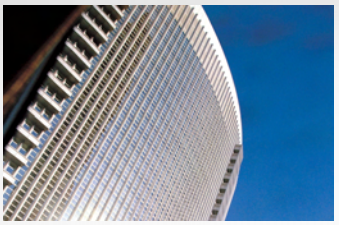
ICE-CEL

INTEGRATED SOLUTIONS BY DB

ICE-CEL

Integrated Systems



DUNHAM-BUSH

Products that perform...By people who care

INTRODUCING A NEW CONCEPT IN PACKAGED AIR CONDITIONING!

These new big building air conditioning products 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.

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 26°F [-3.3°C] by an air conditioning liquid chiller is pumped through the tubes, causing the surrounding water to freeze. When fully frozen, the Ice-Cel stores 240 TR-hours [844 kWh] of cooling capacity, so, for example, it would require 10 hours operation of a 24 TR [84 kW] chiller to fully freeze the water in the tank.

Then to serve a cooling load, the ice can be melted at a rate dictated by load, ranging from 0 to 36 TR [0 to 127 kW]. For example, the Ice-Cel could serve a steady load of 20 TR [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 34°F- 38°F [1.1°C- 3.3°C].

Dunham-Bush integrated systems are offered in two forms:

Packaged Integrated Systems in the range of 25 to 75 TR [88 to 264 kW] which include a chiller and up to 3 Ice-Cel tanks mounted on a skid with integral microcomputer controls, glycol pump and interconnecting piping. They are available with either air- or water-cooled heat rejection.

Pre-engineered Integrated Systems in the range from 100 to 550 TR [352 to 1934 kW] which consist of a chiller, multiple Ice-Cels, pump and micro-computer 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?

The most common application of an Ice-Cel Integrated System is in large building air conditioning, where it is used to store cooling effect 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.

ADVANTAGES TO A BUILDING OWNER OF ICE THERMAL STORAGE

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 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: Many 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 colder air distribution, 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. So 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.

INSTALLING AN ICE-CEL PACKAGE 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 1).

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 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 INTEGRATED SYSTEM ADVANTAGES

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

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

INSTALLING A PRE-ENGINEERED SYSTEM

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 or buried in the ground. (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.

PRE-ENGINEERED INTEGRATED SYSTEM ADVANTAGES

Pre-engineered matched components assure reliable operation.

Pre-engineered controls take the guesswork out of control logic.

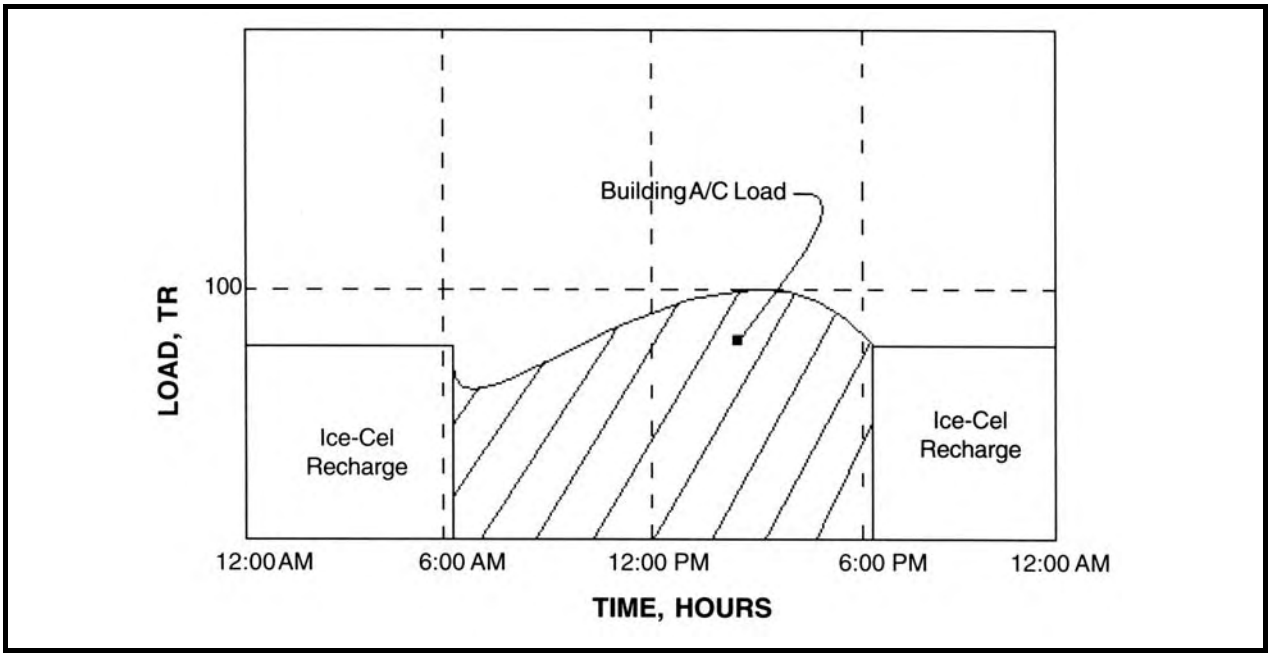
Modular components afford flexibility in location.

One source responsibility for all major air conditioning equipment.

OPERATING STRATEGIES

THERE ARE TWO BASIC STRATEGIES

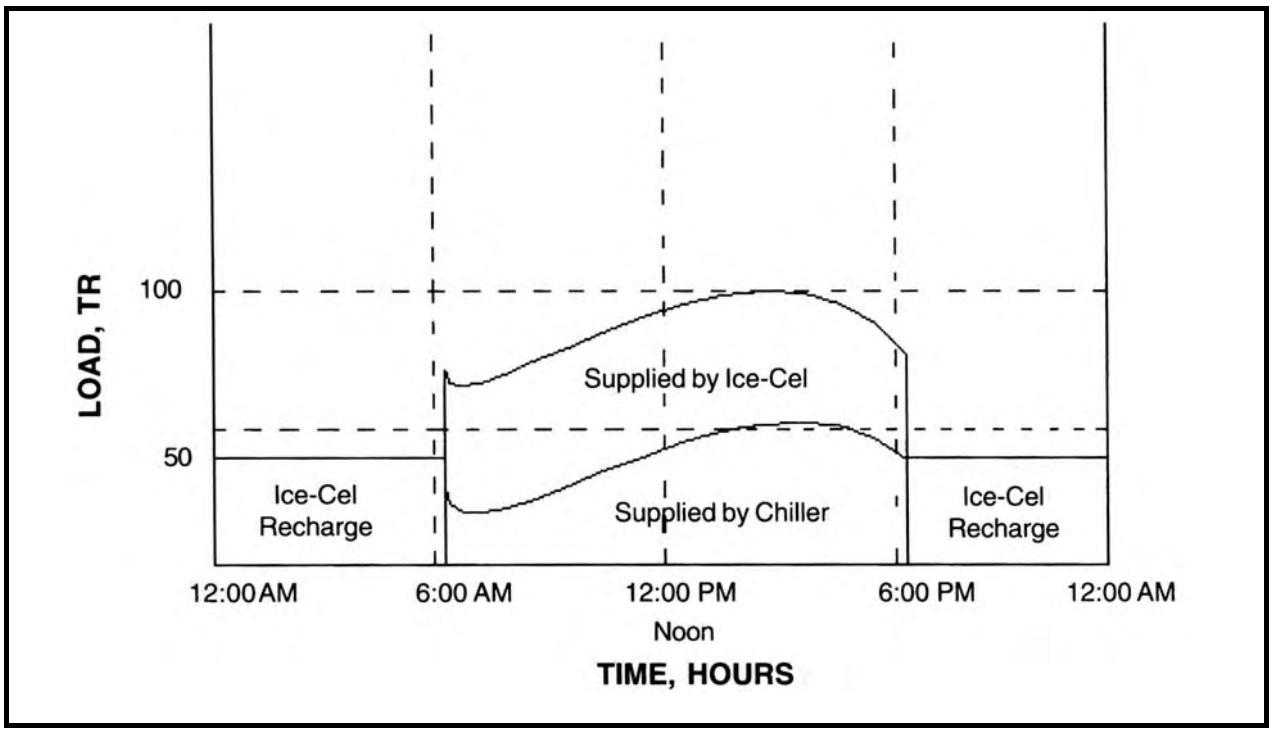
1. Full Storage



OPERATING STRATEGIES

With Full Storage, the Ice-Cel tanks supply enough cooling capacity to meet the maximum expected daily cooling demand, and chiller capacity is provided to replenish the ice during the nighttime recharge period. For example, consider a building with 75 TR [264 kW] maximum cooling demand, operating from 7 a.m. to 7 p.m., with an 80% load factor. The maximum daily cooling demand is 12 hours x 75 TR x 0.80 = 720 TR-hours [2535 kWh]. If this is completely furnished by Ice-Cels, it will require 720/240=3 cels. To recharge the Ice-Cels during a 12 hour nighttime period will require chiller capacity of 720/12=60 TR [211 kW]. An ACSR-3 Ice-Cel Packaged Integrated System will meet this requirement. The advantage of full storage is that the chiller will not operate during the daytime peak demand period.

2. Partial Storage



With Partial Storage, the liquid chiller is used at night to recharge the Ice-Cel and during the day to supplement the Ice-Cel in serving the air conditioning load. Using the same building example as above, we might choose to use 2 Ice-Cels, with 480 TR-hours [1690 kWh] storage capacity.

Then to recharge the Ice-Cels in 12 hours, we need chiller capacity of 480/12 = 40 TR [141 kW]. An ACSR-3 Ice-Cel Packaged Integrated System will meet this requirement. During the day, this chiller doing air conditioning duty will have about 64 TR [225 kW] capacity because of higher suction temperature. Daytime chiller demand will be only 35% of its full capacity.

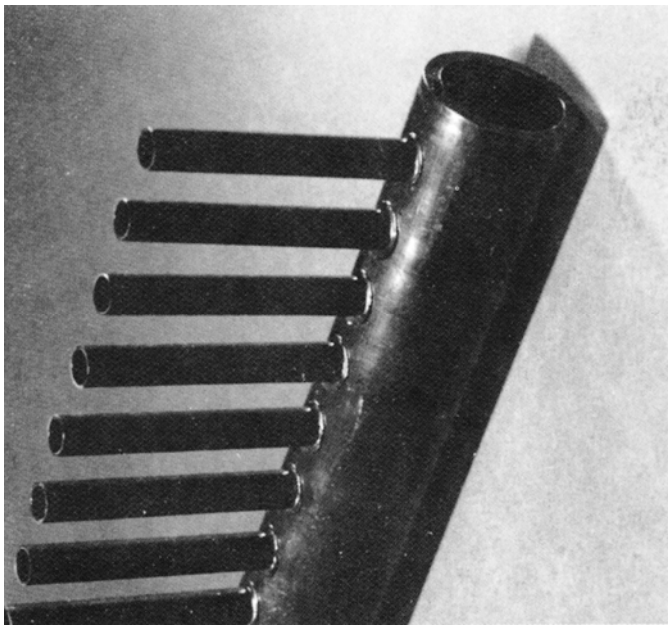
Comparing the results of Full Storage vs. Partial Storage

	Full Storage	**Partial Storage**
Capital Cost	100%	70%
Chiller Demand Reduction	100%	73%

ICE-CEL CONSTRUCTION

The Ice-Cel tank is a double-wall fiberglass tank with 2 inches [51 mm] of urethane foam insulation between the two walls. This insulation is so effective that heat leakage in an 80°F [27°C] room is limited to 0.14 TR [0.5 kW]. A removable cover of the some construction is provided. The heat exchanger consists of horizontal rows of serpentine coils of 0.75 inches [19 mm] OD polyethylene tubes held in a rigid bundle by radial plastic spacer bars.

Each coil of tubes 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 250 psig [1724 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 materials; stainless or zinc-coated steel.

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

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.

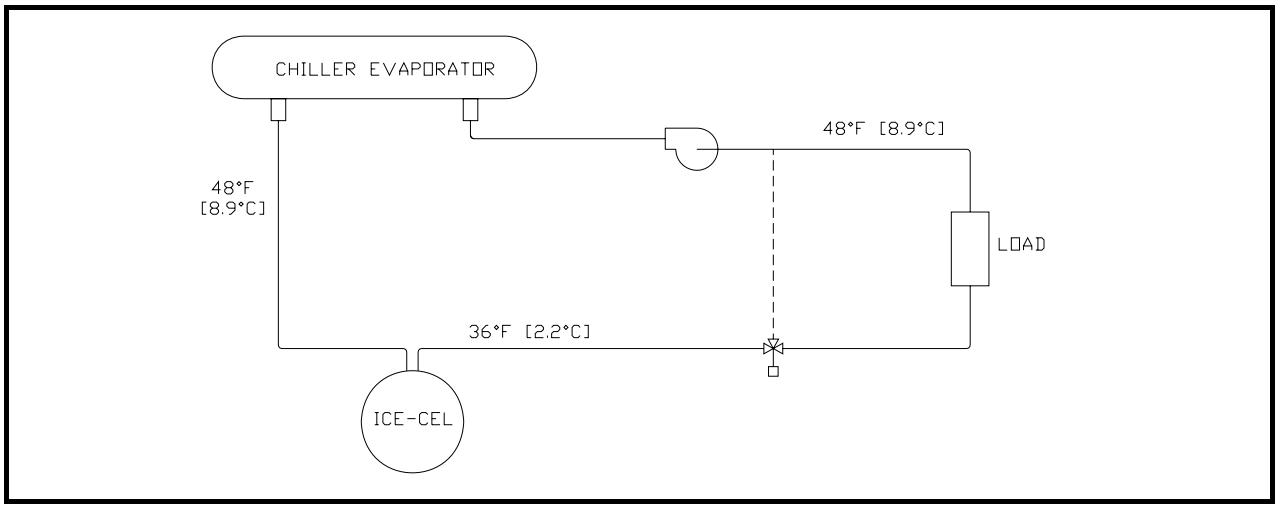
Propylene glycol solution, which is non-toxic and therefore avoids EPA regulation, is also acceptable in Ice-Cel systems, providing performance equal to ethylene glycol at somewhat higher pressure drop.

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. Dunham-Bush offers either Ethylene or Propylene Glycol specifically formulated and pre-mixed by Dow Chemical Co. for use in Ice-Cel HVAC systems, delivered to the job site.

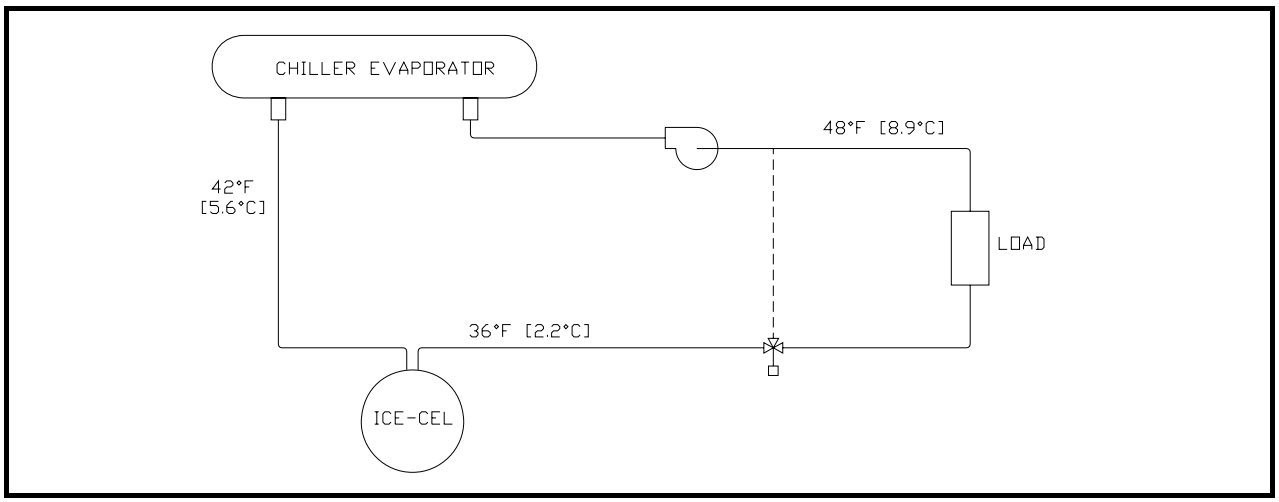
PIPING SYSTEM

PACKAGED INTEGRATED SYSTEMS

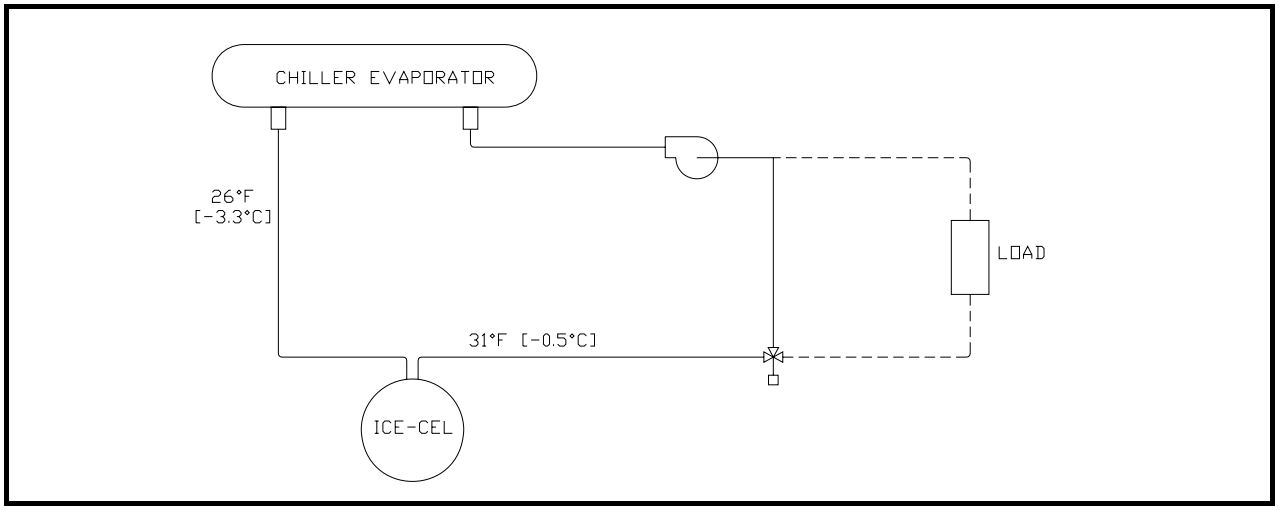
1. Melt Mode Full Storage



2. Melt Mode Partial Storage



3. Freeze Mode



ICE-CEL PACKAGED INTEGRATED SYSTEMS

TABLE 1 PHYSICAL SPECIFICATIONS

Model No.	Length		Width		Height		Shipping Weight		Operating Weight		Glycol Solution	
	inches	mm	inches	mm	inches	mm	lbs	kg	lbs	kg	USgal	liters
ACSR-1	153	3890	100	2540	104	2640	5,055	2,293	26,184	11,877	323	1,223
ACSR-2	351	8920	100	2540	104	2640	11,075	5,024	53,331	24,191	645	2,443
ACSR-3	501	12720	100	2540	104	2640	15,424	6,996	78,717	35,705	956	3,621
ACSX-2	351	8920	100	2540	104	2640	10,412	4,723	52,693	23,901	648	2,455
ACSX-3	501	12720	100	2540	104	2640	15,641	7,095	78,925	35,800	956	3,621
WCSR-1	145	3680	100	2540	104	2640	4,047	1,836	25,176	11,420	323	1,223
WCSR-2	245	6220	100	2540	104	2640	8,011	3,634	50,267	22,801	645	2,443
WCSR-3	345	8760	100	2540	104	2640	12,058	5,469	75,342	34,175	956	3,621

TABLE 2 PERFORMANCE DATA

Model No.	No. of Ice-Cels	Chiller Model No.	Storage Capacity		Freeze Mode Chiller *			Air Conditioning Chiller **			Pump Selection			
					Capacity		Power kW	Capacity		Power kW	Ethylene Glycol		Propylene Glycol	
			TR-hr	kWh	TR	kW		TR	kW		Model No.	Hp	Model No.	Hp
ACSR-1	1	ACDR025	240	844	17.4	61.2	23.2	22.3	78.4	29.4	1¼ A5B2	1.5	1 ¼ R6-5	2.0
ACSR-2	2	ACDR070	480	1688	49.4	174.0	67.9	63.7	224.0	85.2	2 A9D70S1B	3.0	2 A9D44S2B	5.0
ACSR-3	3	ACDR080	720	2532	58.9	207.0	85.3	75.7	266.0	102.6	2½ A9D76S1B	5.0	2½ A9D76S1B	5.0
ACSX-2	2	ACDX060	480	1688	44.5	156.0	58.1	57.1	201.0	77.4	2 A9D70S1B	3.0	2 A9D44S2B	5.0
ACSX-3	3	ACDX080	720	2532	57.4	202.0	75.8	74.7	263.0	101.5	2½ A9D76S1B	5.0	2½ A9D5182B	7.5
WCSR-1	1	WCDR030	240	844	23.2	81.6	25.7	30.8	108.0	31.6	1¼ R6-5.5	3.0	1¼ R6-5.75	3.0
WCSR-2	2	WCDR065	480	1688	47.5	167.0	49.9	64.2	226.0	59.9	2 A9D84S1B	5.0	2 A9D84S1B	5.0
WCSR-3	3	WCDR095	720	2532	69.8	245.0	74.2	93.0	327.0	88.6	2½ A9D76S1B	5.0	2½ A9D76S1B	5.0

* At 80°F [26.7°C] ambient air temperature for AC Models.
At 75°F [23.9°C] entering condensing water temperature for WC models, 60 Hz.

** At AHRI Std. rating conditions: 44°F [6.7°C] leaving brine.
95°F [35°C] ambient air temperature for AC models.
85°F [29.4°C] entering condensing water temperature for WC models, 60 Hz.

ICE-CEL PRE-ENGINEERED INTEGRATED SYSTEMS

TABLE 3 PHYSICAL SPECIFICATIONS

Ice-Cel Model TS240 Thermal Storage Models		
Diameter	100 inches	2.54 m
Height	97.5 inches	2.48 m
Weight, empty	2,249 lbs	1,020 kg
Volume of glycol solution	310 USgal	1,174 liters
Volume of water	2, 200 USgal.	8,333 liters
Weight, total operating	23,269 lbs	10,555 kg

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

TABLE 4 PERFORMANCE DATA

Chiller Model No.	No. of Ice-Cels	Storage Capacity		Freeze Mode Chiller *			Air Conditioning Chiller **		
				Capacity		Power kW	Capacity		Power kW
		TR-hr	kWh	TR	kW		TR	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

* At 80°F [26.7°C] ambient air temperature for AC Models, 60 Hz.
At 75°F [23.9°C] entering condensing water temperature for WC models, 60 Hz.

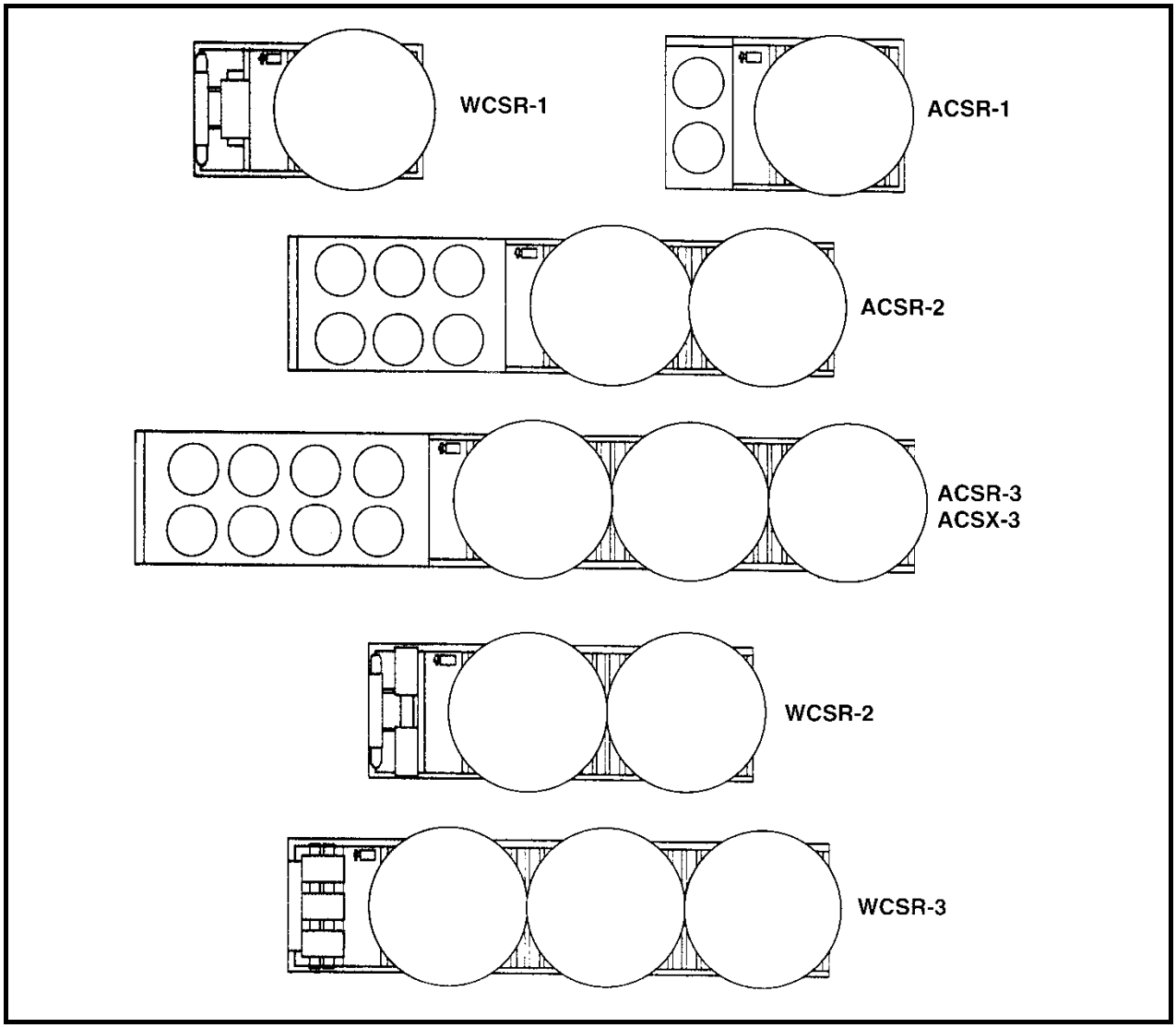
** At AHRI Std. rating conditions: 44°F [6.7C] leaving brine.
95°F [35°C] ambient air temperature for AC models, 60 Hz.
85°F [29.4°C] entering condensing water temperature for WC models, 60 Hz.

CONTROLS

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

1. Capacity control of chiller to maintain selected leaving chilled liquid temperature.
2. All safety functions to protect the chiller
3. Dual leaving chilled liquid setpoints to provide for ice freeze mode and air conditioning mode.
4. Annual calendar scheduling to program for weekends, holidays, special events, etc.
5. Daily scheduling to initiate freeze cycle and melt cycle.
6. Provide for partial storage: proportioning of chiller/ Ice-Cel cooling capacity vs. time of day.
7. Operate chiller at full load in freeze mode until brine temperature decreases, then shut down chiller.
8. Start and stop condenser pump on water cooled machines. Control fan staging on air cooled machines.
9. Remote monitoring is available by remote terminal or computer, connected by hard wiring or phone modem.

PLAN VIEWS: ICE-CEL PACKAGED INTEGRATED SYSTEMS



ICE-CEL

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