Ice-enhanced Air-cooled Chiller Plant

An EarthWise™ System from Trane

Now with support for Stealth™ chiller

Ingersoll Rand

EarthWise Systems are good for business

Trane EarthWise™ Systems are a comprehensive approach to HVAC system design that supports what is best for your building, right for the environment and good for your bottom line.

Cooling without compromises. EarthWise Systems deliver prepackaged operational efficiencies that support sustainable building performance making it easy to do the right thing. Trane EarthWise systems leverage high-efficiency HVAC equipment and advanced controls to optimize whole system design and operation.

Energy prices are uncertain, but trends are not. With even higher energy costs on the horizon, owners should be making plans to mitigate the impact on operating expenses. An obvious place to start is with one of the biggest energy consumers in the building: the cooling system. Adding thermal energy storage to an HVAC system can reduce energy costs associated with comfort cooling by shifting equipment operation from high- to low-cost times of day.

The Trane EarthWise Ice-enhanced Air-cooled Chiller Plant simplifies the design and implementation of thermal storage systems. This means you can take advantage of the one component of energy pricing that has not gone up in 30 years—off-peak electricity.

The one component of energy pricing that has not gone up in 30 years is off-peak electricity.

Smart meters and demand response programs are coming to a utility near you. With thermal storage in place, you are ready to respond to these signals or events, without compromising your building operations. Having the capability to respond to energy signals or scarcity allows you to play an active role in controlling the energy costs for your facility. You also contribute to national energy security by helping all of us work together to use our energy resources wisely.

Supporting renewable energy. By shifting energy use to times when renewable energy is available, thermal storage systems contribute significantly to the emerging vision of energy in the future. Energy storage doesn't have to be an industrial power battery made out of expensive, cutting-edge materials. It can be as simple as a few ice tanks on every mid- to large-scale cooling system. Today's ice storage systems are more cost optimized and flexible than ever.

Thermal energy storage can work in tandem with other renewable energy systems. In many locations suitable for capturing wind energy, the wind blows hardest at night. That electricity generation is not good timing for a building, unless it uses thermal energy storage. Conversely, solar energy must be converted during the day, when electricity generation may be strained both by cooling equipment demand and by reductions in turbine generation performance. By shifting energy for cooling to nighttime hours, we can not only capture green energy from the wind, but we also offload its burden on solar energy during the day.

EarthWise Ice-enhanced Air-cooled Chiller Plant

The Trane EarthWise™ Ice-enhanced Air-cooled Chiller Plant includes eight standard configurations for air-cooled chillers, ice tanks and customizable system controls that provide an advanced starting point for designing an ice storage system.

Trane has engineered and developed this prepackaged system based on previous successes. Approximately 80 percent of the installed ice storage projects use air-cooled chillers and internal melt modular ice tanks. By limiting the scope to a specific style of chiller, the appropriate type of ice storage system can be readily identified.

Identifying the repeatable aspects of these designs allows us to compress the time it takes for the system to go from the idea phase to the commissioning phase. System completion packaged skids, preprogrammed control sequences, operator graphics and drawings are some of the new features developed to support this system.

As with every EarthWise System, Trane provides, supports, and deploys energy modeling during the system design phase. Trane Air-conditioning Economics (TRACE™) software can be used to determine whether this system can be expected to help your building earn high performance designation.

System package benefits

Reduced risk and engineering costs

- Preprogrammed system controls
- Pre-engineered system packages

Repeatability

- Avoid installation and commissioning pitfalls
- Avoid or reduce custom programming
- Simplify maintenance with repeated elements across many installed systems

Optimized components

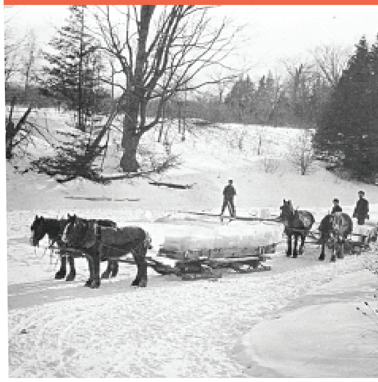
- Least expensive first-cost system
- Lowest total cost of ownership system
- System expansion in the most appropriate way (more chiller, or more tank?)

Reliability

- CALMAC IceBank® tanks have no moving parts
- Ice provides partial system redundancy, minimizing assets to maintain

A little history …

Trane has been educating the industry for decades on chiller-based thermal storage systems. Refrigeration itself began as an ice storing and melting application, which is why cooling is rated in tons. So it's appropriate that a natural element such as frozen water and its capacity for storing thermal energy can and should be tapped again for Earth-friendlier cooling.



Better together for simplified off-peak cooling

Air-cooled chillers fit well with ice storage. This EarthWise system delivers water-cooled, chilled-water system performance without water-cooled complexity while costing the same or only slightly more than a traditional chilled-water system.

Efficiency

- Air-cooled chillers use compressors well suited for making ice, with a low performance penalty when not making ice.
- Using cold fluid and cold air reduces transfer energy in fans and pumps, and sheet metal and piping costs can be reduced.
- Electric grid efficiency is improved by allowing a utility to have less "spinning reserves" idling and wasting energy.
- Natural gas turbines are more efficient at night than during the day, saving energy.

Cost

- By using ice as part of the system redundancy, chiller size can be reduced, which offsets much of the cost of adding ice storage tanks to a partial storage project.
- By using cold fluid and cold air, fans, pumps, and ductwork can be right sized in a trade-off with energy costs.
- In many climates, air-cooled chillers may use glycol in the evaporator already to prevent freezing during cold weather, so the cost of glycol is already included.
- Ice storage is a lot less expensive per ton-hour than chilled-water storage for small to medium sized systems.

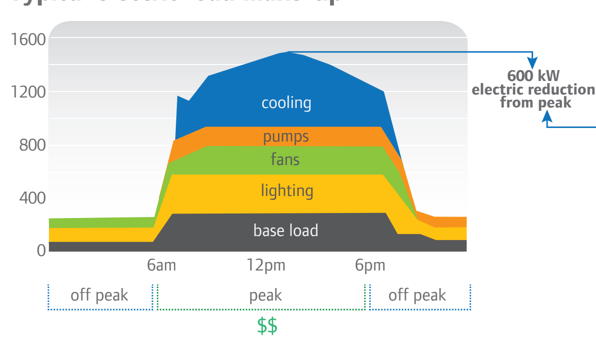
Flexibility

- Easy conversion to add ice-making capability to existing air-cooled chillers.
- Chiller plants with ice storage allow for operational flexibility; the cooling is created when it makes sense, not necessarily when it is used.

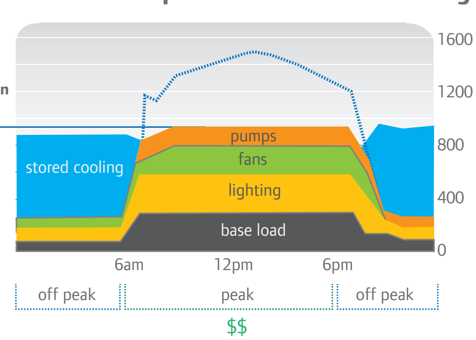
Standardized system designs

- By making decisions about the system design, the common options are easier to accommodate in system controls. These controls are then standardized to help reduce opportunities for errors and reduce custom control programming.
- The System Completion Module is a Trane-designed, -built and functionally tested skid that reduces design and installation time, lowers the system complexity, and standardizes maintenance with parts identification and warranty by a single provider.

Typical electric load make-up

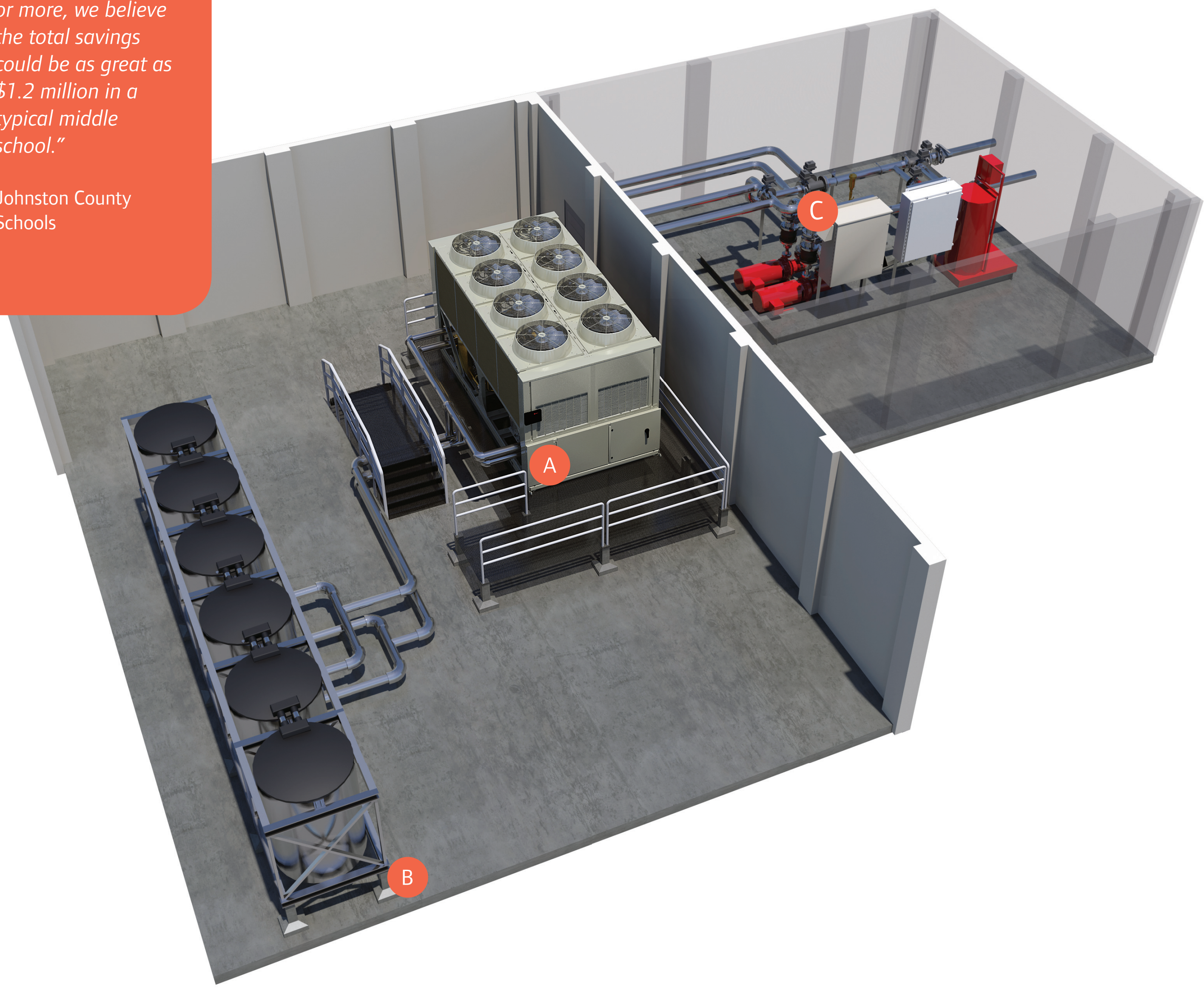


Electric load profile with thermal storage



"We have found project simple paybacks of as little as two years, always less than four years. Over the anticipated life of the school of 40 years or more, we believe the total savings could be as great as $1.2 million in a typical middle school."

Johnston County Schools



A **Trane air-cooled chillers** with built-in ice storage support provide water-cooled efficiency without the added cost, maintenance and complexity of a water-cooled system.

B **CALMAC IceBank® thermal energy storage tanks** offer pre-engineered, factory-built reliability with tested, efficient and repeatable performance.

C **System completion module** provides single-source responsibility. Each module includes a pre-engineered pumping system, single point power and control connection, factory mounted Trane controls, installation logistics, start-up and commissioning coordination, and warranty/technical support.

Why modular ice tanks?

Pre-engineered, factory-built reliability and documented performance. Factory-built modular ice tank performance is documented, tested and repeatable over the life of the system. The net usable ton hours of a modular, standardized tank are known. In contrast, field-built ice tank performance is unknown. The cylindrical shape of the CALMAC tank is stronger and the high density polyethylene construction with thermal welds is very durable. There are no moving parts and the tank is 99 percent recyclable.

Why internal melt ice tanks?

Internal melt tanks like the CALMAC IceBank® do not send melt water out to the load coils. An intermediate medium such as glycol is used in a closed loop between the tanks and the chiller. An optional heat exchanger can be easily added to separate the glycol loop from the water loop if needed. Alternatively, glycol can be sent all the way to the load coils, especially in smaller systems. Here are just a few key benefits of internal melt ice tanks.

Efficiency (warmer charge temperatures). Counter-flow heat exchanger provides consistent temperatures throughout the tank for repeatable optimum charge and discharge performance. Average ice build is ½ inch for efficient charging performance.

In contrast, an external melt coil will make ice through ice, and require a lower charge temperature and more chiller energy.

No agitation required. External melt tanks are more prone to ice bridging and capping. A bridge joins adjacent tubes with ice, preventing the efficient flow of water for melting. A cap is a block of ice that pushes up and out of contact with the coil surface. Both bridging and capping reduce the net usable capacity of the ice, unless agitation is used to stir the tank and create more uniform ice production and melting.

Charge while cooling. This mode is not possible with external melt tanks, because the fluid melting the ice is the fluid going through the chiller. It's not possible to melt ice while you're simultaneously building ice. However, peak (instantaneous) tons discharged will be lower with internal melt tanks.

All models of Trane air-cooled chillers can be deployed into an ice-enhanced air-cooled chiller plant, including the Stealth™ chiller model RTAE.

Why air-cooled chillers?

Designed for ice-making efficiency. With few exceptions, air-cooled chillers use positive displacement compressors: screw and scroll technology. They are readily capable of creating the extra head pressure required on ice storage systems, and are especially efficient at night when the outdoor dry-bulb temperatures are suppressed. The change in outdoor dry bulb from day to night is typically more drastic than the change in outdoor wet bulb, which gives air-cooled equipment more efficiency improvement at night than water-cooled equipment.

Lower system cost. This system is simpler and therefore costs less to engineer and install, with lower cost components. Because an air-cooled system is typically smaller, it's also easier to package and pre-engineer, with few options that take extra time to properly consider. Air-cooled chillers are often regularly selected to cool anti-freeze solutions, to protect them while operating in cold climates, so the cost of glycol may already be included.

Simplicity. Smaller, air-cooled systems are not as complex and require fewer maintenance tasks. As the systems get larger, water-cooled systems make more sense because water-cooled chillers are available in higher capacities.

Why use the Stealth™ air-cooled chiller in an ice storage system?

Even better efficiency. Stealth chillers with ice are 20-30% more efficient during daytime operation than other air-cooled chillers with ice, leading to a further reduction in both energy and energy cost. For partial storage systems, even the most downsized chiller will not run fully loaded during the on-peak period, except on days with the maximum expected cooling load. Trane Stealth chillers have an ideal combination of ice making capability with efficiency that does not diminish when operated at part-load during daytime operation.

Lower sound. Stealth chillers are quieter than other air-cooled chillers, so applying them in sound sensitive applications may mean the difference between wanting full storage (having the chillers off during certain parts of the day) and a less expensive partial storage system. In addition, the Stealth chiller can be asked to make ice while still having its premium sound option active.

When does ice storage make sense?

There are number of reasons to bring ice storage into the system design discussion as we previously addressed. The real question is: When does it make sense? The answer should be: When it has the lowest life-cycle cost compared to alternative systems, and fits within the budget. There are a number of economic analysis tools readily available.

The easiest way to include ice storage and stay within budget is to use air-cooled chillers, not too many tanks, and a downsized chiller. However, the lowest life-cycle cost system may include more tanks and larger chillers and cost more to install. Whether the preferred larger system is affordable today can be determined by the availability of incentives or rebates from one or a number of sources.

Off-peak cooling using ice storage is not for everyone. The following are key considerations.

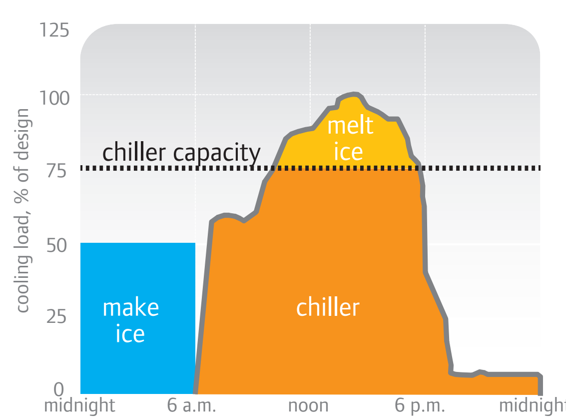
Are you seeking green building designation? High-performance building designation steers the discussion toward systems that have lower energy costs. How much can an ice storage system reduce annual energy? Ice storage systems can earn up to six LEED points (depending on the baseline system and local utility rates), as well as LEED Pilot Program points (one or two). For projects following ASHRAE 189.1 (the high performance green building standard), ice storage can help satisfy the prescriptive requirement in 7.4.5.1 Peak Load Reduction:

"Building projects shall contain automatic systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand of the building by not less than 10% of the projected peak demand. Standby power generation shall not be used to achieve the reduction in peak demand."

How much does it cost up front? It may cost more to install than you think you can afford, though you may be able to get the system cost in budget by using the right design. It's easier to justify an ice storage system when improvements to your system are planned, and if you already have a chilled-water system in place or planned. The incremental cost is the key.

Depending on the shape of your design-day load profile, a downsized chiller can be the right fit if you're able to use the ice for a portion of the customary system redundancy allowance. The figure below shows a chiller sized to handle the design-day peak load only when supplemented with ice. The load profile allows for tanks to be charged after the coincident cooling loads have diminished.

For more information on ice storage for LEED projects, refer to Trane *Engineers Newsletter* volume 36-3 (2007). Visit trane.com/EN.



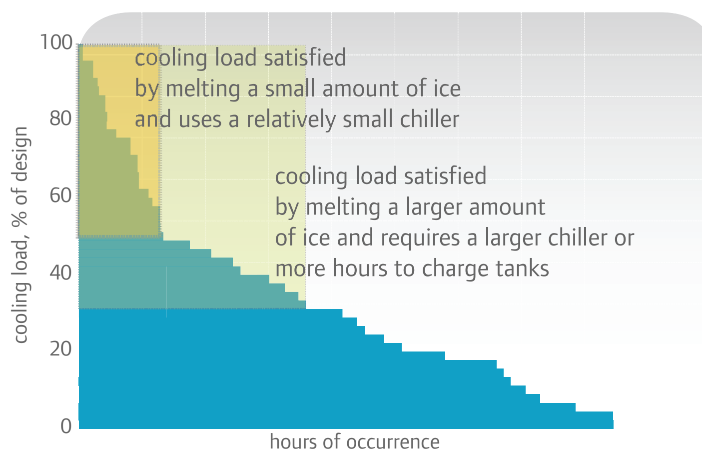
What are the electric rates and are there incentive programs? Electric rate structures in many areas are suitable for ice storage. In some cases, the electric rate structure necessary for ice storage to reduce energy cost is one that you're not subscribed to right now. This can be as simple as a call to the local utility company to find out what electricity rates are available, and if there are rebates or other incentives in your area for off-peak cooling.

Generally speaking, ice storage should be considered when one or more of the following exist in your electricity rate structure.

- Demand charges greater than $6 per kW
- Daytime energy is $0.06 per kWh more expensive than night time energy
- Flat rate ("negotiated pricing") accounts for the load profile during negotiations
- Load profile penalties (i.e., stepped rates, kWh/kW floating cutoffs, "Hours of Use Demand")
- Demand ratchet clauses ("larger of monthly demand or 80 percent of previous 12-months' demand")
- Real time pricing (look ahead signal of electricity costs, changes as often as every 15 minutes)
- Curtailment rates (agreeing to reduce power use when a load reduction is requested)

What is the cooling load profile? The hours in the day when the chiller isn't at full capacity are used to recharge the ice tanks. You may not have a cooling load that varies enough throughout the day to accommodate storing cooling energy. If the load-profile is flat, larger chilled-water storage systems may become attractive, especially if the system requires a high degree of redundancy, such as a data center or a manufacturing process. Life-cycle analysis should account for year-round cooling loads. The graph below shows a cooling load duration curve. The shape of the curve tells you how many ton-hours are setting your on-peak electricity costs. A larger system would satisfy more of system peak cooling requirements.

Do I have other reasons for storage such as limited or unreliable electricity? Some buildings are constrained by the consistent availability of electricity. Examples include buildings in areas that suffer from regular brownouts and blackouts, facilities switching from steam-driven to electric chillers, buildings in formerly rural areas without adequate infrastructure, or those with onsite power generation. Ice storage can be part of the solution because it requires less peak energy generation and smaller emergency generators.



Sample life-cycle analysis

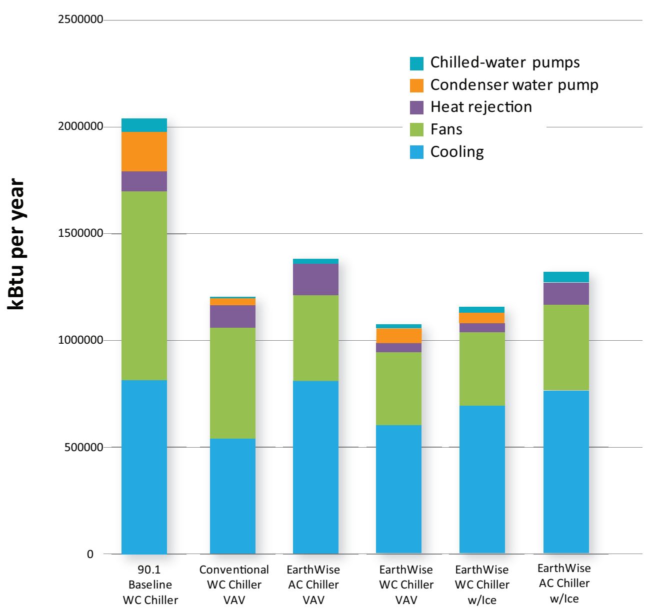
The following energy and annual operating costs were calculated using TRACE™ for a mid-sized, 275-ton office building in San Jose, California. The ASHRAE 90.1 baseline is at the far left, with various system options charted to the right.

Site energy consumption. The EarthWise chilled-water system options all save energy over the energy code baseline chiller system. (See *Site energy* graph below.) The EarthWise ice-enhanced air-cooled chiller system at the far right uses more site energy than the water-cooled chiller systems. However, for a comprehensive evaluation of ice storage, we must continue the analysis and consider source energy, first cost and overall operating costs.

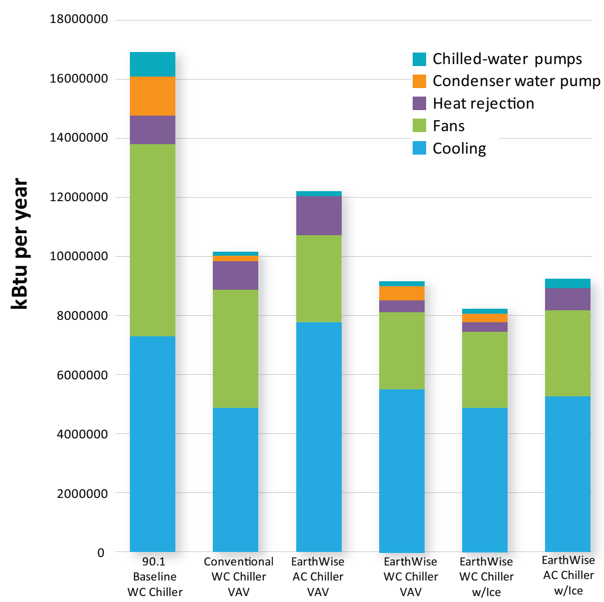
Source energy consumption is fuel energy used to create the electricity. Because power generation equipment is less efficient on hot summer days, converting site energy to source energy better reflects the overall energy consumed. (See *Source energy* graph below.)

The EarthWise air-cooled ice storage system has source energy use comparable to an EarthWise water-cooled, chilled-water system without ice storage.

TRACE energy analysis:
Cooling equipment site energy (kBtu)



TRACE energy analysis:
Cooling equipment source energy TDV (kBtu)



System costs. Annual operating costs include energy, maintenance and water costs. (See *life-cycle* graph below.) First costs include the equipment and installation costs of the system. Life-cycle costs include all revenue and cost streams for 20 years, including economic factors such as inflation and tax implications.

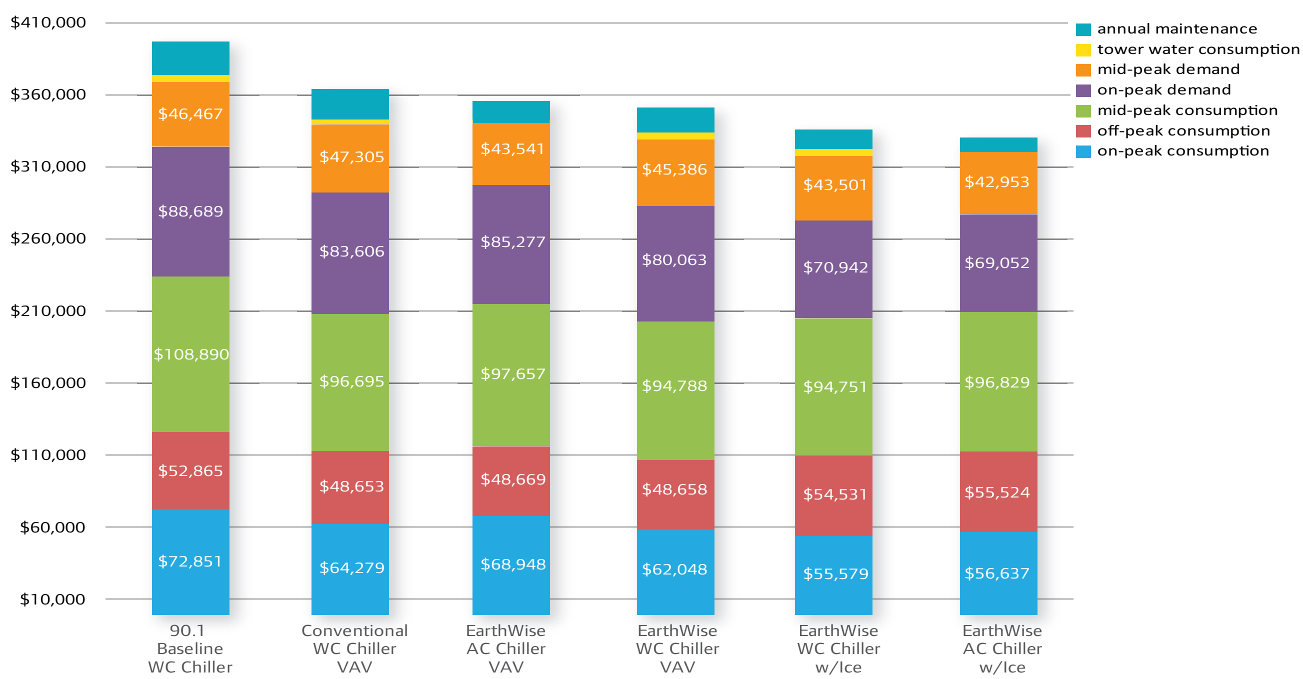
For this particular combination of building, climate, and utility tariff, the EarthWise ice-enhanced air-cooled chiller system had the lowest first cost and the lowest total cost of ownership of all the alternatives.

For LEED® designation, this system would have earned approximately two points for energy cost savings and would help with water conservation credits. In addition, a LEED 2009 pilot program allows for an additional one to two points for ice-storage systems, depending on how the building automation system responds to utility signals.

Life-cycle analysis demonstrates 14 -20% energy cost savings.

- Two to three LEED points
- One to two LEED pilot points
- Plus help on water credits (for more points don't downsize pipes or ducts)

TRACE life-cycle analysis: Annual operating expense, full building



$13.92/ft²	$12.68/ft²	$10.52/ft²	$11.42/ft²	$11.35/ft²	$10.98/ft²	cooling installed cost per ft²
$10,325,891	$9,402,723	$8,709,196	$8,879,988	$8,594,794	$8,405,565	20-year life cycle cost

How much ice?

The following considerations will drive the number of tanks to install.

Chiller capability and charge time.
An existing chiller retrofit for ice storage has a defined maximum flow rate that determines the number of tanks it can charge. The number of hours available for charging tanks may also limit the number of tanks that could be purchased.

Budget. The budget alone can determine how many tanks to purchase. If too few tanks are purchased, the final charge temperature may require more glycol solution. You also might consider downsizing your chiller. In any case, system redundancy should be considered, which leads to the next topic, operational flexibility.

Operational flexibility requirements. If your only ice making chiller shuts down unexpectedly, and it's your only chiller, and there is a critical cooling load, let's hope it happened when stored ice is available for cooling. If it did, you may have eight hours or possibly several mild days to resolve the problem before you run out of ice. The desire for complete redundancy may lead to the purchase of another chiller (n+1), a back-up cooling system for critical loads, or preinstalled rental chiller piping connections.

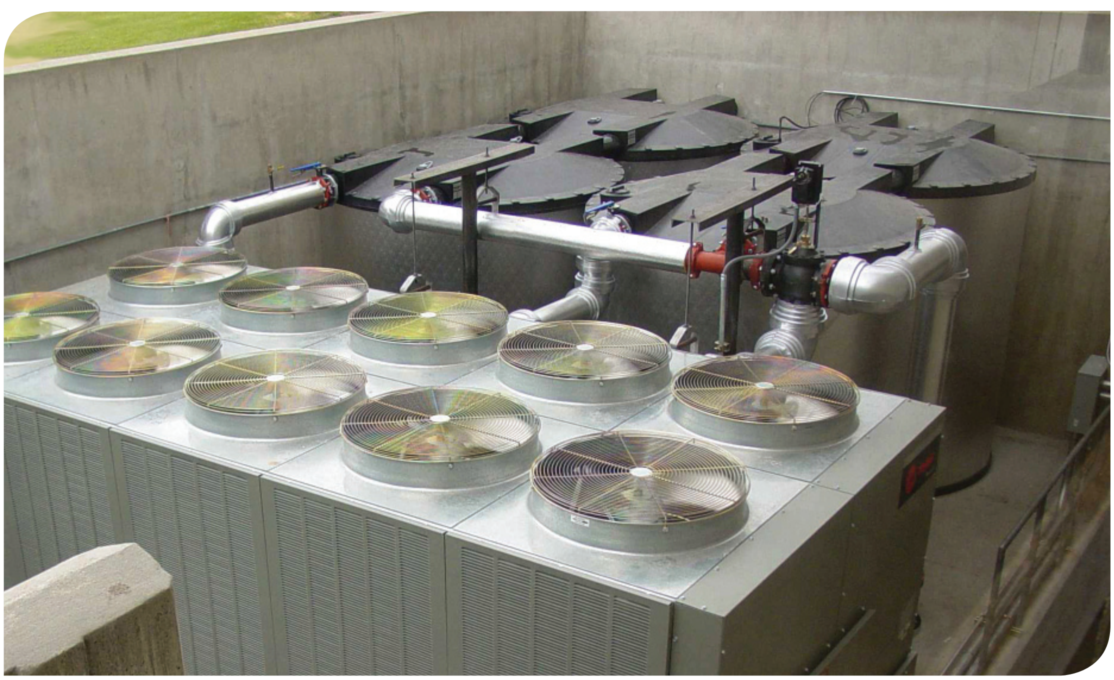
Power constraints. You may design your system to ride through a power disturbance or an outage with the chiller off to meet the critical loads or the minimum amount of cooling. Or, the system size can be dictated by on-site power generation or available utility power.

Energy saving strategy. Partial storage means the chiller(s) will be supplemented with ice melting during the discharge period. Partial storage is usually selected for long on-peak windows (6-8 hours or more) and lowest first cost. Partial storage can have the lowest life-cycle cost especially when rebates are unavailable, and/or when the chiller is already purchased or being retrofitted for ice making. Partial storage is an excellent peak shaving strategy when high on-peak demand charges ($8 or higher) and/or ratchet clauses are in place.

Full storage means that the chiller(s) will be off during the discharge period. Full storage is used for short on-peak windows (2-4 hours) and maximum load-shifting strategies, especially when rebates are based on shifted ton or shifted kW. Full storage provides more benefit when a large difference between on- and off-peak kWh charges (such as a $0.10 difference per kWh) drive the strategy to maximum load shift.

Space limitations. Sometimes the number of tanks is determined by the amount of available space. This is more of a concern on water-cooled systems that can utilize more tanks than with smaller, air-cooled systems. But given the financial incentives of off-peak cooling, previously unavailable space may become available.

Knowing either the number of tanks or the chiller size allows easy preliminary selection using the information on pp. 30-31. The number of hours to charge the tanks narrows the list of possibilities. When more about the project is known, CALMAC IcePick™ and Trane chiller selection software (TOPSS™) are used for final system design.



Four tanks occupy the space initially planned for a second chiller.

How much chiller?

Determining how much of the on-peak load should be met with ice storage is arbitrary, and is typically dictated by the cooling load profile and the objectives of the designer or building owner. A common starting point is 30 to 40 percent of the design day cooling load. As more of the building load is served by ice storage, on-peak chiller capacity and building electrical demand are reduced. However, more ice needs a larger chiller to charge the tanks in the same length of time. There is a balance to be struck.

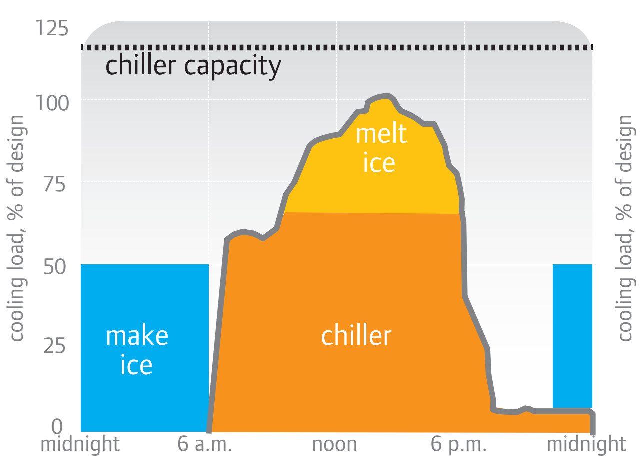
Greater ice storage capacity requires greater chiller ice-building capacity. One solution that's easy to find mathematically is the ice storage capacity that results in a chiller working as hard as it can during the day, while still being able to charge all the tanks at night. While this selection results in the smallest chiller net capacity, it does not necessarily represent the best life-cycle cost system. TRACE software can help you determine if a larger system is economically justified.

Possible starting points:

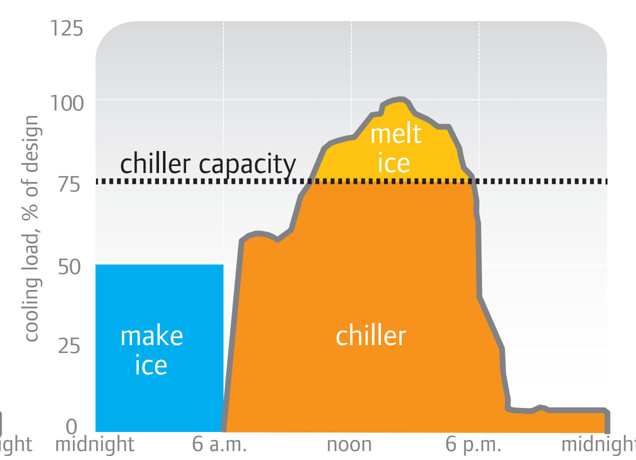
- Maximum number of tanks your chiller can charge in the amount of available hours (maximum freeze time)
- Smallest chiller needed on a design day, with or without an ice contribution (minimum melt rate)
- Electrical constraint for the chiller on a design day
- Maximum number of tanks you are prepared to put on site

Visualize the options

The following two figures show a load profile and two different options for the amount of the design day load that is to be met with the stored ice.



conventional chiller sizing



downsized chiller sizing

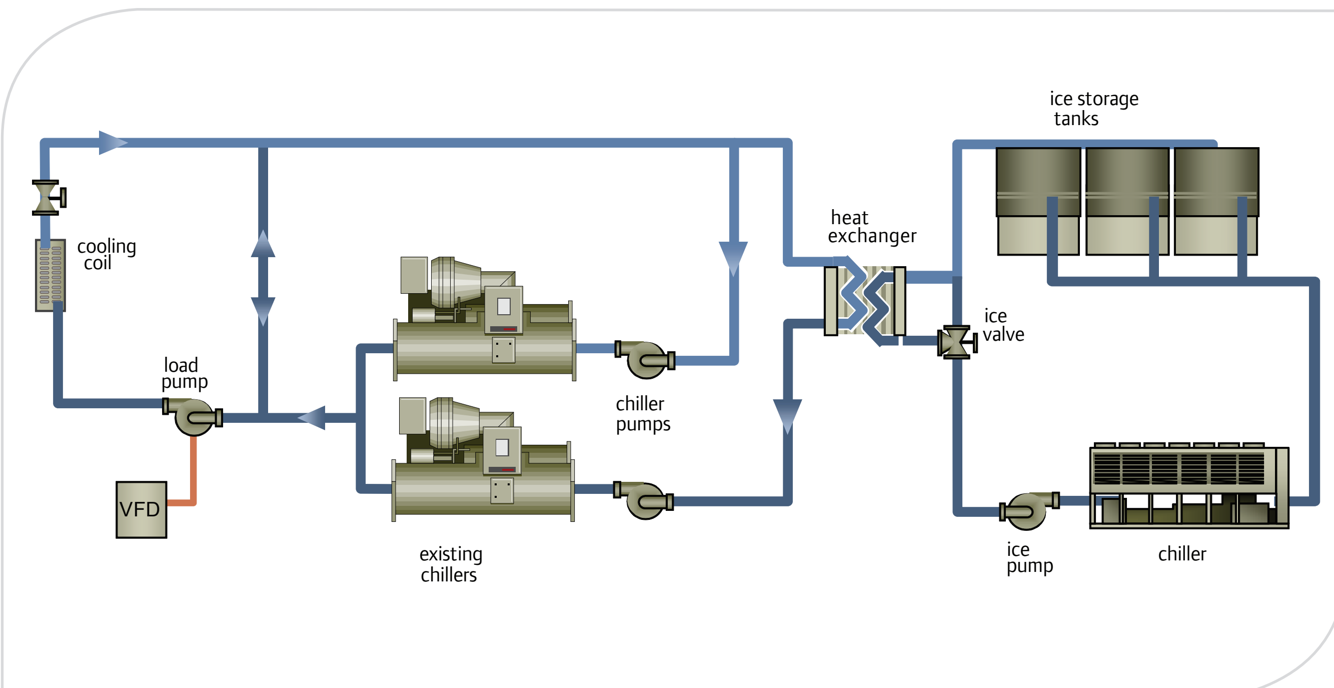
Adding ice to a chilled-water system

Ice plant as a system component

While existing air-cooled chillers can often be retrofit for making ice, other types of chilled-water systems can benefit by adding a self-contained ice plant to the system. Below is an example of an ice-enhanced air-cooled chiller plant installed upstream of one of two existing centrifugal chillers, separated by a heat exchanger to isolate glycol. If the flows are suitable, the new plant could be upstream of both existing chillers.

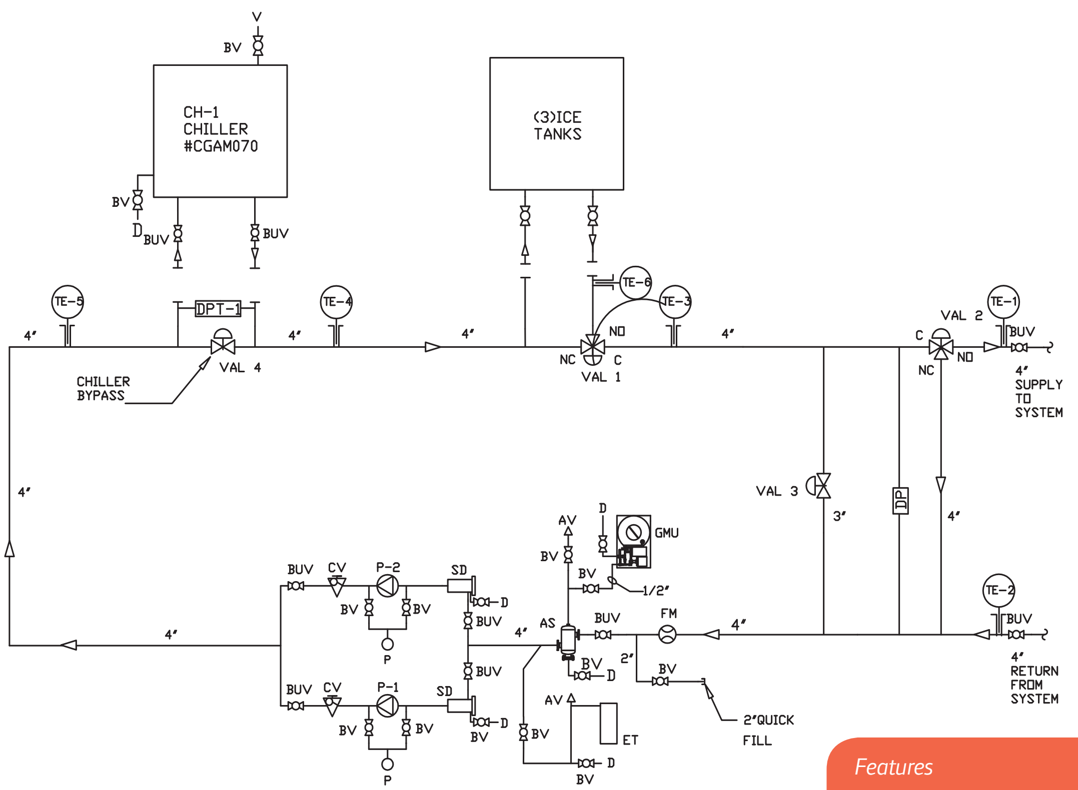
Benefits of adding ice to an existing chilled-water system include redundancy for one or more chillers, expansion of the system, maximum reuse of existing components and better system efficiency. Existing chillers do not need retrofitting and can handle cooling loads while the new ice chiller charges the tanks.

Consider the location of the heat exchanger to balance with ice plant flow rates and capacity. Locating the heat exchanger upstream of existing chiller(s) provides easier load-shifting and ice-priority control, while a downstream ice plant location improves chiller efficiency.



Standard configurations

Variable flow cooling, constant flow charging



TAG	ITEM
AS	AIR SEPARATOR
AV	AUTO AIR VENT
BUV	BUTTERFLY VALVE
BV	BALL VALVE
CH	CHILLER
CV	CHECK VALVE
DPT 1	DP SWITCH
DPT 2	DP SWITCH
D	DRAIN
ET	BLADDER EXPANSION TANK
FLX	FLEX CONNECTOR
FM	FLOW METER
GMU	GLYCOL MAKEUP UNIT
P	PRESSURE GAUGE
P/T	PRESSURE AND TEMPERATURE GAUGES
P1	PUMP 1
P2	PUMP 2
TE-1	SENSOR
TE-2	SENSOR
TE-3	SENSOR
TE-4	SENSOR
TE-5	SENSOR
TE-6	SENSOR
SD	SUCTION DIFFUSER
V	VENT
VAL 1	TANK MOD 3WAY
VAL 2	SYSTEM DIV 3WAY
VAL 3	VP BYPASS 2WAY NC
VAL 4	CHILLER ISO 2WAY NC

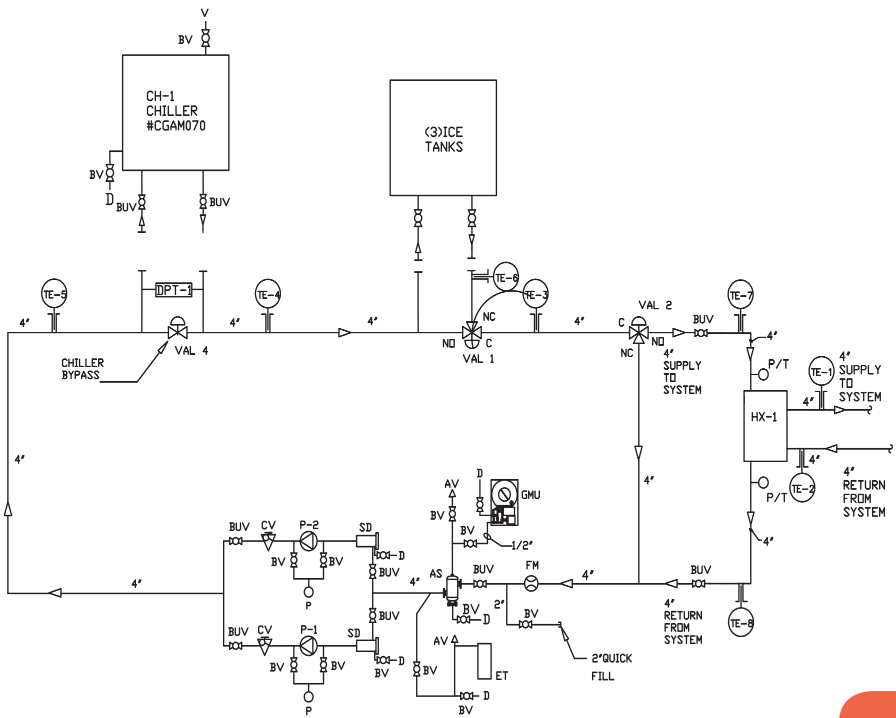
Features

- Lower pump energy than constant flow
- Load bypass during charge mode charges tanks quickly
- Variable Frequency Drive (VFD) eliminates need for triple duty valve for system balancing
- VFD communicates with system controller for power management and reporting

Considerations

- Cost of VFD on pump
- Building load during charge cycle should be kept to a minimum either by:
  - ignoring calls for cooling, or
  - installing a separate cooling system for critical spaces, or
  - delaying charge until after loads diminish, reducing the amount of time available for charging tanks.

Decoupled with heat exchanger



TAG	ITEM
AS	AIR SEPARATOR
AV	AUTO AIR VENT
BUV	BUTTERFLY VALVE
BV	BALL VALVE
CH	CHILLER
CV	CHECK VALVE
DPT 1	DP SWITCH
D	DRAIN
ET	BLADDER EXPANSION TANK
FLX	FLEX CONNECTOR
FM	FLOW METER
GMU	GLYCOL MAKEUP UNIT
P	PRESSURE GAUGE
P/T	PRESSURE AND TEMPERATURE GAUGES
P1	PUMP 1
P2	PUMP 2
TE-1	SENSOR
TE-2	SENSOR
TE-3	SENSOR
TE-4	SENSOR
TE-5	SENSOR
TE-6	SENSOR
TE-7	SENSOR
TE-8	SENSOR
SD	SUCTION DIFFUSER
V	VENT
VAL 1	TANK MOD 3WAY
VAL 2	SYSTEM DIV 3WAY
VAL 3	N/A
VAL 4	CHILLER ISO 2WAY NC
HX	HEAT EXCHANGER

Features

- Easier to plug into an existing decoupled system, possibly with an existing air-cooled chiller, reuse distribution pump
- Cost of glycol is lower with the shorter glycol loop, a consideration as systems get larger
- Water in the coils rather than glycol

Considerations

- Cost of heat exchanger
- Cooling during charge mode is more complicated and therefore not supported by this phase of prepackaged system controls
- Care must be taken to avoid freezing water on the load side of the heat exchanger – a tempering loop may be preferred

Supports the way you work

For the Engineer

Making it all happen without blowing the budget is critical. Trane and CALMAC worked together to create system drawings and control sequences to help you—whether you select one of our packaged systems, or make a custom design of your own.

For selecting the right size system, CALMAC IcePick™ software takes you from a design day load profile to the smallest chiller, or other combinations of ice and chiller to meet the design day load with capacity to spare. Another software tool, IceCycle from Trane, helps determine the final charge temperature based on the chiller, the flow rate, and the number of tanks. This tool can be used to determine:

- if the chiller and tanks operate within their flow constraints during the charging mode,
- the final charge temperature for a full charge based on the flow rate, chiller and tanks,
- the max discharge tons and stored ton-hours, and
- if the tanks can be charged in the amount of time available.

(Data on p. 24 provides information for the chiller performance entries for IceCycle and IcePick.)

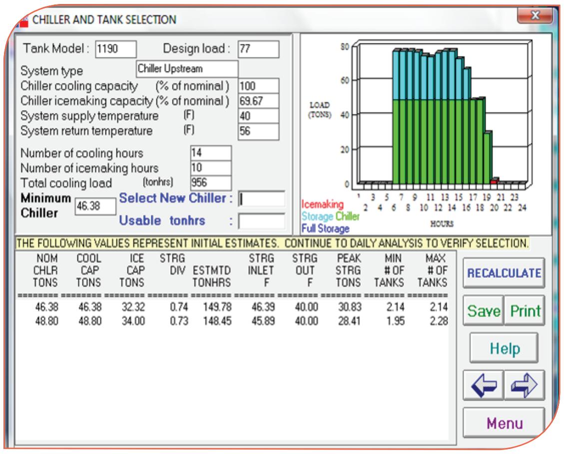
Once you have IcePick and IceCycle results, the chiller selection software will provide performance at the average charge temperature and allow you to test stability, performance, and percent glycol required for the selected chiller at the final charge temperature.

The beauty of a prepackaged EarthWise System is that it efficiently passes knowledge and expertise to the people who make it happen. While this makes us choose specific, detailed configurations, it also allows for an advanced starting point—reducing the risk and confusion of doing something for the first time.

Trane and CALMAC give you tools for calculating system payback, optimizing control algorithms, modeling system performance, and provide BIM drawings to support efficient design practices.

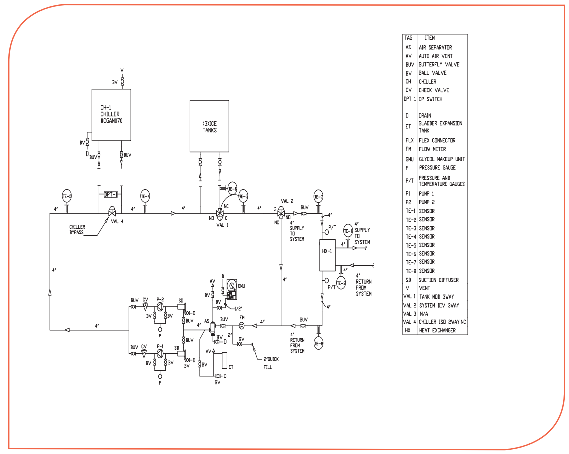
CALMAC IcePick design day chiller size starting point

With the design day load profile, this software finds combinations of chiller and tanks.



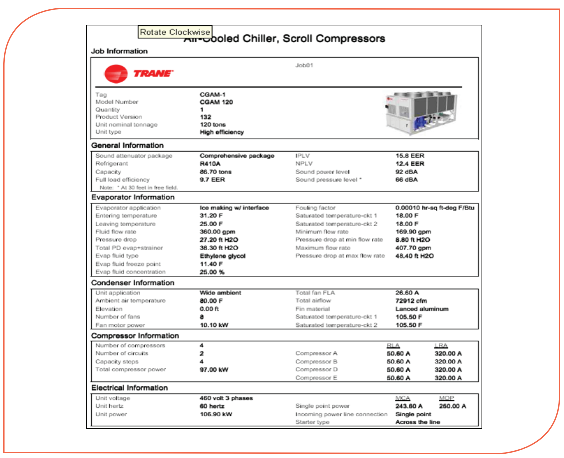
Schematics with Bills of Material

Layouts of four sizes of completion skids, with and without the optional heat exchanger, are available.



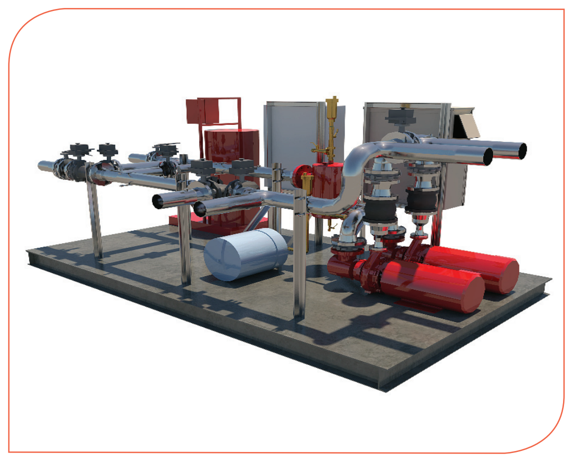
Chiller selection software

Trane official product selection software (TOPSS™) provides detailed capacity and flow information.



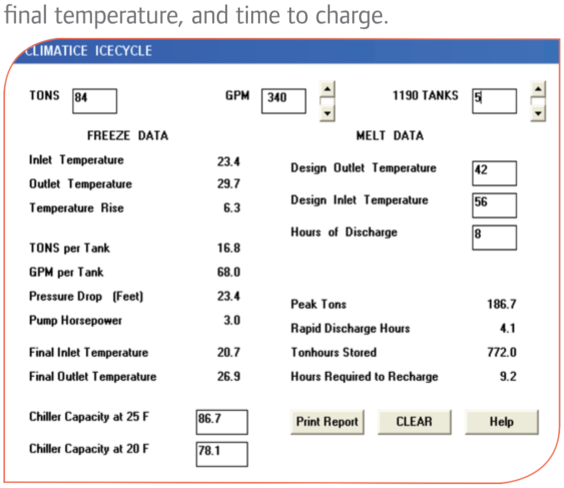
BIM drawing files

Chillers, tanks and system completion skids available in .dwg and Revit formats.



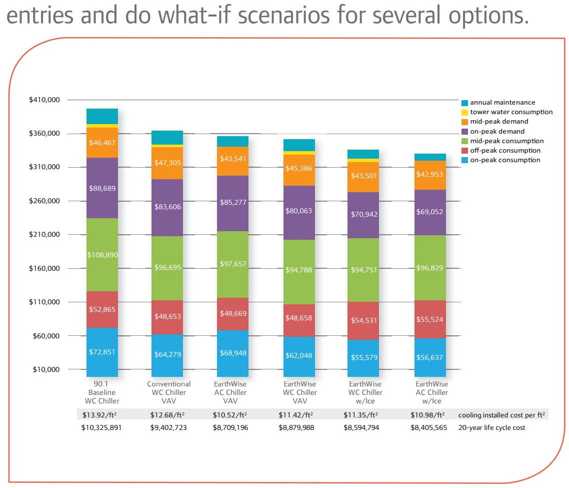
IceCycle from Trane

Focuses on balancing flows between chiller(s) and tanks, final temperature, and time to charge.



TRACE modeling software and support

TRACE energy analysis software can take your load design entries and do what-if scenarios for several options.



For the System Installer

System installers can either stick-build the system using our suggested systems, or purchase a system completion skid from Trane Creative Solutions. With the system completion skid, system installers can take advantage of a prepackaged EarthWise System—reducing the risk and confusion of doing something for the first time. Simpler selection, submittals, and ordering processes save time and reduce errors. Prepiped pumping and accessories on a factory-built and -commissioned completion skid reduce startup time on the job.

In addition, CALMAC IceBank tanks are available with tank connection piping already completed. You have the option of two or three packs with same end connections or opposite end connections for reverse return piping (recommended) arrangements.

System completion skids

Pre-engineered pump modules also include ancillary equipment such as valves, sensors, expansion tanks and a glycol management system.

IceBank packages

For systems with multiple tanks, installation is quicker with a crane and combinations of two or three 1190 tanks installed as one group.

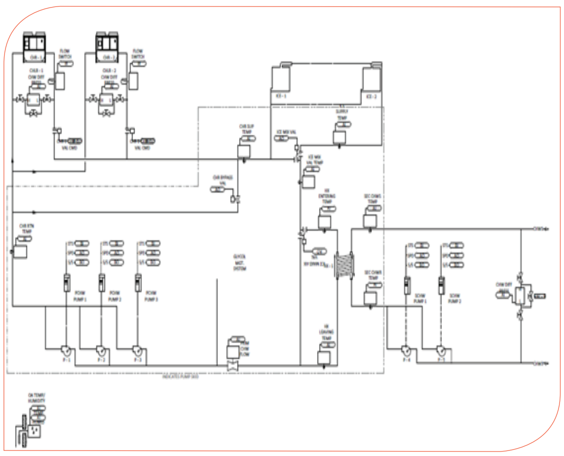
For the Controls Programmer

We've taken several steps to streamline the controls installation and compress the time it takes to complete the programming phase of the project.

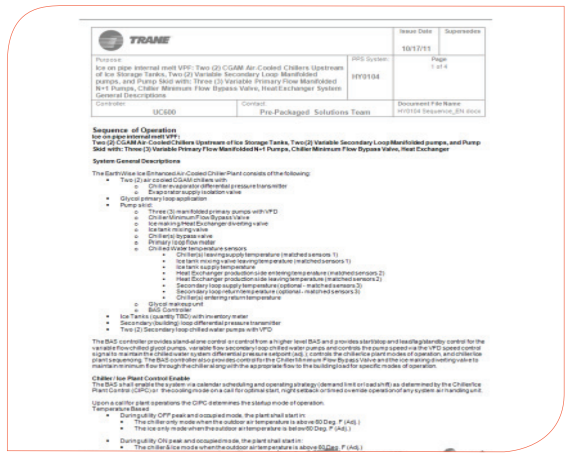
Standardized controls programming provides a common, repeatable experience for the building operator and service organization and saves time. The graphical programming is done at both the sub-system and system level, complete with graphics and dashboards. In addition, the sub-system controls are preloaded and shipped with the system completion skid.

Pre-packaged Solutions (PPS)

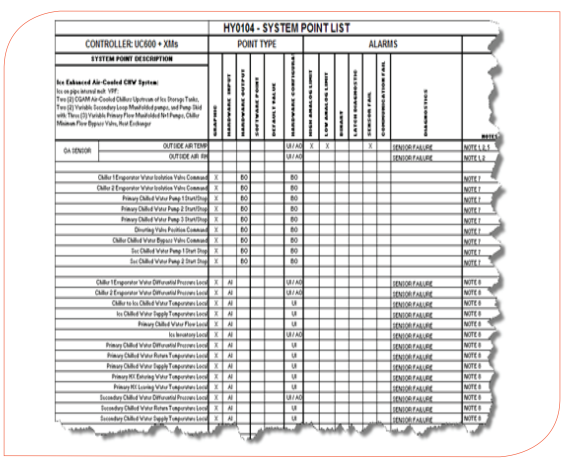
Controls wiring diagrams



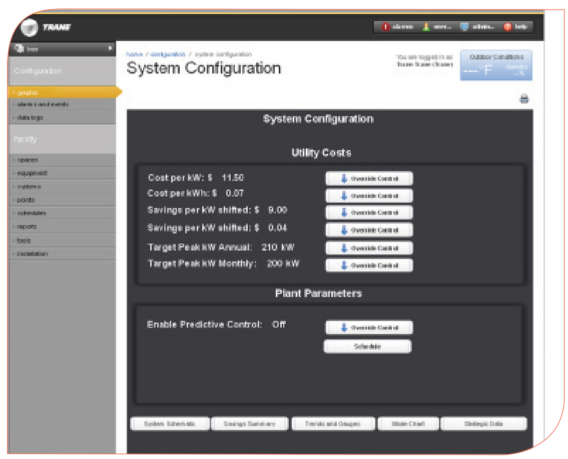
Sequences of operation



I/O point summaries



Configuration screen



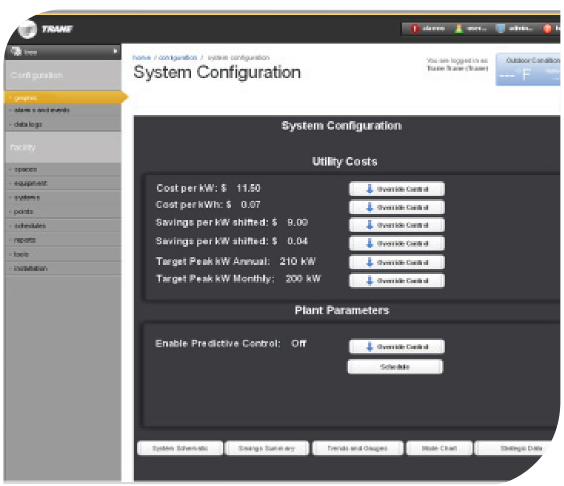
For the Building Operator

An operator selects the expected daily load profile based on the day type and weather forecast to determine how the plant will operate.

More advanced information about the system and how it is operating can be accessed from other interface screens. Scheduling modes of operation is accomplished by a simple-to-use interface accessed through the dashboard.

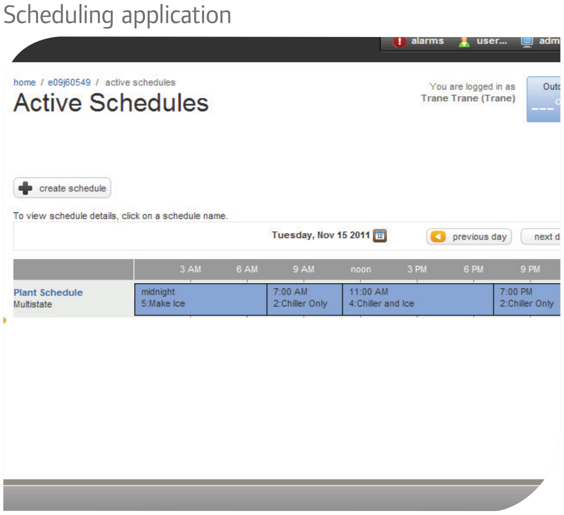
The dashboard on the right can include a link from the chiller and ice plant screen to the air handlers. Air handler at-a-glance information can be mapped to this screen, if desired.

Configuration screen

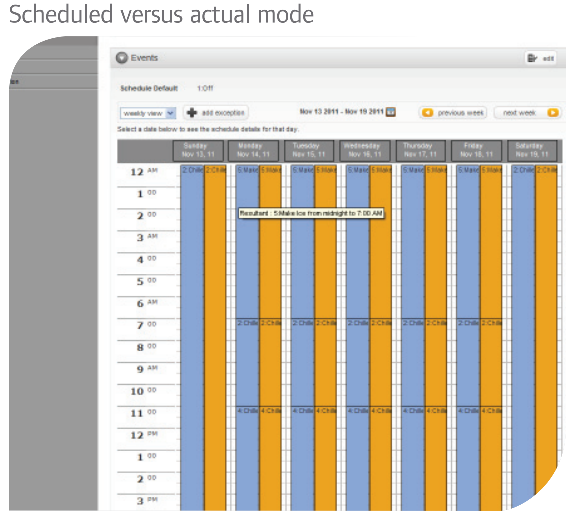


At-a-glance gauges

Scheduling application



Scheduled versus actual mode

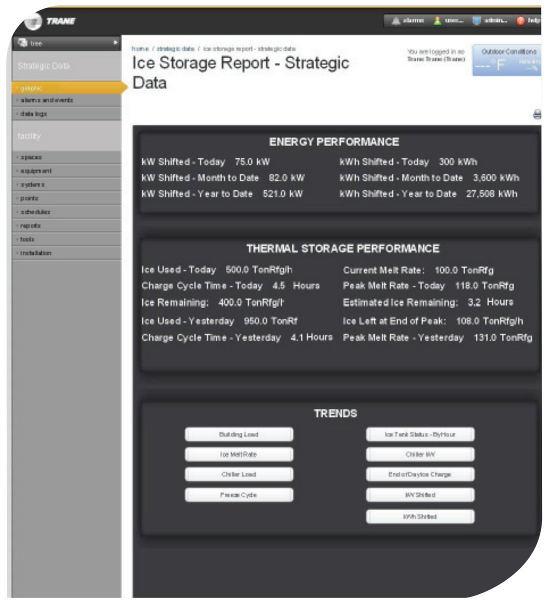


For the Owner

Preprogrammed displays demonstrate how the system saves money when operating and provides opportunities to further optimize system operation.

You want to know that your system is saving money as predicted. One of the common "complaints" about this system is that it saves more money than predicted.

Performance summary



For the Occupants

A lobby or entrance hall is an optimal place to display the great work your facility is doing to reduce energy costs. Students, employees or customers can see the benefits and learn about the EarthWise System you've installed.

Graphics illustrate the system operation and performance at a moment in time. The economic dashboard estimates system savings.

Savings calculations

System Components

Air-cooled Chillers


CGAM


RTAC

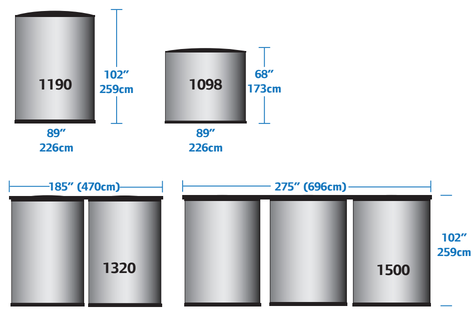

RTAE

Chiller performance data

	operating conditions						chiller flow and pressure drop						combined capacity and efficiency				
	evap. 40/54 °F 95°F ent. air		evap 42/56 °F 95°F ent. air		evap 48/56 °F 95°F ent. air		min flow	PD@ min flow	flow @3x nom. tons	PD@3x nom. ton flow	max flow	PD@ max flow		48-38 °F	56-48 °F	melt mode at 95°F ambient	
	tons	kW	tons	kW	tons	kW	gpm	ft of H_2O	gpm	ft of H_2O	gpm	ft of H_2O	tanks	melt tons	chiller tons	kW/ ton	Full load design day EER
CGAM020	18.3	22.8	18.9	23.0	20.5	23.5	29.1	6.4	60.0	25.7	69.7	32.9	1	23.5	20.5	0.534	22.5
CGAM026	23.3	29.4	24.1	29.7	26.1	30.3	37.2	7.4	78.0	31.9	89.4	41.0	1	30.6	26.1	0.534	22.5
CGAM030	26.1	32.9	27.0	33.2	30.0	33.9	41.8	9.4	90.0	43.1	100.3	52.5	1	35.3	30.0	0.519	23.1
CGAM035	30.9	39.1	32.0	39.4	34.6	40.2	49.1	6.5	105.0	27.9	117.7	34.4	2	41.2	34.6	0.530	22.6
CGAM040	35.2	44.7	36.5	45.1	40.0	46.2	56.7	9.1	120.0	38.8	136.1	49.5	2	47.1	40.0	0.530	22.6
CGAM052	45.6	57.6	47.2	58.1	51.3	59.6	73.5	7.9	156.0	33.4	176.4	42.1	3	58.8	51.3	0.541	22.2
CGAM060	52.5	65.1	54.4	65.6	59.5	66.9	83.9	8.0	180.0	34.3	201.4	42.3	3	70.6	59.5	0.514	23.3
CGAM070	61.7	76.9	63.9	77.6	69.6	79.4	99.4	7.6	210.0	33.0	238.6	42.2	3	82.4	69.6	0.522	23.0
CGAM080	70.5	85.4	73.0	86.1	79.5	88.0	114.7	7.4	240.0	30.3	275.3	39.2	4	94.1	79.5	0.507	23.7
CGAM090	79.6	96.3	82.3	97.2	89.5	99.4	128.3	6.7	270.0	27.9	307.8	35.8	4	105.9	89.5	0.509	23.6
CGAM100	89.3	107.4	92.5	108.2	100.7	110.4	144.4	7.3	300.0	30.1	346.6	39.6	4	117.6	100.7	0.506	23.7
CGAM110	97.2	119.8	100.7	120.8	109.4	123.4	156.5	7.5	330.0	32.3	375.7	41.3	5	129.4	109.4	0.517	23.2
CGAM120	106.2	132.0	109.9	133.2	119.3	136.3	169.9	8.6	360.0	38.3	407.7	48.8	5	141.2	119.3	0.523	22.9
CGAM130	114.9	137.9	118.9	139.1	129.2	142.1	183.7	8.9	390.0	40.9	440.8	51.0	6	152.9	129.2	0.504	23.8
RTAC140S	122.3	160.6	128.1	164.1	146.4	175.5	193.0	3.8	420.0	18.4	709.0	51.9	6	164.7	146.4	0.564	21.3
RTAC140H	124.9	157.8	131.1	161.0	150.8	171.7	202.0	3.2	420.0	14.2	741.0	44.0	6	164.7	150.8	0.544	22.1
RTAC155S	134.2	174.7	140.5	178.5	160.8	191.0	215.0	4.0	465.0	19.1	785.0	54.1	7	182.4	160.8	0.557	21.6
RTAC155H	138.7	171.2	145.4	174.7	167.0	186.1	217.0	3.2	465.0	15.3	796.0	44.4	7	182.4	167.0	0.533	22.5
RTAC170S	148.7	190.4	155.3	194.4	175.9	206.9	202.0	3.2	510.0	21.2	741.0	43.9	7	200.0	175.9	0.550	21.8
RTAC170H	151.1	184.8	158.4	188.6	181.8	200.9	241.0	3.3	510.0	15.1	883.0	44.9	7	200.0	181.8	0.526	22.8
RTAC185S	163.3	210.7	170.3	215.2	192.6	229.5	226.0	3.5	555.0	21.9	796.0	44.3	8	217.6	192.6	0.559	21.4
RTAC185H	169.4	206.9	176.8	211.0	199.8	224.0	217.0	3.5	555.0	23.8	796.0	48.1	8	217.6	199.8	0.537	22.4
RTAC200S	178.6	231.8	186.3	236.8	210.4	253.0	241.0	3.3	600.0	21.1	883.0	44.9	9	235.3	210.4	0.568	21.1
RTAC200H	185.8	228.3	193.9	233.0	218.7	247.7	241.0	3.5	600.0	22.9	883.0	48.7	9	235.3	218.7	0.546	22.0
RTAC225S	199.0	256.8	207.0	262.1	231.4	278.9	223.0	3.7	675.0	35.1	796.0	48.1	10	294.1	231.4	0.531	22.6
RTAC225H	201.9	250.9	210.4	256.1	236.7	272.6	241.0	3.5	675.0	28.9	883.0	48.6	10	294.1	236.7	0.514	23.4
RTAC250S	218.6	281.3	227.4	287.3	254.1	306.0	241.0	3.5	750.0	35.6	883.0	48.6	11	323.5	254.1	0.530	22.7
RTAC250H	223.8	276.9	233.1	282.6	261.2	300.3	241.0	3.5	750.0	35.6	883.0	48.6	11	323.5	261.2	0.514	23.4
RTAC275S	240.4	309.1	250.6	315.5	281.9	335.6	309.0	3.4	825.0	25.2	1134.0	46.7	13	352.9	281.9	0.529	22.7
RTAC275H	245.4	299.3	256.7	305.6	292.3	325.6	375.0	3.5	825.0	17.3	1374.0	47.6	13	352.9	292.3	0.505	23.8
RTAC300S	270.8	352.1	282.0	359.7	316.1	383.0	339.0	3.4	900.0	25.1	1243.0	47.1	15	411.8	316.1	0.526	22.8
RTAC300H	277.8	342.7	290.0	350.0	327.3	372.7	375.0	3.4	900.0	20.7	1374.0	47.5	15	411.8	327.3	0.504	23.8
RTAC350S	308.4	401.5	321.1	410.4	359.5	437.8	375.0	3.4	1050.0	28.3	1374.0	47.5	17	441.2	359.5	0.547	21.9
RTAC350H	312.3	377.8	325.8	385.0	367.9	407.6	404.0	3.5	1050.0	24.8	1483.0	48.5	17	441.2	367.9	0.504	23.8
RTAC400S	365.9	474.1	380.4	484.0	424.3	514.3	404.0	3.5	1200.0	32.3	1483.0	48.5	19	470.6	424.3	0.575	20.9
RTAC400H	376.3	464.3	392.0	473.9	440.6	503.6	461.0	3.6	1200.0	25.3	1690.0	49.3	19	470.6	440.6	0.553	21.7
RTAC450S	403.8	523.9	419.6	535.0	466.9	568.7	422.0	3.5	1350.0	37.5	1548.0	48.7	21	529.4	466.9	0.571	21.0
RTAC500H	442.1	574.1	459.4	586.5	511.6	624.9	461.0	3.6	1500.0	39.3	1690.0	49.3	23	588.2	511.6	0.568	21.1
RTAE150	124.5	142.5	132.0	146.0	154.4	155.7	171.0	2.9	450.0	24.3	626.0	46.9	7	200.0	154.4	0.439	27.3
RTAE165	142.2	158.8	150.5	162.4	176.0	173.3	187.0	3.0	495.0	24.9	684.0	47.5	8	217.6	176.0	0.440	27.3
RTAE180	155.9	178.1	164.8	182.1	191.7	193.4	202.0	2.8	540.0	24.4	742.0	45.9	9	235.3	191.7	0.453	26.5
RTAE200	172.2	195.3	182.3	199.8	213.8	214.0	228.0	2.9	600.0	24.0	835.0	46.5	10	294.1	213.8	0.421	28.5
RTAE225	194.9	211.2	205.8	215.7	239.3	229.9	261.0	3.0	675.0	23.5	957.0	47.3	11	323.5	239.3	0.408	29.4
RTAE250	217.5	243.7	229.3	249.1	265.6	266.3	288.0	3.0	750.0	24.3	1055.0	48.0	12	340.0	265.6	0.440	27.3
RTAE275	238.3	264.4	251.8	270.5	292.2	288.8	318.0	2.8	825.0	22.8	1165.0	45.5	13	352.9	292.2	0.448	26.8
RTAE300	257.1	287.6	272.6	294.6	319.2	315.5	354.0	2.9	900.0	22.0	1299.0	46.0	14	375.0	319.2	0.454	26.4

all chiller and tank performance based on 25% ethylene glycol

CALMAC IceBank® 1190



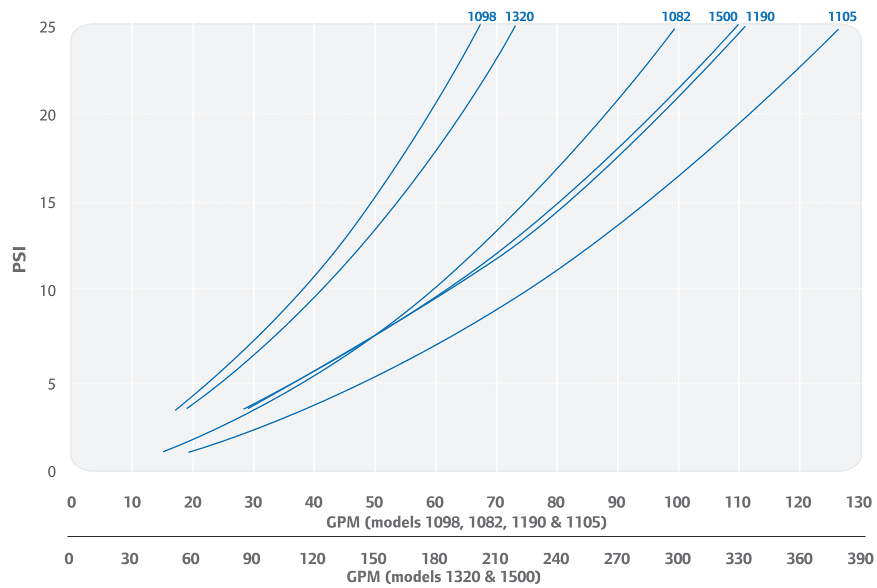
Specifications

Dimensions (L x W x H)	89″ x 91″ x 102″
Filled weight	16,900 lbs
Floor loading	391 lb/sq. ft.
Inlet/outlet flange connection size	4″
Manufacturer product line	IceBank®
Maximum operating pressure	90 psi
Maximum operating temperature	100°F
Net usable capacity*	162 ton/hr
Shipping weight	2000 lb
Volume of water ice	1655 gal
Volume of solution in heat exchanger	157 gal

*Typical value, varies with conditions

Pressure drop curves

Based on 25% ethylene glycol. Contact Trane or CALMAC representative for other fluids or concentrations.



CALMAC IceBank tank weights and dimensions

Model	Nominal (net usable) ton-hrs*	Flange size (in.)	Shipping weight (lb)	Filled weight (lb)	Floor loading (lb/ft2)	Width (in.)	Length (in.)	Height (in.)
1500C	486	4	6000	50600	391	89	273	102
1320C	324	4	4000	34000	391	89	181	102
1190	162	4	2000	16900	391	89	92	102
1105	105	4	1315	10885	360	73 ¾	76 ½	102
1098	98	4	1275	10235	237	89	92	69 ½
1082	82	4	1065	8580	283	73 ¾	76 ½	84 ½
1045	41	2	580	4380	150	73 ¾	76 ½	48

*Typical value, varies with conditions

To access AutoCAD or Revit drawing files, visit http://calmac.com/products/icebankc_specs.asp

Maximum operating pressure for all tanks is 90 psi
Dimensions can change, contact CALMAC for up-to-date specifications
Dimensions reflect the larger of same side or reverse side connections
Models 1190, 1098, 1105 and 1082 tanks can be ordered with two, three, or four flanges with headers underneath the lid.
Models 1320 and 1500 are pre-piped packages of two and three 1190 tanks, respectively, and require a crane for rigging. All other models can be installed by forklift.
A-style tanks have a 2-inch flanged connection with forklift bases. These are used for the small project, replacement market. A 2-inch flange simplifies installation.
C-style tanks have a 4-inch flanged connection without a forklift base. The C-style tanks have the option to be manufactured with two, three or four flanges.
This option works because under the lid is a connecting header.

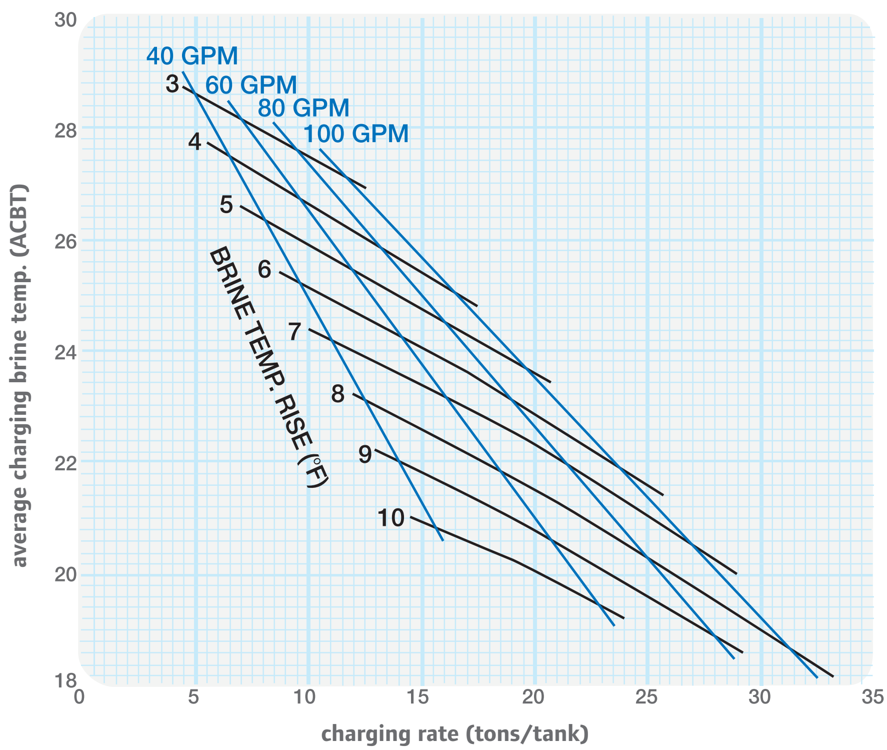
IceBank Performance in Charge Mode (Model 1190)

The table below shows the capacity that can be absorbed by the tank at various average charging temperatures. Both CALMAC IcePick™ and Trane IceCycle software incorporate this information into the calculations. The table below illustrates the balance that must be struck between chiller and tank sizing.

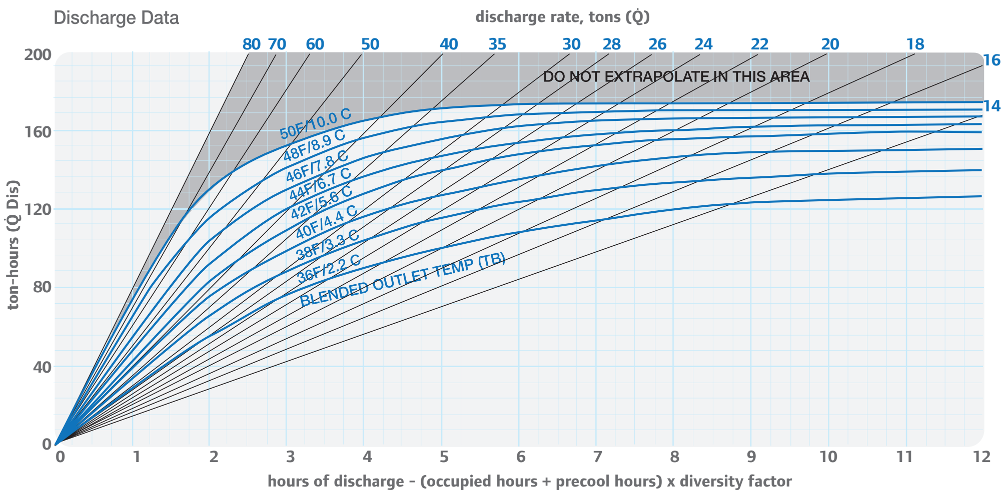
Minimum charging brine temperature to IceBank for full charge (ºF)

	tons/tank						
Average charging temperature (ºF)	5	10	15	20	25	30	35
28	25.7	25.1					
27	24.7	24.3	23.8				
26		23.4	22.9				
25		22.7	22.1	21.4			
24		22.1	21.4	20.7			
23			20.8	20.1	19.3		
22			20.1	19.5	18.6		
21			19.5	18.9	18.1	17.6	
20				18.3	17.7	17.2	
19					17.3	16.7	
18						16.1	15.8

Charging rate by flow rate

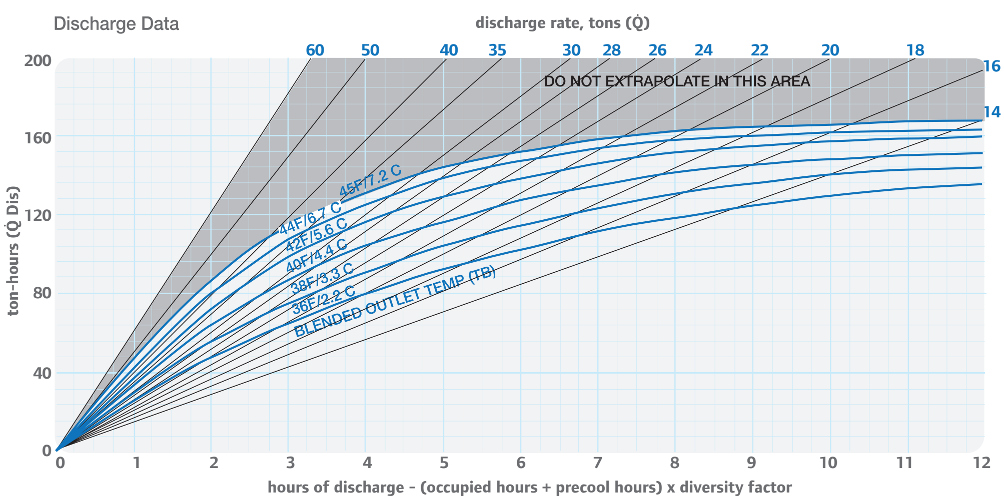


IceBank Performance in Discharge Mode (Model 1190)



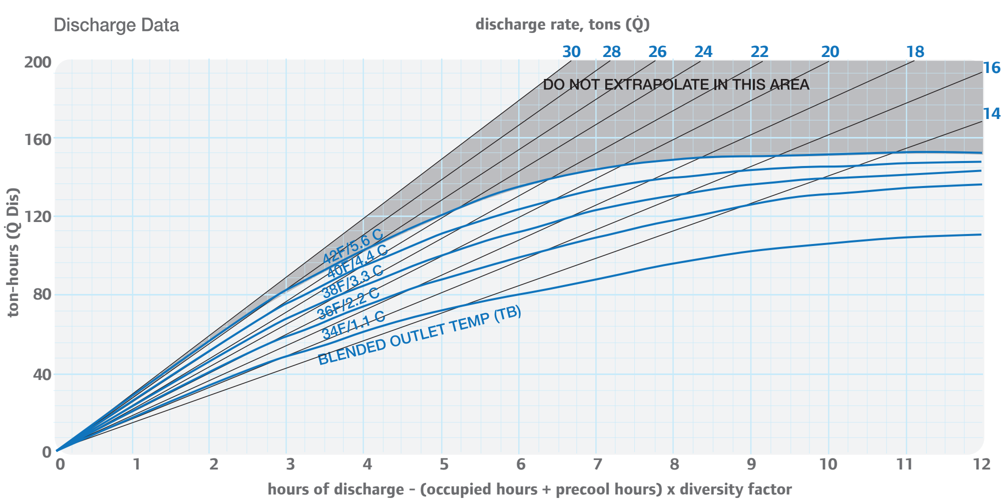
storage inlet temperature (Tin)

60°F



storage inlet temperature (Tin)

50°F



storage inlet temperature (Tin)

45°F

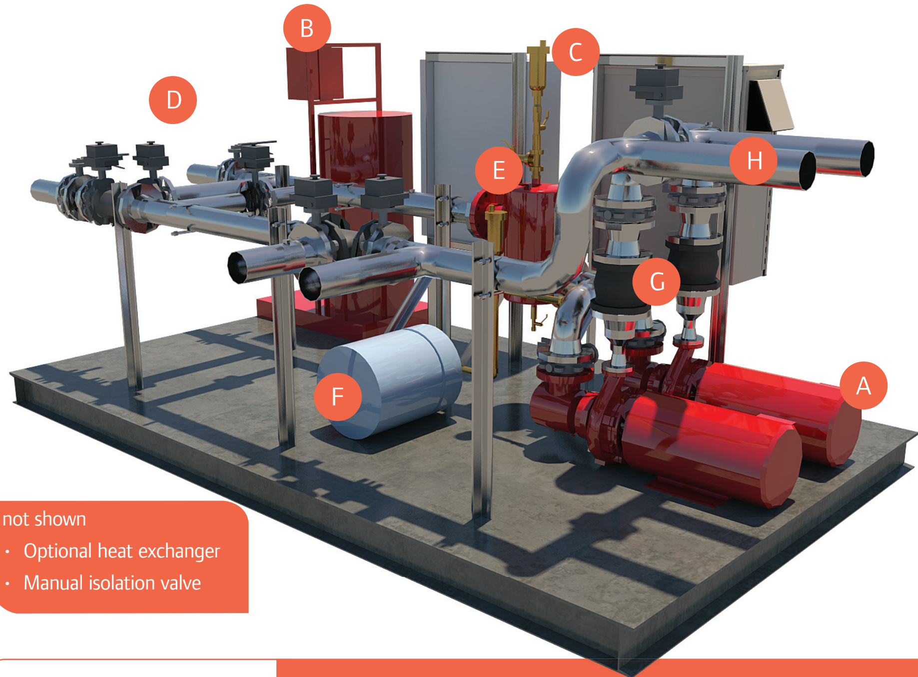
System Completion Module

Electrical data

skid type	pumps running	pump impeller size	HP	pump FLA			controls (amps)			208V			460V			575V		
				208V	460V	575V	208V	460V	575V	skid MCA	RDE	skid MOP	skid MCA	RDE	skid MOP	skid MCA	RDE	skid MOP
No HEX, 1 Chiller	1	1.5x1x8	15	42	19	17.2	6.94	3.14	2.5	59.4	70	100	26.9	35	45	24.0	30	40
1 HEX, 1 Chiller	1	1.5x1x6	7.5	22	9.9	8.6	6.94	3.14	2.5	34.3	40	50	15.5	20	25	13.3	20	25
No HEX, 2 Chiller	2	1.5x1x8	15	42	19	17.2	6.94	3.14	2.5	101.4	125	125	45.9	60	60	41.2	50	50
1 HEX, 2 Chiller	2	1.5x1x6	7.5	22	9.9	8.6	6.94	3.14	2.5	56.4	70	70	25.4	30	35	21.9	25	30
No HEX, 1 Chiller	1	3x1.5x8	20	54	25	20.9	6.94	3.14	2.5	74.4	90	125	34.4	45	50	28.6	35	45
1 HEX, 1 Chiller	1	3x2x13	15	42	19	17.2	6.94	3.14	2.5	59.4	70	100	26.9	35	45	24.0	30	40
No HEX, 2 Chiller	2	3x1.5x8	20	54	25	20.9	6.94	3.14	2.5	128.4	150	175	59.4	70	80	49.5	60	70
1 HEX, 2 Chiller	2	3x2x13	15	42	19	17.2	6.94	3.14	2.5	101.4	125	125	45.9	60	60	41.2	50	50
No HEX, 1 Chiller	1	3x2.5x8	30	80	36	32.7	6.94	3.14	2.5	106.94	150	175	48.1	60	80	43.4	60	70
1 HEX, 1 Chiller	1	4x3x11.5	20	54	25	20.9	6.94	3.14	2.5	74.4	90	125	34.4	45	50	28.6	35	45
No HEX, 2 Chiller	2	3x2.5x8	30	80	36	32.7	6.94	3.14	2.5	186.9	225	250	84.1	100	110	76.1	90	100
1 HEX, 2 Chiller	2	4x3x11.5	20	54	25	20.9	6.94	3.14	2.5	128.4	150	175	59.4	70	80	49.5	60	70
No HEX, 1 Chiller	1	4x3x8	30	80	36	32.7	6.94	3.14	2.5	106.94	150	175	48.1	60	80	43.4	60	70
1 HEX, 1 Chiller	1	4x3x11.5	20	54	25	20.9	6.94	3.14	2.5	74.4	90	125	34.4	45	50	28.6	35	45
No HEX, 2 Chiller	2	4x3x8	30	80	36	32.7	6.94	3.14	2.5	186.9	225	250	84.1	100	110	76.1	90	100
1 HEX, 2 Chiller	2	4x3x11.5	20	54	25	20.9	6.94	3.14	2.5	128.4	150	175	59.4	70	80	49.5	60	70
No HEX, 1 Chiller	1	4x3x8	40	104	47	39	6.94	3.14	2.5	136.9	175	225	61.9	80	100	51.3	70.0	90
1 HEX, 1 Chiller	1	5x4x11.5	25	68	31	25.4	6.94	3.14	2.5	91.9	110	150	41.9	50	70	34.3	45.0	50
No HEX, 2 Chiller	2	4x3x8	40	104	47	39	6.94	3.14	2.5	240.9	300	300	108.9	125	150.0	90.3	100.0	125
1 HEX, 2 Chiller	2	5x4x11.5	25	68	31	25.4	6.94	3.14	2.5	159.9	200	225	72.9	90	100.0	59.7	70.0	80
No HEX, 1 Chiller	1	5x5x13H	75	210	95	76	6.94	3.14	2.5	269.4	350	450	121.9	150	200	97.5	125	150
1 HEX, 1 Chiller	1	6x5x11.5	40	104	47	39	6.94	3.14	2.5	136.9	175	225	61.9	80	100	51.3	70	90
No HEX, 2 Chiller	2	5x5x13H	75	210	95	76	6.94	3.14	2.5	479.4	600	600	216.9	250	300	173.5	200	225
1 HEX, 2 Chiller	2	6x5x11.5	40	104	47	39	6.94	3.14	2.5	240.9	300	300	108.9	125	150	90.3	100	125
No HEX, 1 Chiller	1	6x5x15L	100	261	118	95	6.94	3.14	2.5	333.2	400	500	150.6	200	250	121.3	150	200
1 HEX, 1 Chiller	1	8x6x12M	50	130	59	49	6.94	3.14	2.5	169.4	225	250	76.9	100	125	63.8	80	110
No HEX, 2 Chiller	2	6x5x15L	100	261	118	95	6.94	3.14	2.5	594.2	700	800	268.6	300	350	216.3	250	300
1 HEX, 2 Chiller	2	8x6x12M	50	130	59	49	6.94	3.14	2.5	299.4	350	400	135.9	175	175	112.8	125	150

Dimensions and performance data

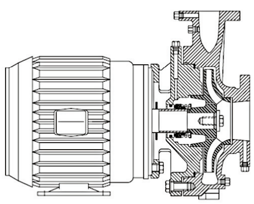
skid type	total head (ft)	skid head (ft)	external head (ft)	pipe mains size	system flow (GPM)	pressure drop (ft/100′)	velocity (ft/sec)	bypass					skid				
								line size	flow (GPM)	PD (ft/100′)	velocity (ft/sec)	pipe size	length	width	height	dry weight (lb) ± 10%	operating weight (lb) ± 10%
No HEX, 1 Chiller	166	86	80	3″	81	2.06	3.52	2.5″	41.8	1.82	2.81	2.5″	12′	7′	70″	5271	6156
1 HEX, 1 Chiller	109	109	N/A	3″	81	2.06	3.52	2.5″	N/A	N/A	N/A	N/A	17′	7′	83″	7394	8426
No HEX, 2 Chiller	166	86	80	4″	162	1.91	4.08	2.5″	41.8	1.82	2.81	2.5″	12′	7′	78″	6075	7102
1 HEX, 2 Chiller	109	109	N/A	4″	162	1.91	4.08	2.5″	N/A	N/A	N/A	N/A	17′	7′	83″	8391	9533
No HEX, 1 Chiller	166	86	80	4″	239	3.85	6.02	3″	80	2	3.47	3″	12′	7′	70″	5650	6677
1 HEX, 1 Chiller	109	109	N/A	4″	239	3.85	6.02	3″	N/A	N/A	N/A	N/A	17′	7′	86″	8647	10219
No HEX, 2 Chiller	166	86	80	6″	478	1.85	5.31	3″	80	2	3.47	3″	12′	7′	78″	7077	8617
1 HEX, 2 Chiller	109	109	N/A	6″	478	1.85	5.31	3″	N/A	N/A	N/A	N/A	17′	7′	86″	9846	11794
No HEX, 1 Chiller	167	87	80	5″	408	3.38	6.54	4″	136	1.39	3.43	4″	12′	7′	78″	6574	7859
1 HEX, 1 Chiller	110	110	N/A	5″	408	3.38	6.54	4″	N/A	N/A	N/A	N/A	17′	7′	100″	9678	11618
No HEX, 2 Chiller	167	87	80	8″	816	1.29	5.24	4″	136	1.39	3.43	4″	12′	7′	92″	9013	11573
1 HEX, 2 Chiller	110	110	N/A	8″	816	1.29	5.24	4″	N/A	N/A	N/A	N/A	17′	7′	100″	12251	15049
No HEX, 1 Chiller	161	81	80	6″	440	3.38	6.54	4″	263	4.58	6.63	4″	12′	7′	80″	7362	8865
1 HEX, 1 Chiller	104	104	N/A	6″	440	3.38	6.54	4″	N/A	N/A	N/A	N/A	17′	7′	100″	11433	13916
No HEX, 2 Chiller	161	81	80	8″	880	1.48	5.65	4″	263	4.58	6.63	4″	17′	7′	96″	9100	11660
1 HEX, 2 Chiller	104	104	N/A	8″	880	1.48	5.65	4″	N/A	N/A	N/A	N/A	17′	7′	100″	13406	16554
No HEX, 1 Chiller	161	81	80	6″	525	2.19	5.83	5″	314	2.1	5.03	5″	12′	7′	80″	7546	9085
1 HEX, 1 Chiller	104	104	N/A	6″	525	2.19	5.83	5″	N/A	N/A	N/A	N/A	17′	7′	100″	11994	14842
No HEX, 2 Chiller	161	81	80	8″	1050	2.04	6.74	5″	314	2.1	5.03	5″	17′	7′	100″	9430	11990
1 HEX, 2 Chiller	104	104	N/A	8″	1050	2.04	6.74	5″	N/A	N/A	N/A	N/A	17′	7′	105″	14027	17540
No HEX, 1 Chiller	159	79	80	8″	905	1.71	6.10	5″	375	2.93	6.01	5″	20′	10′	88″	12797	16310
1 HEX, 1 Chiller	102	102	N/A	8″	905	1.71	6.10	5″	N/A	N/A	N/A	N/A	25′	10′	116.5″	19697	24236
No HEX, 2 Chiller	159	79	80	10″	1810	1.79	7.36	5″	375	2.93	6.01	5″	22′	10′	96″	16589	20882
1 HEX, 2 Chiller	102	102	N/A	10″	1810	1.79	7.36	5″	N/A	N/A	N/A	N/A	27′	10′	116.5″	22441	28217
No HEX, 1 Chiller	165	85	80	8″	1293	3.01	8.30	6″	461	1.74	5.12	6″	26′	11′	88″	17600	21498
1 HEX, 1 Chiller	108	108	N/A	8″	1293	3.01	8.30	6″	N/A	N/A	N/A	N/A	31′	11′	116.5″	27348	34223
No HEX, 2 Chiller	165	85	80	12″	2586	1.5	7.41	6″	461	1.74	5.12	6″	28′	11′	105″	22469	28460
1 HEX, 2 Chiller	108	108	N/A	12″	2586	1.5	7.41	6″	N/A	N/A	N/A	N/A	33′	11′	116.5″	32151	40904



not shown
- Optional heat exchanger
- Manual isolation valve

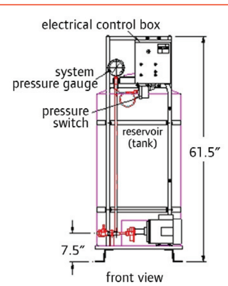
The system completion module includes all system hydronics specialties

- A Pumps (N+1)
- B Integral glycol feeder system
- C Control and electrical panels
- D Motorized control valves
- E Air separator
- F Expansion tank
- G Pump strainers
- H All connective piping



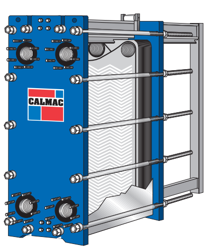
Pumps with TR200 communicating VFD

- Motor mounted horizontal end suction
- Heavy-duty, grease-lubricated ball bearings
- Self-lubricating silicon carbide mechanical seal



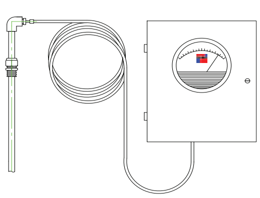
Glycol management system (standard)

CALMAC glycol management system maintains the proper volume of coolant in a building's circulating loop by monitoring the system pressure and adding coolant from a reservoir when the pressure drops below a setpoint.



CALMAC heat exchangers

- True counter-current design for close temperature approach
- Unique interlocking plate design to help ensure a tight seal
- Deep set gasket grooves to improve reliability
- Bolted construction for strength and accessibility



Inventory meter (optional)

- Indoor or outdoor field installation
- White-faced magnehelic display
- Factory-calibrated 4-20 mA output for remote monitoring

(Tracer ice inventory calculation included as standard)

Quick Select Guide

This chart is meant to be used in the preliminary planning stages, before all information about the project is known. Once more detail is available, other tools such as Trane TOPSS™ chiller selection software, CALMAC IcePick™ and Trane IceCycle should be used to verify system performance and completion of the project design. For more combinations contact your account manager.

			6 Hours of Charge									7 Hours of Charge									8 Hours of Charge								
Chiller Model	Chiller Tons		Hours of Discharge									Hours of Discharge									Hours of Discharge								
	Day	Ice	6			8			10			6			8			10			6			8			10		
CGAM 20	20.5	14.0	207	1	36	248	1	34	289	1	33	221	1	39	262	1	36	303	1	34	235	1	41	276	1	38	317	1	36
CGAM 26	26.1	18.4	267	1	47	319	1	44	371	1	42	285	1	50	337	1	47	390	1	44	304	2	53	356	2	49	408	1	46
CGAM 30	30.0	20.4	302	1	53	362	1	50	422	1	48	323	2	57	383	1	53	443	1	50	343	2	60	403	2	56	463	2	53
CGAM 35	34.6	24.0	352	2	62	421	1	58	490	1	56	376	2	66	445	2	62	514	2	58	400	2	70	469	2	65	538	2	61
CGAM 40	40.0	26.2	397	2	70	477	2	66	557	2	63	424	2	74	504	2	70	584	2	66	450	2	79	530	2	74	610	2	69
CGAM 52	51.3	35.8	523	2	92	625	2	87	728	2	83	559	2	98	661	2	92	764	2	87	594	3	104	697	2	97	800	2	91
CGAM 60	59.5	40.6	600	2	105	719	2	99	838	2	95	641	3	112	760	2	104	879	2	100	682	3	120	801	3	110	920	3	105
CGAM 70	69.6	48.2	707	3	124	846	2	116	985	2	112	755	3	132	894	3	123	1033	3	117	803	3	141	942	3	129	1082	3	123
CGAM 80	79.5	54.4	804	3	141	963	3	132	1122	3	127	858	3	151	1017	3	140	1176	3	134	912	4	160	1071	4	147	1230	3	140
CGAM 90	89.5	62.5	912	3	160	1091	3	150	1270	3	144	975	4	171	1154	4	158	1333	3	151	1037	4	182	1216	4	167	1395	4	159
CGAM 100	100.7	68.9	1017	4	179	1219	3	167	1420	3	161	1086	4	191	1288	4	177	1489	4	169	1155	5	203	1357	4	186	1558	4	177
CGAM 110	109.4	75.6	1110	4	195	1329	4	183	1548	3	176	1186	5	208	1405	4	193	1623	4	184	1262	5	221	1480	5	203	1699	4	193
CGAM 120	119.3	83.2	1215	4	213	1454	4	200	1692	4	192	1298	5	228	1537	5	211	1775	4	202	1381	6	242	1620	5	223	1859	5	211
CGAM 130	129.2	89.2	1311	5	230	1569	4	216	1827	4	208	1400	5	246	1658	5	228	1917	5	218	1489	6	261	1747	5	240	2006	5	228
RTAC140	146.4	99.8	1477	5	259	1770	5	243	2063	4	234	1577	6	277	1870	5	257	2162	5	246	1677	7	294	1969	6	271	2262	6	257
RTAC155	160.8	109.0	1619	6	284	1941	5	267	2262	5	257	1728	6	303	2050	6	282	2371	6	269	1837	7	322	2159	7	297	2480	6	282
RTAC170	175.9	118.5	1766	6	310	2118	5	291	2470	5	281	1885	7	331	2236	6	307	2588	6	294	2003	8	351	2355	7	323	2707	7	308
RTAC185	192.6	131.9	1947	7	342	2332	6	320	2718	6	309	2079	8	365	2464	7	338	2849	7	324	2211	9	388	2596	8	357	2981	7	339
RTAC200	210.4	144.7	2130	7	374	2551	6	350	2972	6	338	2275	8	399	2696	7	370	3117	7	354	2420	9	425	2840	8	390	3261	8	371
RTAC250	254.1	171.8	2556	8	448	3064	8	421	3572	7	406	2727	10	479	3236	9	444	3744	8	425	2899	11	509	3408	10	468	3916	10	445
RTAC275	281.9	191.9	2843	9	499	3407	8	468	3971	8	451	3035	11	532	3599	10	494	4163	9	473	3227	12	566	3791	11	521	4355	11	495
RTAC300	316.1	216.8	3198	11	561	3830	9	526	4462	9	507	3414	12	599	4047	11	556	4679	10	532	3631	14	637	4264	12	586	4896	12	556
RTAC350	359.5	243.8	3620	12	635	4339	11	596	5058	10	575	3863	14	678	4582	12	629	5301	12	602	4107	16	721	4826	14	663	5545	13	630
RTAC375	392.0	268.9	3965	13	696	4749	12	652	5533	11	629	4234	15	743	5018	13	689	5802	13	659	4503	17	790	5287	15	726	6071	15	690
RTAC400	424.3	294.4	4312	14	757	5161	13	709	6010	12	683	4607	16	808	5455	15	749	6304	14	716	4901	19	860	5750	17	790	6599	16	750
RTAC450	466.9	321.8	4732	15	830	5666	14	778	6600	13	750	5054	18	887	5988	16	823	6922	15	787	5376	20	943	6310	18	867	7243	17	823
RTAC500	511.6	352.6	5185	17	910	6209	15	853	7232	14	822	5538	19	972	6561	18	901	7584	17	862	5891	22	1033	6914	20	950	7937	19	902
RTAE150	154.4	98.7	1429	5	251	1721	5	239	2013	4	229	1522	6	267	1814	5	252	2105	5	239	1614	7	283	1906	6	265	2198	6	250
RTAE165	176.0	111.8	1625	6	285	1958	5	272	2291	5	260	1730	7	304	2063	6	286	2395	6	272	1835	7	322	2167	7	301	2500	6	284
RTAE180	191.7	122.3	1773	6	311	2136	6	297	2498	5	284	1888	7	331	2250	6	313	2612	6	297	2002	8	351	2365	7	328	2727	7	310
RTAE200	213.4	135.2	1969	7	345	2372	6	329	2776	6	315	2095	8	368	2499	7	347	2902	7	330	2222	9	390	2625	8	365	3028	8	344
RTAE225	239.3	155.0	2227	8	391	2679	7	372	3131	7	356	2372	9	416	2824	8	392	3276	8	372	2517	10	442	2969	9	412	3421	9	389
RTAE250	265.6	173.3	2479	8	435	2981	8	414	3483	7	396	2641	10	463	3143	9	436	3645	8	414	2803	11	492	3305	10	459	3807	10	433
RTAE275	292.2	187.9	2711	9	476	3264	8	453	3816	8	434	2887	11	507	3439	10	478	3992	9	454	3063	12	537	3615	11	502	4168	10	474
RTAE300	319.2	204.0	2955	10	518	3558	9	494	4161	9	473	3146	11	552	3749	10	521	4352	10	495	3337	13	585	3940	12	547	4543	11	516

Peak Cooling Discharge (tons) | Peak Cooling Discharge (tons) | Peak Cooling Discharge (tons)

Number of CALMAC 1190 Modules | Number of CALMAC 1190 Modules | Number of CALMAC 1190 Modules

Partial Storage System Capacity (ton-hours) | Partial Storage System Capacity (ton-hours) | Partial Storage System Capacity (ton-hours)

The assumptions embedded in this table may not be reflective of your specific project constraints. For example, this table is set up for one chiller, and your project may have more than one chiller capable of making ice. Flow, pressure limits, and other constraints may be higher than you desire. Careful consideration of all the relevant project application requirements is essential prior to finalizing the system design.

9 Hours of Charge									10 Hours of Charge									11 Hours of Charge									12 Hours of Charge								
Hours of Discharge									Hours of Discharge									Hours of Discharge									Hours of Discharge								
6			8			10			6			8			10			6			8			10			6			8			10		
249	1	44	290	1	40	331	1	38	263	1	46	304	1	42	345	1	39	277	2	49	318	2	44	359	2	41	291	2	51	332	2	46	373	2	42
322	2	56	374	2	52	426	2	48	340	2	60	393	2	55	445	2	51	359	2	63	411	2	57	463	2	53	377	2	66	429	2	59	482	2	55
363	2	64	423	2	59	483	2	55	384	2	67	444	2	62	504	2	57	404	2	71	464	2	64	524	2	60	424	2	74	484	2	67	544	2	62
424	2	74	493	2	68	562	2	64	448	2	79	517	2	72	586	2	67	472	3	83	541	2	75	610	2	69	496	3	87	565	2	78	634	2	72
476	2	84	556	2	77	636	2	72	502	2	88	582	2	81	662	2	75	529	3	93	609	2	85	689	2	78	555	3	97	635	3	87	715	3	81
630	3	111	733	3	102	835	3	95	666	3	117	769	3	107	871	3	99	702	4	123	804	3	112	907	3	103	738	4	129	840	3	115	943	3	107
722	3	127	841	3	116	960	3	109	763	3	134	882	3	121	1001	3	114	803	4	141	922	4	127	1041	3	118	844	4	148	963	4	132	1082	4	123
851	4	149	991	3	136	1130	3	128	900	4	158	1039	4	143	1178	4	134	948	5	166	1087	4	149	1226	4	139	996	5	175	1135	4	156	1274	4	145
967	4	170	1126	4	155	1285	4	146	1021	4	179	1180	4	162	1339	4	152	1076	5	189	1235	5	170	1394	4	158	1130	6	198	1289	5	177	1448	5	165
1100	5	193	1279	4	176	1458	4	166	1162	5	204	1341	5	184	1520	5	173	1225	6	215	1404	5	193	1583	5	180	1287	6	226	1466	6	201	1645	5	187
1224	5	215	1426	5	196	1627	5	185	1293	5	227	1494	5	205	1696	5	193	1362	6	239	1563	6	215	1765	5	201	1431	7	251	1632	6	224	1834	6	208
1337	6	235	1556	5	214	1775	5	202	1413	6	248	1632	6	224	1850	5	210	1488	7	261	1707	6	235	1926	6	219	1564	7	274	1783	7	245	2002	6	227
1465	6	257	1703	6	234	1942	5	221	1548	6	272	1786	6	245	2025	6	230	1631	8	286	1870	7	257	2108	7	240	1714	8	301	1953	7	268	2191	7	249
1578	7	277	1837	6	252	2095	6	238	1667	7	293	1926	7	265	2184	6	248	1757	8	308	2015	7	277	2273	7	258	1846	9	324	2104	8	289	2363	8	268
1776	7	312	2069	7	284	2362	6	268	1876	7	329	2169	7	298	2462	7	280	1976	9	347	2269	8	312	2562	8	291	2076	10	364	2369	9	325	2661	8	302
1946	8	341	2268	7	312	2589	7	294	2055	8	361	2377	8	326	2698	8	307	2164	10	380	2486	9	341	2807	8	319	2273	11	399	2595	10	356	2916	9	331
2122	9	372	2473	8	340	2825	8	321	2240	9	393	2592	9	356	2944	8	335	2358	11	414	2710	9	372	3062	9	348	2477	11	435	2829	10	389	3181	10	361
2343	10	411	2728	9	375	3113	8	354	2475	10	434	2860	10	393	3245	9	369	2607	12	457	2992	11	411	3377	10	384	2739	13	480	3124	11	429	3509	11	399
2564	11	450	2985	9	410	3406	9	387	2709	11	475	3130	10	430	3551	10	403	2854	13	501	3274	11	450	3695	11	420	2998	14	526	3419	12	470	3840	12	436
3071	12	539	3579	11	492	4088	11	464	3243	12	569	3751	12	515	4259	12	484	3415	15	599	3923	14	539	4431	13	504	3587	16	629	4095	15	562	4603	14	523
3419	14	600	3983	12	547	4546	12	517	3611	14	633	4175	14	573	4738	13	538	3803	17	667	4367	15	600	4930	14	560	3995	18	701	4558	16	626	5122	16	582
3848	16	675	4480	14	615	5113	13	581	4065	16	713	4697	15	645	5329	15	606	4282	19	751	4914	17	675	5546	16	630	4499	21	789	5131	18	705	5763	18	655
4351	17	763	5070	16	696	5789	15	658	4595	17	806	5314	17	730	6033	17	686	4838	21	849	5557	19	763	6276	18	713	5082	23	892	5801	21	797	6520	20	741
4772	19	837	5556	17	763	6340	16	720	5041	19	884	5825	19	800	6609	18	751	5309	23	931	6093	21	837	6877	20	782	5578	25	979	6362	23	874	7146	22	812
5196	21	912	6044	19	830	6893	18	783	5490	21	963	6339	21	871	7187	20	817	5785	25	1015	6633	23	911	7482	22	850	6079	28	1067	6928	25	952	7776	24	884
5698	23	1000	6631	20	911	7565	20	860	6019	23	1056	6953	23	955	7887	22	896	6341	28	1112	7275	25	999	8209	24	933	6663	30	1169	7597	27	1044	8531	26	969
6243	25	1095	7267	22	998	8290	21	942	6596	25	1157	7619	25	1047	8642	24	982	6949	30	1219	7972	27	1095	8995	26	1022	7301	33	1281	8324	30	1143	9348	28	1062
1706	7	299	1998	7	278	2290	6	260	1799	7	316	2091	7	290	2382	7	271	1891	9	332	2183	8	303	2475	8	281	1983	10	348	2275	9	316	2567	8	292
1939	8	340	2272	7	316	2605	7	296	2044	8	359	2376	8	330	2709	8	308	2148	10	377	2481	9	345	2814	9	320	2253	11	395	2586	10	359	2918	9	332
2117	9	371	2479	8	344	2841	8	323	2231	9	391	2593	9	360	2956	9	336	2345	11	411	2708	10	376	3070	9	349	2460	12	432	2822	11	392	3185	10	362
2348	10	412	2752	9	382	3155	9	359	2475	10	434	2878	10	400	3281	9	373	2601	12	456	3005	11	417	3408	10	387	2728	13	479	3131	12	435	3534	11	402
2662	11	467	3114	10	433	3566	10	405	2807	11	492	3259	11	453	3711	11	422	2952	14	518	3404	12	473	3856	12	438	3097	15	543	3549	13	493	4001	13	455
2965	12	520	3467	11	482	3969	11	451	3127	12	549	3629	12	504	4131	12	469	3289	15	577	3791	14	527	4293	13	488	3451	16	606	3953	15	549	4455	14	506
3239	14	568	3791	12	527	4343	12	494	3415	14	599	3967	13	551	4519	13	514	3590	16	630	4143	15	575	4695	14	534	3766	18	661	4318	16	600	4871	15	553
3527	15	619	4131	13	574	4734	13	538	3718	15	652	4322	15	600	4925	14	560	3909	18	686	4512	16	627	5116	15	581	4100	19	719	4703	17	653	5307	17	603
		Peak Cooling Discharge (tons)									Peak Cooling Discharge (tons)									Peak Cooling Discharge (tons)									Peak Cooling Discharge (tons)						
	Number of CALMAC 1190 Modules									Number of CALMAC 1190 Modules									Number of CALMAC 1190 Modules									Number of CALMAC 1190 Modules							
Partial Storage System Capacity (ton-hours)									Partial Storage System Capacity (ton-hours)									Partial Storage System Capacity (ton-hours)									Partial Storage System Capacity (ton-hours)								

Controls

Ice-enhanced, Air-cooled Chiller Plant EarthWise Systems include an optional system completion module, preprogrammed control sequences, operator graphics, reports, drawings and guide specifications.

BACnet communicating system controller (Tracer SC) and sub-system controller (UC600)

Preprogrammed sequences

- One chiller, no heat exchanger
- Two chillers, no heat exchanger
- One chiller with heat exchanger and two distribution pumps
- Two chillers with heat exchanger and two distribution pumps

Control functions

- System scheduling
- Six modes of operation
  - Off
  - Chiller only - single and multiple chiller
  - Ice only
  - Chiller and ice
  - Make ice
  - Make ice and cool
- System mode determination
- Chiller plant demand limiting
- Ice inventory management
- Chilled fluid system control
- Chiller/ice sequencing and control
- Color graphic based chiller and plant status screens

- System and chiller diagnostic messages
- System and chiller reporting
- Failure modes and recovery
- Heat exchanger sequencing and control (option)
- Pump control for water loops (option)

Information displayed at sub-system controller and at system controller

- Ton hours used last ice discharge cycle
- Ton hours stored last ice build cycle
- Peak kW
- Estimated savings

Ingersoll Rand

Ingersoll Rand (NYSE:IR) advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands—including Club Car®, Ingersoll Rand®, Thermo King® and Trane®—work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a global business committed to a world of sustainable progress and enduring results.

APP-PRC001-EN 10 Jan 2014
Supersedes APP-PRC001-EN 02 Dec 2011

We are committed to using environmentally conscious print practices.

trane.com
ingersollrand.com