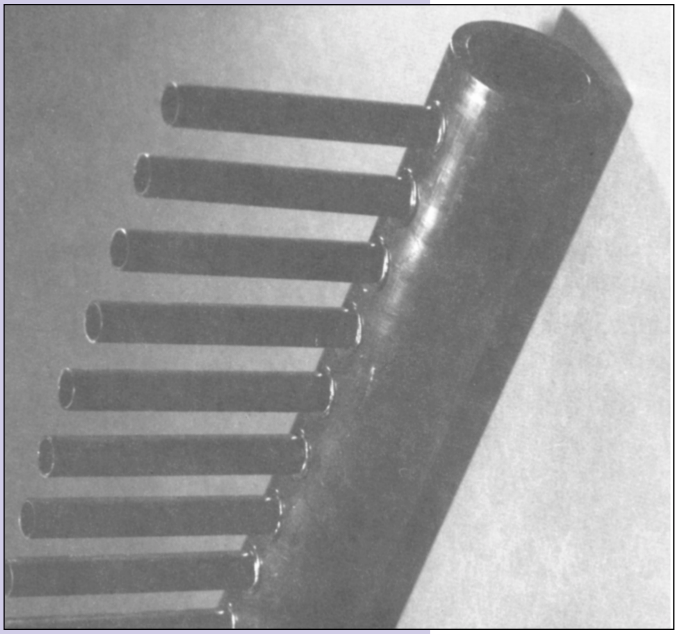
Engineered System Advantages

Ice-Cel Engineered Systems offer the following advantages:

1. Pre-engineered matched components assure reliable operation.
2. Pre-engineered controls take the guesswork out of control logic.
3. Modular components afford flexibility in location.
4. One source responsibility for all major air conditioning equipment.

Ice-Cel construction:

The Ice-Cel tank is a double-wall fiberglass resin tank with two inches (5.1 cm) of urethane foam insulation sealed between the two walls, yielding a minimum of R-14 insulation factor. A removable top cover of similar construction is provided. The tank insulation is so effective that losses due to heat in 90°F (32°C) ambient air are limited to 0.08 tons (0.28 kW) or about 0.8% of total storage per day.



The heat exchanger consists of horizontal rows of serpentine coils of .75 in (1.9 cm) OD high-density polyethylene tubing held in a rigid bundle by radial plastic spacer bars.

Each coil of tubing is connected to vertical inlet and outlet headers of the same polyethylene material. Tubes are thermally welded into the headers to form one homogeneous heat exchanger with no fittings or joints to leak. The heat exchanger is tested to 200 psig (1379 kPa) and rated for a maximum operating pressure of 150 psig (1034 kPa). The headers have stub-outs of PVC pipe for easy connection to external piping.

All metal parts within the Ice-Cel that support the heat exchanger and secure it within the tank are made of corrosion-resistant stainless steel.

The Ice-Cel design is protected by U.S. Patent 5,109,920 and other patents.

The Ice-Cel is available in three different sizes.

The TS240 is the flagship model, designed for most domestic applications. The TS180 is slightly smaller, and is able to be transported inside a shipping container. The TS120 is a low-height model for indoor locations or other special-purpose applications.

ICE-CEL MODEL PHYSICAL SPECIFICATIONS

TABLE 4

	TS240	TS180	TS120
Diameter [in. (m)]	101 (2.56)	89 (2.26)	89 (2.26)
Height [in. (m)]	97.5 (2.48)	94.5 (2.40)	72.5 (1.84)
Volume of glycol solution [gal. (l)]	310 (1,174)	230 (870)	167 (632)
Volume of water [gal. (l)]	2,200 (8,333)	1,620 (6,132)	1,190 (4,504)
Weight, empty [lb. (kg)]	2,275 (1,032)	1,700 (771)	1,310 (594)
Weight, total operating [lb. (kg)]	23,300 (10,567)	17,475 (7,925)	13,650 (6,190)

Because they are modular and of rugged construction, Ice-Cels can be located in any convenient place where there is a reasonably flat deck capable of supporting the weight. Every Ice-Cel model features built-in lifting lugs for use with factory-supplied wheels or a lifting assembly. Typically, Ice-Cels are mounted on a concrete slab or structural framework, either in an equipment room or outdoors. They are also well suited to either complete or partial burial.

CAPACITY (TON-HOURS)

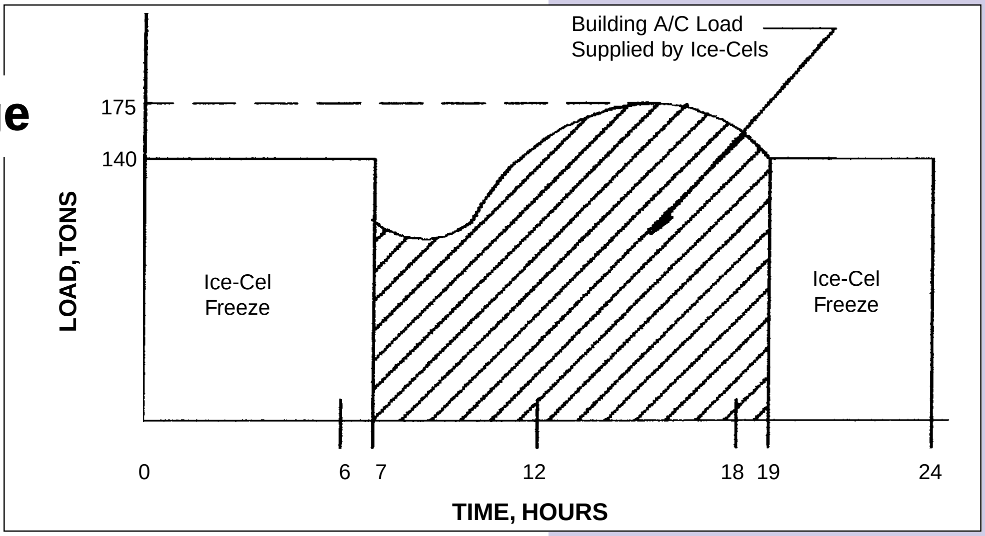
	TS240	TS180	TS120
Total storage capacity, based on heating tank water to 50°F:	240	180	120
Latent storage capacity based on melting ice to water at 32°F:	210	160	109

For detailed performance data, contact your Dunham-Bush sales representative.

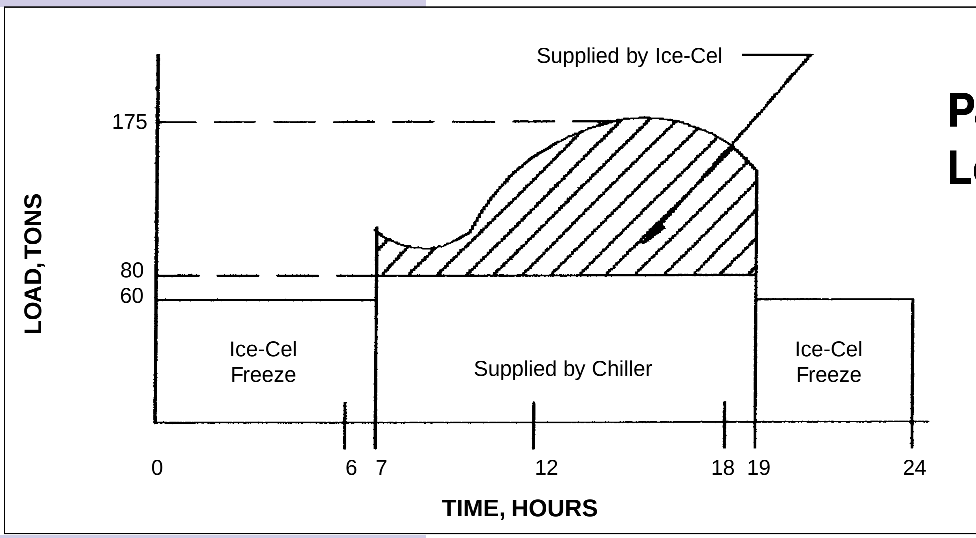
Operating strategies:

There are three popular thermal storage operating strategies: Full Storage, Partial Storage Load Leveling, and Partial Storage Demand Limiting.

Full Storage



With Full Storage, the Ice-Cel tanks are sized to meet the design day cooling load. The chillers are sized to fully recharge the Ice-Cels at night. For example, consider a building with a maximum cooling demand of 175 tons (615 kW). The building is occupied between 0700 and 1900 hours, with an 80% load factor. The maximum daily cooling demand is 12 hrs. x 175 x 0.80 = 1680 ton-hours (5904 kWh). The Ice-Cels are sized to meet the entire daily load 1680 T-H/240 T-H = <u>7 Ice-Cels</u>. The chiller required to recharge the Ice-Cels at night is 1680/12 = 140 tons (493 kW) of ice making capacity. This is equivalent to 140/0.75 = 187 tons capacity on air conditioning duty. The factor of 0.75 is the approximate ratio of ice making to air conditioning chiller capacity, due to the reduced suction temperature in ice making mode.



Partial Storage Load Leveling

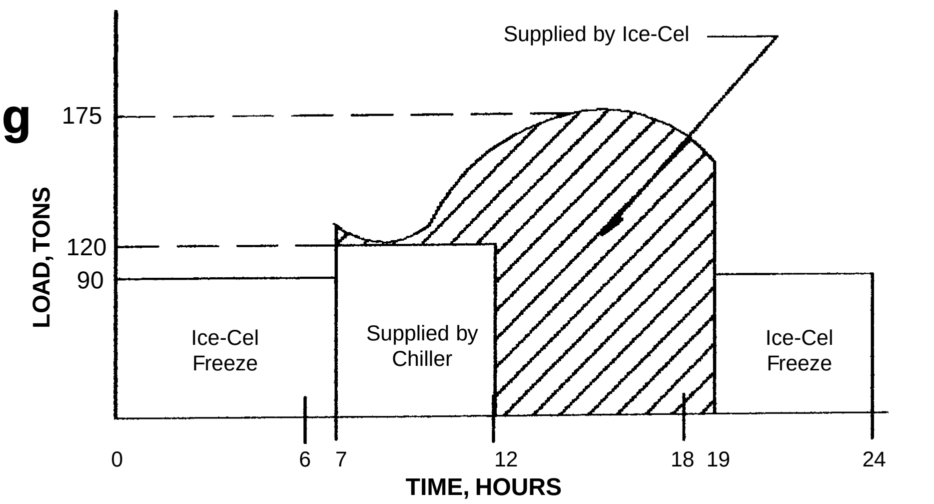
With Partial Storage Load Leveling, the liquid chiller operates twenty-four hours a day. At night the chiller makes ice, and during the day the chiller operates at a constant demand level, supplemented by ice. Using the same building example as above and calculating the ton-hours of ice storage required:

$$\text{THice} = \frac{\text{TH total}}{1 + \dfrac{\text{Chiller cooling hours}}{\text{(0.75) Freeze hours}}} = \frac{\text{1680 T-H}}{1 + \dfrac{12}{(.75)(12)}} = \text{720 T-H (2530 kWh)}$$

3 Ice-Cels

The chiller capacity required is: Q chiller = THice/Freeze (hrs) = 720/12 = 60 Tons (211kW) of ice making capacity. The actual A. C. tons = 60/0.75 = 80 tons (282 kW). An ACSR-3 Packaged System will meet this building load.

Partial Storage Demand Limiting



With Partial Storage Demand Limiting, chiller operation is avoided in peak demand period. The chiller recharges the Ice-Cels at night and supplies cooling between the hours of 0700 and 1200. Ice serves the entire building load during peak demand period 1200-1900. Using the same building example as above and calculating the ton-hours of ice storage required:

$$\text{THice} = \frac{\text{TH total}}{1 + \frac{\text{Chiller cooling hours}}{\text{(0.75) Freeze hours}}} = \frac{\text{1680 T-H}}{1 + \frac{5}{(.75)(12)}} = \text{1080 T-H (3796 kWh)}$$

5 Ice-Cels

The chiller capacity required to freeze the Ice-Cels, Q chiller = THice/Freeze Hours = 1080/12 = 90 tons (316 kW) of ice making capacity. The chiller capacity on A. C. duty = 90/0.75 = 120 tons (422 kW).

Comparing the results of the three strategies illustrated above with a conventional chiller-only system:

	Conventional Chiller	Full Storage	Partial Storage Demand Limiting	Partial Storage Load Leveling
Chiller size, tons (A/C)	175	187	120	80
No. of Ice-Cels	0	7	5	3
Capital cost re chiller only	100%	217%	148%	103%
Demand charge re chiller only	100%	0%	0%	46%

Calculations do not include potential savings from low temperature air distribution.

Glycol solutions

Ethylene glycol solutions have been most popular for ice thermal storage systems because of good heat transfer properties and low cost. However, recent EPA regulations regarding the toxic nature of ethylene glycol have made it less desirable to building owners.

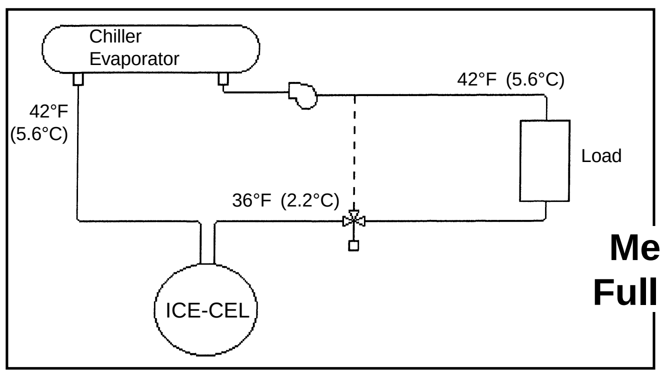
Propylene glycol solutions are non-toxic and therefore avoid EPA regulation. They are also acceptable in Ice-Cel systems and provide performance equal to ethylene glycol at somewhat higher pressure drop.

Whichever glycol solution is chosen, it is important that the correct inhibitors be included in the solution, compatible with the materials of typical HVAC systems: copper, steel, brass and plastic. Uninhibited or automotive glycols are unacceptable in HVAC systems.

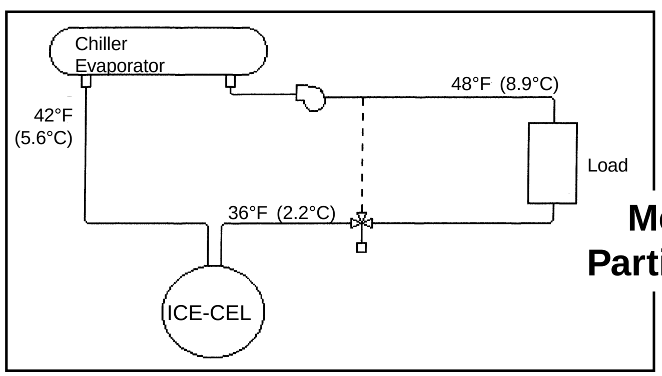
Contact your local Dunham-Bush sales representative for acceptable ethylene or propylene glycol solutions for use in Ice-Cel HVAC system. The glycol is specially formulated and premixed by Dow Chemical Company for use in Dunham-Bush products.

Piping System: Packaged Systems

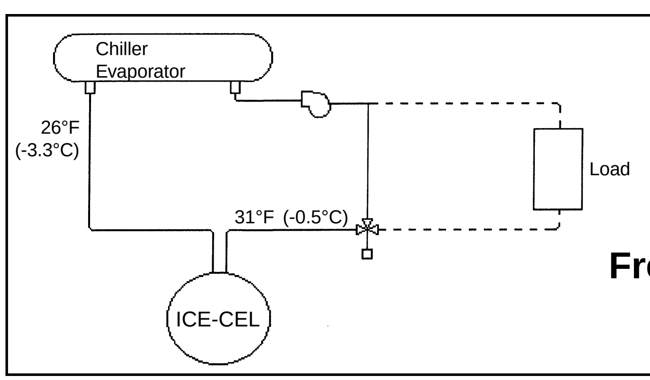
Typical Packaged System Piping:



Melt Mode Full Storage



Melt Mode Partial Storage



Freeze Mode

Controls

Control for Both Packaged and Engineered Integrated Systems is provided by a microcomputer mounted in the chiller control panel. Control functions provided include:

A. Conventional chiller controls:

1. Capacity control to start and stop compressors and maintain selected leaving chilled liquid temperature.
2. All safety functions to protect the chiller.
3. Dual mode leaving chilled liquid setpoints to provide for both air conditioning and ice freezing duty.
4. Start and stop chilled liquid pump and condenser water pump; if applicable.
5. Record and display current and past history of alarms.

B. Thermal Storage Controls:

1. Provide controls for six available modes:
   a. Freeze only
   b. Freeze plus cooling
   c. Cooling with ice only
   d. Cooling with chiller plus ice
   e. Cooling with chiller only
   f. Off
2. Provide for daily scheduling of above modes in as many different daily schedules as desired. These schedules can then be assigned to days of the week. Finally, holiday schedules can be assigned as days of the year.
3. Provide for operating the chiller at full load during the freeze mode until leaving brine temperature falls to a preset value; then shut down the chiller.
4. When optional ice inventory meter is installed, read out % charge level at all times.

C. Control of Multiple Chillers: In an installation involving multiple chillers, the microcomputer on one master chiller can be used to control the starting and stopping of all chillers.

D. Remote Communications: The microcomputer can communicate to a remote terminal, P.C. or building automation system by (a) hard wiring up to 50 feet via RS232 port or (b) via telephone modem.

E. Graphics Package: Available as an option to use in conjunction with remote terminal, P.C. or B.A.S.

TABLE 1 PERFORMANCE DATA
ICE-CEL PACKAGED SYSTEMS

Model No.	No. of Ice-Cels	Chiller Model No.	Storage Capacity		Freeze Mode ① Chiller			Air Conditioning ② Chiller			Pump Selection	
					Capacity		Power	Capacity		Power		
			Ton-hr	kWh	Tons	kW	kW	Tons	kW	kW	Model No.	hp
ACSR-1	1	ACDR025	240	844	17.4	61.2	23.2	22.3	78.4	29.4	R5-1 1/4	2
ACSR-2	2	ACDR070	480	1688	49.4	174	67.9	63.7	224	85.2	R6-2 1/2	5
ACSR-3	3	ACDR080	720	2532	58.9	207	85.3	75.7	266	102.6	R6-2 1/2	7.5
ACSX-2	2	ACDX060	480	1688	44.5	156	58.1	57.1	201	77.4	R6-2 1/2	5
ACSX-3	3	ACDX080	720	2532	57.4	202	75.8	74.7	263	101.5	R6-2 1/2	7.5
WCSR-1Q	1	WCDR030Q	240	844	18.9	66.5	18.7	25.6	90.0	22.8	R6-1 1/4	3
WCSR-1	1	WCDR030	240	844	23.2	81.6	25.7	30.8	108	31.6	R6-1 1/4	3
WCSR-2Q	2	WCDR065Q	480	1688	37.5	132	37.1	50.8	179	45.3	R6-2 1/2	5
WCSR-2	2	WCDR065	480	1688	47.5	167	49.9	64.2	226	59.9	R6-2 1/2	5
WCSR-3	3	WCDR095	720	2532	69.8	245	74.2	93.0	327	88.6	R6-2 1/2	7.5
WCSR-4	4	WCDR105	960	3376	76.2	277	81.7	99.4	349	102	R6-2 1/2	10
WCSX-2	2	HWSC075	480	1688	47.0	165	41.0	63.0	222	56.0	R6-2 1/2	5
WCSX-3	3	HWSC100	720	2532	63.0	222	54.0	84.0	295	71.0	R6-2 1/2	7.5

① At 80°F (26.7C) ambient air temp. for AC Models
At 75°F (23.9C) entering condensing water temp. for WC models, 60 Hz.

② At ARI Std. rating conditions: 44°F leaving brine
95°F (35C) ambient air temp for AC models
85°F (29.4C) entering condensing water temp. for WC models, 60 Hz.

TABLE 2 PHYSICAL DATA
ICE-CEL PACKAGED SYSTEMS

Model No.	Length		Width		Height		Shipping Wt.		Operating Wt.		Glycol Solution	
	in.	cm.	in.	cm.	in.	cm.	Lb.	kg.	Lb.	kg.	Gal.	Litres
ACSR-1	175	394	100	254	104	264	5,785	2624	26,918	12,210	323	1223
ACSR-2	355	902	100	254	104	264	11,208	5084	53,588	24,307	661	2502
ACSR-3	508	1290	100	254	104	264	15,411	6990	78,966	35,818	994	3763
ACSX-2	355	902	100	254	104	264	10,866	4929	53,240	24,149	665	2517
ACSX-3	508	1290	100	254	104	264	15,885	7205	79,540	36,079	1007	3812
WCSR-1Q	181	384	100	254	104	264	4,407	1999	25,555	11,592	323	1223
WCSR-1	181	384	100	254	104	264	4,422	2006	25,570	11,598	323	1223
WCSR-2Q	252	640	100	254	104	264	8,316	3772	50,715	23,004	656	2483
WCSR-2	252	640	100	254	104	264	8,456	3836	50,855	23,067	656	2483
WCSR-3	352	894	100	254	104	264	12,111	5493	75,780	34,373	992	3755
WCSR-4	449	1140	100	254	104	264	15,202	6896	99,993	45,356	1316	4982
WCSX-2	252	640	100	254	104	264	8,841	4010	51,226	23,236	656	2483
WCSX-3	352	894	100	254	104	264	11,798	5351	75,365	34,185	992	3755

TABLE 3 PERFORMANCE DATA
ICE-CEL ENGINEERED SYSTEMS

Chiller Model No.	No. of Ice-Cels	Storage Capacity Ton-hr	Storage Capacity kWh	Freeze Mode Chiller ① Capacity Tons	Freeze Mode Chiller ① Capacity kW	Freeze Mode Chiller ① Power kW	Air Conditioning Chiller ② Capacity Tons	Air Conditioning Chiller ② Capacity kW	Air Conditioning Chiller ② Power kW
AIR COOLED									
ACDR125	4	960	3,375	87.8	309	121.8	123.0	432	156.0
ACDR135	5	1,200	4,219	100.8	354	136.2	133.6	470	173.0
ACDX120	4	960	3,375	87.1	306	115.2	115.6	406	155.3
ACDX150	5	1,200	4,219	105.7	372	138.1	138.3	486	184.4
ACDX170	5	1,200	4,219	120.8	425	159.2	156.6	551	213.3
ACDX185	6	1,440	5,063	133.4	469	174.1	172.8	608	232.7
ACDX210	6	1,440	5,063	141.2	497	188.0	184.6	649	248.2
ACDX235	7	1,680	5,907	155.8	548	208.7	201.0	707	279.5
ACDX255	8	1,920	6,751	170.4	599	230.8	217.4	764	310.7
WATER COOLED									
WCDR130	4	960	3,375	93	327	98	125	439	118
WCFX10	3	720	2,531	71	250	64	94	331	71
WCFX12	4	960	3,375	89	313	81	117	411	89
WCFX15	5	1,200	4,219	107	376	97	145	510	109
WCFX18	6	1,440	5,063	129	454	113	174	612	125
WCFX20	6	1,440	5,063	143	503	126	190	668	139
WCFX22	7	1,680	5,907	161	566	142	213	749	157
WCFX24	8	1,920	6,751	180	633	159	235	826	174
WCFX27	9	2,160	7,594	198	696	175	264	928	193
WCFX30	10	2,400	8,438	217	763	192	292	1,027	214
WCFX33	11	2,640	9,282	239	840	207	324	1,139	229
WCFX36	12	2,880	10,126	262	921	222	354	1,245	244
WCFX39	13	3,120	10,970	283	995	258	379	1,333	284
WCFX42	14	3,360	11,814	302	1,062	274	408	1,435	303
WCFX45	14	3,360	11,814	321	1,129	290	438	1,540	323
WCFX48	15	3,600	12,657	344	1,209	306	469	1,649	339
WCFX51	16	3,840	13,501	367	1,290	322	500	1,758	355
WCFX54	17	4,080	14,345	390	1,371	337	531	1,867	371

① At 80°F (26.7C) ambient air temp. for AC Models, 60 Hz.
At 75°F (23.9C) entering condensing water temp. for WC models, 60 Hz

② At ARI Std. rating conditions: 44°F (6.7C) leaving brine
95°F (35C) ambient air temp for AC models, 60 Hz
85°F (29.4C) entering condensing water temp. for WC models, 60 Hz

TABLE 4 ICE-CEL MODEL PHYSICAL SPECIFICATIONS

	TS240	TS180	TS120
Diameter [in. (cm)]	101 (256)	89 (226)	89 (226)
Height [in. (cm)]	97.5 (248)	94.5 (240)	72.5 184)
Volume of glycol solution [gal. (l)]	310 (1,174)	230 (870)	167 (632)
Volume of water [gal. (l)]	2,200 (8,333)	1,620 (6,132)	1,190 (4,504)
Weight, empty [lb. (kg)]	2,275 (1,032)	1,700 (771)	1,310 (594)
Weight, total operating [lb. (kg)]	23,300 (10,567)	17,475 (7,925)	13,650 (6,190)

For physical data on chillers and pumps, see appropriate Dunham-Bush product catalog.

Guide Specifications

PART 1: GENERAL

1.01 WORK INCLUDED

A. Provide complete ice thermal storage units suitable for outdoor installation. Contractor shall furnish and install ice thermal storage units as shown and scheduled on the drawings. Units shall be installed in accordance with this specification.

1.02 DESIGN BASE

A. The construction drawings indicate a system based on a selected manufacturer of equipment and the design data available to the Engineer during construction document preparation. Size, configuration and space allocations are consistent with that manufacturer's recommendations and requirements.

B. Other listed or approved manufacturers are encouraged to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the design base or other manufacturers' for any different services, space, clearances, etc.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. General Provisions: Section 15010
B. General Completion and Start-up: Section 15020
C. Equipment & Pipe Identification: Section 15021
D. Tests: Section 15025 E. Chilled Water System: Section 15702

1.04 SUBMITTALS

A. Submit shop drawings on each piece of equipment specified in accordance with Specifications Section 51010, General Provisions.

B. Furnish three (3) sets of Operations and Maintenance Data.

1.05 START-UP

A. The Contractor shall provide labor to accomplish the check, test and start-up procedure as recommended by the unit manufacturer.

B. The start-up serviceman shall provide and complete the manufacturer's check, test and start forms. One copy shall be sent to the Engineer and one copy to the manufacturer's factory.

C. (The unit manufacturer shall provide a factory trained serviceman to supervise the original start-up of the units for final operation.)

1.06 WARRANTY

A. The equipment supplier shall provide a guarantee on the entire ice thermal storage system for a period of one (1) year from date of start-up or 18 mouths from date of shipment, whichever occurs first. The manufacturer shall provide an additional 9 years on the tank and 4 years on the heat exchanger.

B. Date of successful start-up shall be certified by the Mechanical Contractor to the Engineer and Owner.

PART 2: PRODUCTS

2.01 ICE THERMAL STORAGE UNITS

A. General

1. Furnish and install as shown on the plans ice thermal storage units. Units shall be Dunham-Bush Model TS240 or equal.
2. The units are to be completely factory assembled ice thermal storage units complete with removable cover, insulation, heat exchanger and pipe connections.
3. The units shall be built in accordance with all applicable national and local codes including ASTM specification D-4097-88.

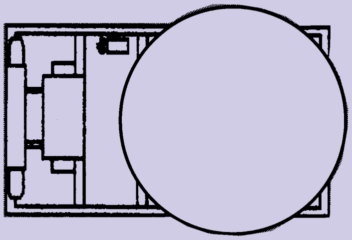
B. The units shall be furnished as shown on capacity schedules and drawings.
C. Construction: The ice thermal storage units are to be completely factory assembled double wall tanks constructed of 1/8 inch fiberglass sufficient to protect the units from shipping and handling damage and capable of underground installation. The walls shall include two inches thickness of urethane foam insulation between the two layers of fiberglass. The walls shall have an insulation resistance of R-14 or more. Sidewalls and bottom of the tank shall be of the same insulated double-wall construction described above. A removable cover of the same construction shall be provided. The heat exchanger shall consist of horizontal rows of serpentine coils of 3/4 inch OD polyethylene tubing held in a rigid bundle by radial plastic spacer bars. Each coil of tubing shall be connected to vertical inlet and outlet headers of the same polyethylene material. Tubes shall be thermally welded into the headers to form one homogeneous heat exchanger with no fittings or joints to leak. The heat exchanger shall be tested to 250 psig and rated for a maximum operating pressure of 150 psig. The headers shall have 2 inch male stub-outs of PVC pipe for easy connection to external piping. A 3/4 inch FPT water overflow fitting shall be provided. All metal parts within the ice thermal storage unit shall be fabricated of corrosion-resistant stainless or zinc-coated steel.
D. The ice thermal storage units shall have built-in bolting pads of sufficient strength to allow attachment of rigging devices or casters for easy movement of the units during installation.
E. (The manufacturer shall furnish a rigging kit with lifting brackets, spreader bar and chains for crane lifting and heavy duty industrial-type casters for ease of rolling the units during installation without damage.)
F. (The manufacturer shall provide (sufficient quantity) (____ gallons) of thoroughly premixed ____% solution of (Dowtherm SR-1 ethylene glycol)(Dowfrost propylene glycol) and de-ionized water for the mechanical contractor to completely charge the building piping system. Field charging of concentrated (not premixed) glycol is not acceptable.)

PART 3: EXECUTION

3.01 INSTALLATION WORK BY MECHANICAL CONTRACTOR

A. Install ice thermal storage units on a flat surface, level within 1/16 inch and of sufficient strength to support the unit loading in operating condition.
B. Assemble and install all components furnished loose by manufacturer as recommended by the manufacturer's literature.
C. Complete all glycol connections so unit and glycol circuits are serviceable.
D. (Provide and install valves in glycol piping upstream and downstream of the pipe stub-outs to provide means of isolating ice thermal storage units for maintenance and to balance and trim system.)
E. Furnish and install taps for thermometers and pressure gauges in glycol piping adjacent to inlet and outlet of ice thermal storage unit.
F. Thoroughly clean the interior of all glycol solution piping.
G. Fill the glycol circuit with glycol solution as prescribed in Section 2.01.F above. Circulate and fully vent all air from the glycol circuit prior to refrigeration start-up.
H. Fill the ice thermal storage cells with water and add algicide as recommended by the manufacturer.

PLAN VIEWS: ICE-CEL PACKAGED INTEGRATED SYSTEMS



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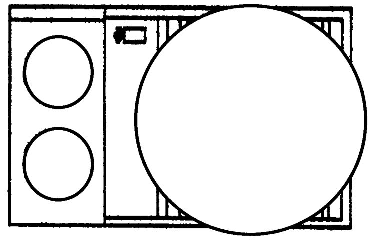

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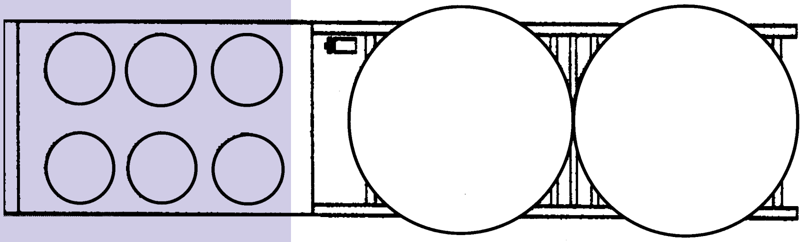

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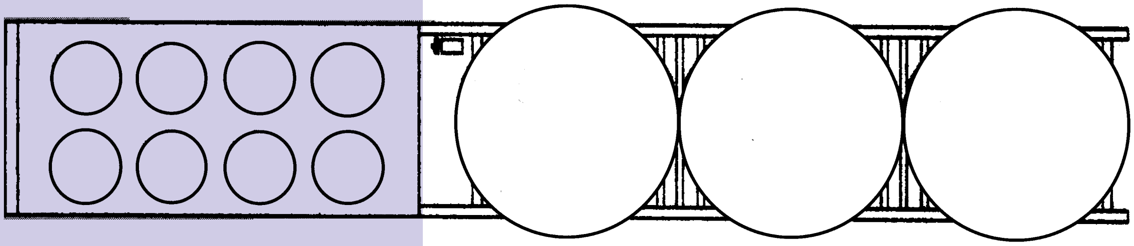

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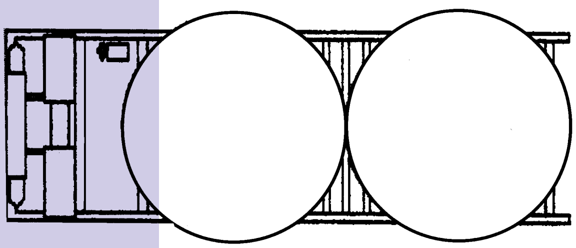

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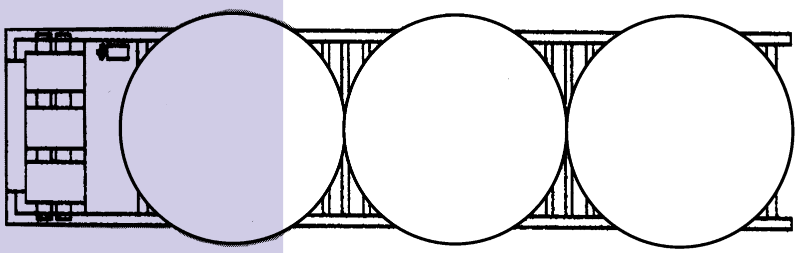

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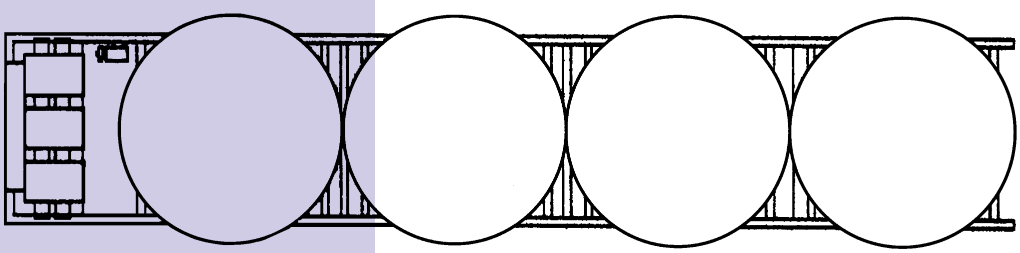

WCSR-4

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