Introduction

Why a Q & A on refrigeration?

Considering a marine refrigeration system can be intimidating. Not only do you have to figure out the price /value equation, but also sort out issues of construction, installation, operation and efficiency. Defender believes that this Q & A will help open the door to the enjoyment a reliable, efficient marine refrigeration system can bring to your boating activities.

Price/Value

Where does the ICE+ system fit on the price scale for marine refrigeration systems?

The ICE+ system was designed to provide a lower cost alternative to the very best "no compromise" systems on the market. We recognize that such equipment is not required by, or financially available to, everyone who wants good refrigeration. But for customers that want above average performance without paying top of the line prices, ICE+ is superior to all other units in its price range and to many systems costing far more.

Efficiency factors

How is the energy efficiency compared between systems?

The total daily energy consumption of any refrigeration system depends on the size, temperature and insulation of the box which is being cooled as well as the efficiency of the system. Trying to judge the energy consumption of a system by looking at running current can be very misleading since it does not tell how long that particular unit will run per day.

What is the difference between "evaporator" and "holding" plate systems?

An evaporator plate exposes the evaporator (the tubing through which the refrigerant runs immediately following the expansion device) directly to the air, achieving cooling directly by the refrigeration system. A "holding" plate system uses a tank filled with a "phase-change" solution. The refrigeration system freezes the solution and then turns off, cooling the air indirectly as the solution thaws and absorbs heat through the tank's walls.

Is there a standard measure for evaluating efficiency among systems?

A true comparison between systems can be made by referring to the energy required to cool the same box to the same temperature over a 24 hour period. In 1995 (ICE+ was introduced in 1996) "Cruising World" magazine conducted such a test. Using the numbers from the Cruising World test, the ICE+ would beat out most other systems, some selling for nearly double the price!

What is an EER rating?

Additionally, one can compare compressor EER ratings. By US law, all manufacturers of hermetically sealed type compressors (the type used in most moderately priced holding plate systems) must test and publish an EER for each model. The EER, or energy efficiency ratio, is the compressor's capacity in BTUs per hour divided by watts of input power. The compressor used in the Technautics system and nearly all other hermetically sealed marine systems is manufactured in Germany by Danfoss and has an EER of 2.43. By comparison, the American made compressor used on the ICE+ has an EER of 3.71, or 50% better than that of the Danfoss compressor.

What do the numbers mean?

While compressor efficiency isn't the whole story, it is logical that the system using a more efficient compressor will have used less energy at the end of the day. In fact, the ICE+ will use only 2/3 rds or less the energy required by the Technautics and other similarly priced, hermetically sealed holding plate systems. The ICE+ system compares well to many holding plate systems costing much more and very favorably to systems within its price range.

What is the heat removal capacity of ICE+?

Under comparative test conditions ICE+ removes heat at 1800 BTU/HR for refrigerator units and 1000 BTU/HR for freezers. ICE+ can cool refrigerator and freezer units as large as those typically found on 50' sailboats or bigger. Important factors which affect cooling capacity, however, are insulation thickness and condition, location and access frequency of the box. A single ICE+ compressor can drive up to four holding plates.

Operation

What size box will it cool?

Making generalizations about maximum box sizes which a system can handle can be misleading. The thickness and condition of the insulation play at least as large a role as does box volume in estimating heat load. ICE+ is powerful enough to handle the refrigerators and freezers typically found on sailboats up to 50' in length and sometimes larger. ICE+'s heat removal capacity translates into the system's ability to cool a 6 cu. ft. freezer and a 12 cu. ft. refrigerator or one single box exceeding 20 cu. ft.! To determine specific requirements, please complete and mail/fax the brief requirements survey to Defender.

Is the ICE+ air or water cooled?

The ICE+ comes standard with a copper-nickel, water-cooled condenser for improved performance in hot climates. Water cooling means that the compressor does not need to receive extra ventilation. It can, therefore, be mounted in an engine room or any convenient location. The non-priming centrifugal pump, which is standard equipment with ICE+ units, needs to be mounted below the waterline. Unlike the standard centrifugal pump, an optional "self-priming" water pump may be mounted above the waterline and can be "T-ed" into existing thru-hulls.

Is it possible to shut down the refrigerator or freezer independently of the other?

NO. Since all plates are connected in series both boxes must operate simultaneously.

What does the "Self-Diagnostic System" do?

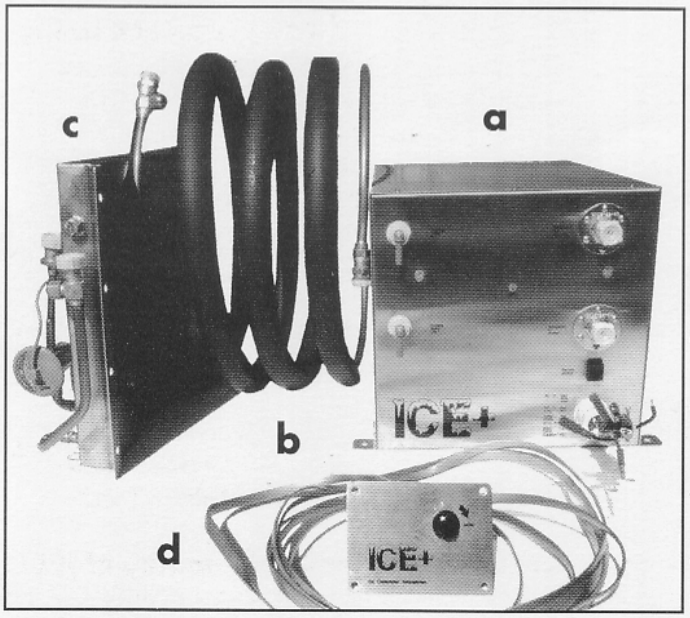
The ICE+ offers a continuous system monitoring capability as a standard feature. Using a system of audible "beeps", the control panel alerts the owner when things happen, such as when voltage is being received as expected (good) or when loss of cooling water, excessive heat, low voltage, etc. is detected (not so good).

How big does my battery bank have to be to operate the system?

Designing a "proper" battery bank is a topic of considerable complexity and beyond the scope of this refrigeration Q & A. Items like other equipment sharing the bank, boating locale and use will determine the specific answer. The best general answer is, however, "The largest one you can afford given space, weight and money." Defender publishes a separate TechNote™ on the topic and will be happy to send a copy upon request.

Construction

What are the main system components?



The ICE+ base system consists of:

a stainless steel case enclosed main compressor

b pre-charged 15' insulated 3/8" return line and 15' 3/16" discharge line

c one holding plate with expansion valve

d control panel and connection wire.

e centrifugal sea water pump (not shown)

What options are available?

Optional equipment to upgrade or customize ICE+ for your boat include self-priming pump for above waterline installation; additional holding plates; 6' or 12' extension line set, an upgraded remote control panel which adds visual (tri-color LED and bar graph temperature gauge) readouts to the standard audible system alerts and 2', 3', or 4' link lines for connecting additional holding plates.

What are the major construction differences of ICE+ holding plates over other manufacturer's plates?

ICE+ plates offer important and measurable advantages over those used in other systems. For example, comparing ICE+ and other systems, ICE+'s holding plates, manufactured for Defender by Glacier Bay (the world's accepted leader in marine refrigeration technology), are 100% argon-welded, 16 gauge 304 stainless steel, utilizing propylene glycol. By contrast, units such as Technautics' are seam-welded/soft soldered with a SS food service tray.

The ICE+ evaporator is continuous copper coil with a 56% pure silver bulkhead joint, while evaporators such as Technautics are an air conditioning coil with brazed joint construction with soft soldered bulkhead joint.

These differences add up to ICE+'s cooling performance being four times that of Technautics units and nearly six times comparable Adler-Barbour units.

What connectors are used for the pre-charged refrigerant lines?

Ice+ uses state-of-the-art quick-disconnect fittings between the compressor and line fittings. This choice allows for disconnection/re-connection of the compressor without the need of a certified technician to first evacuate refrigerant from and then re-charge the system. This is an important environmental compliance, maintenance and budget consideration designed into ICE+.

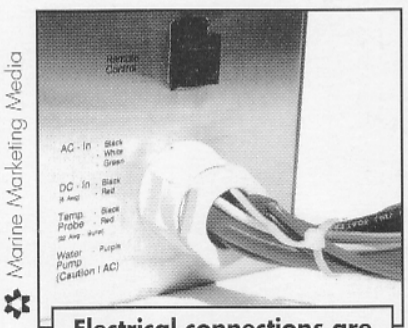
What is the ICE+warranty?

The ICE+ system has a limited 1 year parts and labor warranty. Glacier Bay, Inc., manufacturer of the ICE+ system for Defender, provides covered warranty service at no cost except for shipping charges to and from your destination. Factory after-warranty service is available at a single flat-rate.

INSTALLATION

Can I install the system myself?

Because ICE+ is designed for the budget conscious boater, installation methods are designed to be simple, quick and foolproof. For instance, the main compressor is water cooled and requires no dedicated thru-hulls. Therefore installation does not require extra ventilation. The compressor can be installed in any convenient location which will accommodate its small footprint (10"H x 10.5"W x 14.5"L). The remote thermostat plugs in with a phone-type jack and all electrical supply connections are consolidated and easily made to hard wired connections on the compressor. The connection fittings are "spade" and "bullet" type, reducing power loss and lessening the chance of improper connection. The quiet centrifugal pump must be mounted below the waterline in a continuous run. The pump can, however, sit in the bilge if needed.



Electrical connections are well marked

How far away from the refrigerator/freezer box can the compressor unit be mounted?

The standard line set allows the compressor to be located up to 15' from the holding plate. An extension line set of 6' or 12' can be added to permit a maximum operating distance of up to 27'.

How do I figure out how many holding plates I will need?

The number of holding plates you will need depends on the size of your box, thickness of the insulation and desired temperature (ie. refrigerator or freezer).

Generally speaking, one holding plate is adequate for up to a 6 cu.ft. refrigerator with 3" or more of insulation. If your box is larger than that or you have less insulation, you will probably need a second holding plate. Freezers are a different story entirely. Almost all but the smallest freezers should use two holding plates. If your freezer box is at least 3 cu.ft. in volume you will want multiple plates.

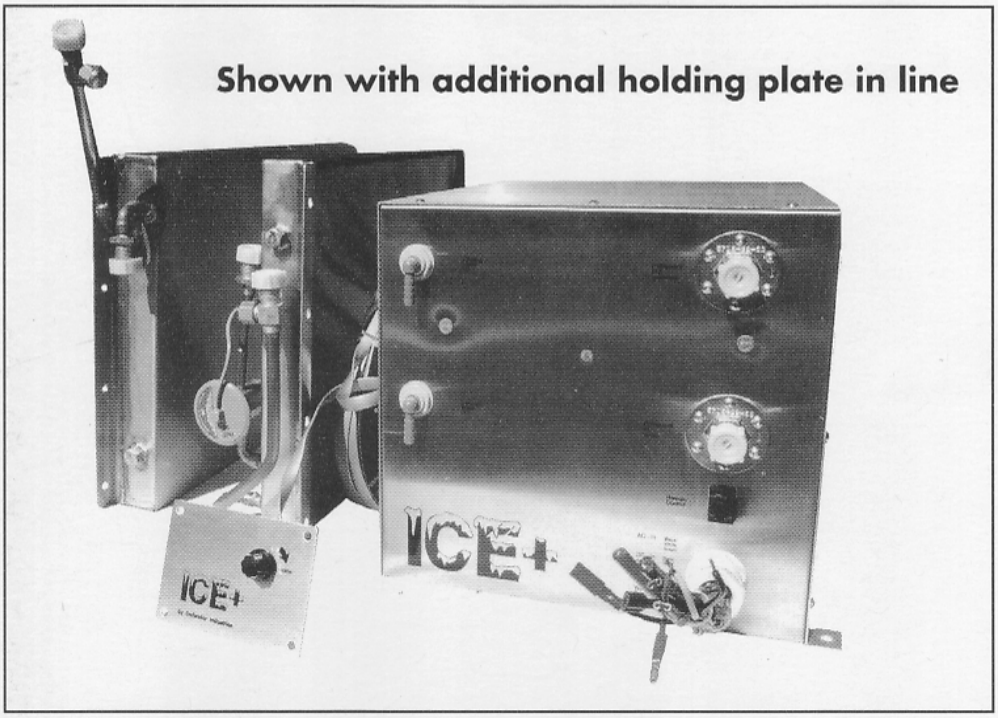
Can I cool a freezer and refrigerator off one compressor?

Yes. There are two ways to accomplish separate refrigerator and freezer compartments.

One way, commonly called a "spill-over" configuration, locates all holding plates in the freezer compartment. The divider between the two compartments has a hole which allows cold air to spill-over into the refrigerator. Temperature control of the refrigerator is accomplished by sliding a shutter to adjust the size of the hole until the correct temperature is achieved. One common misconception is that spill-over systems require fewer holding plates since no plate is used in the refrigerator. However, it will be necessary to add extra plate(s) to the freezer compartment to accommodate the additional heat load.

A second, and we feel better, way to refrigerate one compartment and freeze the other is to use separate refrigerator and freezer plates in each compartment and totally insulate the dividing wall in between. Once the appropriate number of plates for each box is determined, the liquid (discharge) line from the ICE+ compressor unit is connected into the freezer first. The second freezer plate (if any) and refrigerator plate(s) are then connected in series.

In both cases temperature regulation of the freezer compartment determines compressor run cycles. The refrigerator temperature is regulated indirectly by careful and appropriate sizing of the refrigerator plate.



Marine Marketing Media

What is needed to set up the water cooling system?

Nothing more than what comes in the ICE+ installation kit plus good sense and some basic knowledge! A 50 mesh strainer in the raw water line is required (not included but available) to keep the system clean of debris. Both the compressor and water pump have a water intake of 1/4" ID (internal diameter). Since many such strainers require a 1/2" tube, we offer an optional step-down kit to accomodate this situation. Usually two kits are needed along with an appropriate length of 1/4" ID heavy wall vinyl tubing (not included but available) to complete the connection to the compressor.

How do I begin the design process of my marine refrigeration system?

You have already taken one of the biggest steps: learning how and why systems work the way they do. The second step is to complete the brief evaluation form in this publication and, along with a sketch of your boat's layout, send it to us. We can then calculate the number of plates, additional line sets, control panels , etc., for your ICE+ system.