Frigoboat

Marine Refrigeration Systems

Installation & Instruction Manual

For All Models

Air Cooled, Pumped-Water Cooled, Keel Cooled

(Systems using Danfoss BD 35 or BD 50 compressors)

It is important to read this manual thoroughly before installing a Frigoboat system.

Veco NA, LLC
PO Box 3518
Annapolis MD 21403
301.352.6962

info@frigoboat.com

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Chapter 1

Frigoboat systems

A Frigoboat system consists of the following components:

(1) A compressor/condensing unit that is either:

Air cooled – Paris 35F, Capri 35F, Capri 50F
Pumped-water cooled – W35F, W50F (with pump)
Keel cooled – K35F, K50F (with keel cooler)

(2) An electronic controller connected to and installed on the compressor. AEO version installed where designated

(3) Either a mechanical thermostat for refrigerator or freezer, or a Coastal or Carel digital thermostat/thermometer

(4) A Smart Speed Control (SSC) (Optional)

(5) An aluminum or stainless steel evaporator plate

(6) A water pump (For W35F or W50F only)

(7) A Keel Cooler. Standard with K35F and K50F models, optional with Capri 50F

APPLICATION

Frigoboat refrigeration systems are designed to preserve foodstuffs at normal refrigerator or freezer temperatures. Any use other than specified above invalidates the warranty and releases Veco NA of any liability for consequent damage, failure, malfunction, injury, or death.

Chapter 2

Paris 35F, Capri 35F, Capri 50F - Air cooled

These units are designed to be mounted with compressor right way up on a horizontal surface in areas where they will not be susceptible to physical or water damage, but accessible for service. They require good ventilation, preferably expelling the heated air to another location by attaching a flexible duct of not more than 6' in length to the duct ring on the unit. A duct kit is available for Capri 35 and Capri 50 models.

If air is required to be drawn into the unit from another area, the fan may be reversed by removing the housing and re-mounting the fan in the opposite orientation. **Reversing the fan leads does not make the fan run in reverse and the incorrect polarity will result in the fan not operating.**

There should be adequate ventilation to allow cool air to enter the condenser, but not so that the heated expelled air can be drawn back in. The temperature of the air entering the condenser determines the efficiency of the system. Re-circulating the heated air back into the condenser in a sealed or poorly ventilated cabinet will result in poor system performance. Poor system performance will also result from air being drawn in from a heated space, i.e. an engine room.

Chapter 3

W35F, W50F - Water cooled with pump

This unit must be mounted with compressor right way up on a horizontal surface in an area where it will not be susceptible to physical or water damage, but accessible for service. Consideration should be given for access to the hose and refrigerant line connections. A mounting kit is supplied with the compressor that includes rubber mounts and steel inserts. The unit may be screwed or bolted down using the supplied white, plastic washers, if desired. If a Bulkhead Bracket (PN E52135) is used, remove the stainless steel mounts from the compressor.

3:1 Raw water pump

The pump supplied by Frigoboat is self-priming and requires a good intake strainer of 120 mesh. Other pumps of similar performance may be used.

After installation, check for leaks and a water flow of at least 1 gal/min. The pump power must be supplied through a 12v relay whose coil is connected to the fan terminals. The fan terminals on the module are limited to a current draw of 0.7 amps and will deliver 12v even if the system is connected to a 24v supply. Full wiring instructions are included with the compressor.

Chapter 4

K35F, K50F - Water cooled with Keel Cooler

The compressor unit must be mounted with compressor right way up on a horizontal surface in an area where it will not be susceptible to physical or water damage, but accessible for service. **Consideration must be given to the fact that the compressor must be mounted within 5' of the Keel Cooler.** This dimension cannot be extended.

A mounting kit is supplied with the compressor that includes rubber mounts and steel inserts. The unit may be either screwed or bolted down using the supplied white, plastic washers, if desired. If a Bulkhead Bracket (PN E52135) is used, remove the stainless steel mounts from the compressor.

4:1 Keel Cooler

This must be mounted through the hull by drilling a 1 9/16" (40mm) hole (a 1.5" hole may be used, carefully enlarging it, if necessary). Make a dry run(s) without the rubber O-ring and sealant installed, making sure that the keel cooler fits up flush with the hull, chamfering the hole if necessary. **The rubber O-ring must then be installed and properly seated**. Adequate sealant of the correct type must be used, and a bead applied to the area between the O-ring and the shaft of the Keel Cooler is all that is normally required. The compressing of the rubber O-ring will serve to force sealant into any voids around the shaft as the fitting is tightened. Consult your local marine store if you are uncertain of which sealant to use. With the sintered “Ground Plate” models, a dab of sealant should also be applied to the fore and aft ends of the Keel Cooler where it meets the hull to secure its orientation. If installing the “Bare Bones” model, an adequate amount of sealer should be applied under the end fairing cap before the cap is secured to the hull with screws.

If you are installing the stud-type of Keel Cooler (as opposed to the thread-type, which has a large nut as the method of tightening), care should be taken not to over-tighten the nuts on the studs, which could bend the compression bar. If you are installing the thread-type you will need someone to hold the Keel Cooler while you tighten the nut. **The mounting location should be carefully chosen, avoiding areas where lifting slings may be applied or where other damage may occur.**

Consideration should be given to the fact that the Keel Cooler must be below the water-line, and the compressor unit must be mounted within 5' of the Keel Cooler location. On power boats it may be possible to mount the Keel Cooler in a vertical orientation on a section of the transom that is below the waterline when at rest. Keep the two tubes from the Keel Cooler separate and do not insulate them.

Special constraints and working practices apply when installing the keel cooler on a vessel with a cored, metal, or carbon fiber hull. For these applications we suggest you consult a marine professional.

4:2 Grounding and cleaning

Provision is provided for a grounding/bonding wire to be attached. **It is very important that the Keel Cooler is electrically connected to a point that is at the same potential as the battery negative, with no switch in the circuit between the Keel Cooler connection and the battery negative**.

If the Keel Cooler being installed is the type without zincs, it must also be connected to the vessel's bonding system and a sacrificial zinc anode. This is an important safety precaution and does not alter the fact that a connection must be made between the Keel Cooler and a point that is at the same potential as the battery negative post, whether the Keel Cooler has zincs or not.

If the installer is in any doubt as to how to make the grounding/bonding connections, a marine electrical technician should be consulted.

The connections must be checked with a multi-meter after installation to ensure that Keel Cooler and the battery negative post are at the same potential.

The sintered "Ground Plate" Keel Cooler should not be painted unless heavy and consistent fouling proves to be an issue. Clean occasionally with a brush, never with a metal scraper. All models of Keel Cooler must be inspected periodically for corrosion.

Chapter 5

Danfoss Electronic Controller for Frigoboat systems

The Danfoss Electronic Controller is an integral part of the Danfoss BD compressor system. It transforms direct current power from the vessel's batteries into modified alternating current to run the compressor. **Never attempt to run the compressor directly from the batteries or other power source.**

5:1 Voltage

A supply voltage of either 12 or 24 volts dc is required. The controller will run from either voltage without any special settings or adjustments, switching automatically to 24v mode if the voltage is above 17v.

5:2 Multi-speed compressor

Depending on the system, up to six automatic or user-selectable compressor speeds between 2000 RPM and 3500 RPM are available for maximum system performance at the lowest current draw. The Paris 35F has no speed control, running at 2000 RPM. The W50F has manually adjustable speed capability. Models designated "SSC" have automatic speed control via the Smart Speed Control, plus manual speed setting capability. AEO models have fully automatic speed control from "Adaptive Energy Optimizer" routine.

5:3 Safeguards
Protection is provided for the following:

(1) **Low voltage.** To prevent the batteries from being totally discharged, the compressor will be stopped if the voltage at the terminals on the controller falls below 10.6 volts (23.4 on a 24v system). It will not re-start until the voltage rises above 11.7 volts (24.0 on a 24v system).

(2) **High voltage.** If the voltage exceeds 17v, the controller stops the compressor and switches into 24v mode, but will not attempt to start the compressor until the voltage reaches 24v.

(3) **Compressor non-start.** If the compressor does not start, the controller will stop the starting process and attempt a re-start approximately every 45-90 seconds.

(4) **Compressor speed too low.** If the compressor speed falls below 1900 RPM the controller will stop the compressor.

(5) **Fan (and pump) protection.** If the current draw across the fan terminals exceeds 0.7 amps at 12v dc, the compressor will be stopped and a re-start attempted every 45-90 seconds.

(6) **Module overheat.** If the heat sink on the controller exceeds a preset temperature, the compressor will be stopped and will be re-started when normal operating temperatures are resumed.

5:4 Alarm Indicator
A 12v LED may be installed across the "+" and "D" terminals of the controller to indicate a failure condition. Models designated “SSC” have this LED on the display panel of the Smart Speed Control.

Under a fault condition, the compressor will be stopped and an attempted restart will be made approximately every 45 -90 seconds. Under this condition the LCD will blink between 1 and five times every 5 seconds, as follows:

1 Blink:	Supply voltage low, below 10.6v on a 12v system, 23.4v on a 24v system
2 Blinks:	Excessive load on fan terminals, above 0.7 amps
3 Blinks:	Compressor non-start (Common occurrence, and normal when compressor stopped and started again too quickly)
4 Blinks:	Compressor speed below 1900 RPM
5 Blinks:	Controller heat-sink temp too high. Re-sets on cool-down

Note 1
After power is applied to the controller there may be a delay of up to 30 seconds before the compressor starts.

Note 2
The electronic controller, although designed for harsh and marine applications, can be damaged by either direct or incidental contact with water and by water flowing down wires attached to the terminals.

When attaching wires to the terminals on the controller, make sure that all wires approach from below the terminal, and endeavor to mount the compressor and controller combination in a location that is clear of existing and potential water leaks.

Chapter 6

Aluminum H-, F- and B-Type Evaporators
(Horizontal, Flat, Bin Type)

6:1 Location
All types of evaporator need to be located as high as possible in the icebox to maintain the correct temperatures, with consideration being given to access to the interior freezing section in the H and B-type. **Special attention must be given to the fact that air flow must be allowed to circulate to the rear of the evaporator plate.** This includes leaving a gap of approximately 1" between the top of the plate and the roof of the box, and similar spacing at the bottom. In conjunction with this, it is important that the spacers provided be used to offset the evaporator on all points from the icebox wall. Additional spacers may be fashioned from wood, hose, or similar material, if required.

The H- and B-types may be mounted in any position. The F-type **must** be mounted with the indicator arrows pointing upwards, on a vertical wall, and with the refrigerant channels running in a horizontal orientation.

6:2 Bending Instructions for flat plates:
The F-type of flat evaporators may be carefully bent on a minimum 1.25" radius to follow the shape of the icebox. This is best done by holding a section of suitably padded PVC pipe (with an outside diameter of 2.5" or greater) firmly down on the plate, and then carefully bending the section upwards with the palm of your hand. The stainless steel plates need more force to bend and may require the assistance of a second person. This must be done slowly and with great care to avoid excessive kinking of the channels in the evaporator. Never attempt to bend a plate downwards over a pipe as damage may result. The area to be bent should be warmed with a hair dryer or heat gun to approximately 200°F before bending to prevent the paint from cracking. There are sections that must not be bent, and these are indicated on the specification sheet.

6:2 Installation
All evaporators have approximately 9' of copper tubing attached, **with dust-plugs in the end fittings that must remain installed until the very last moment when the connections are ready to be made.** A 1.5" hole needs be drilled in the wall of the icebox, as high as possible, and through successive bulkheads, as required. Carefully unroll the tubing, feeding it through the holes to the area where the compressor/condenser is located. Any bends that need to be fashioned in the tubing must be made carefully with as large a radius as possible to avoid kinking. Excess tubing should be carefully coiled up **outside of the box** and fastened out of the way in a horizontal orientation. One tube is made intentionally longer than the other to enable as small a hole as possible to be made in the box wall, bulkheads, etc. and this allows the couplings to be fed through one after the other. When the tubing run is complete, carefully fashion the longer tube so that the two halves of the coupling can be easily connected. Some evaporators have fragile sections of aluminum tubing close to the body of the evaporator that must be handled very carefully. Warnings to that effect are attached to the evaporators in question.

The section of foam insulation that is free to slide on the tubing should be positioned **starting at the point where the tubing exits the icebox.** It is neither necessary nor desirable to add more insulation to the tubing, as any sweating or ice formation seen on the exposed section of tubing indicates an overcharged condition and needs to be remedied.

Once the evaporator is installed, the exit hole in the box must be sealed with expanding foam, refrigeration putty, or other suitable material. Make sure that any drains are plugged and that there are no other holes or gaps through which warm, moist air can enter the box.

If the tubing is too short to reach the compressor/condensing unit, pre-charged extensions are available in 3 ft, 6 ft, and 10 ft lengths.

6:3 Mechanical thermostat sensing tube attachment

Check to see how you need to attach the thermostat sensing tube before mounting the evaporator. Instructions are included with the evaporator showing how the last 3" or so of the sensing tube must be bent into a "U" shape, the clamping screw loosened, and the tube inserted under the plastic plate so that it lays in the special grooves of the plate. Finish by tightening the clamping screw.

If using the Coastal or Carel digital thermostat, the sensor mounts on the icebox wall, **not on the evaporator**. Full instructions are included with the Coastal and Carel thermostats.

6:4 Mounting

H- and B-type evaporator plates can be mounted in any position.

To mount the H-type horizontally, drill four mounting holes in the roof of the icebox. Start two screws in the rear holes. Slide the mounting slots of the evaporator over the screws, then insert and tighten the two front screws. Finish by tightening the two rear screws.

The B-type can be mounted by using the row of holes along the top rear face of the evaporator. There is a Lid Kit (PN E52095) for the 340B evaporator to facilitate horizontal mounting.

The F-type has numerous mounting holes along the top and bottom edges.

Do not attempt to cut, trim, or drill holes in any evaporator for any purpose. Holes may be drilled in the base of B-type evaporators, as this is a separate piece of aluminum.

Always use the mounting spacers supplied to protect the tubing and to provide adequate air circulation. Additional spacers may be fashioned from hose or similar material, if required.

Chapter 7

Mechanical thermostat for H-, B-, and F-evaporators

(See separate instruction sheets for Coastal and Carel digital thermostat)

7:1 Refrigerator & Freezer thermostats

There are two different thermostats for different applications. The refrigerator version is mounted in a white housing and is designed to be used where the evaporator is mounted in an icebox that is intended to be kept at refrigerator temperatures. If the evaporator is of the H- or B-type and is correctly sized, refrigerator mechanical thermostat is used and the interior portion of these evaporators will be kept at freezer temperatures.

The freezer version is mounted in a blue housing and must be used where the evaporator is mounted in a space that is to be used as a freezer.

If an existing icebox is divided with an insulated barrier, a spillover system can be employed whereby the evaporator is mounted in the freezer compartment, and a thermostatically controlled fan used to keep the refrigerator section at the desired temperature. Instructions are included with the fan.

7:2 Mounting

The mechanical thermostat can be mounted either inside the icebox, or in an alternative location that is within the scope of the sensing tube. If the thermostat is mounted inside the box make sure that liquids or condensation cannot flow down the shaft and into the mechanism by positioning the housing so that the shaft exits either on the bottom or the side. The capillary tube controls the thermostat by the pressure of the gas it contains and must not be kinked, broken, or cut. Any excess tubing may be carefully coiled up and secured out of the way to avoid damage.

When securing the sensing tube, make sure that it only makes contact with the evaporator at the point where it is attached under the plastic mounting plate and that it does not touch any part of the aluminum or copper tubing. If necessary, the tube can be protected with small-bore plastic tubing, either by sliding it on prior to attaching the tube to the evaporator or by slitting it along its length and feeding it over the sensing tube. Run the cable together with the copper lines to the compressor /condensing unit. Care must be taken to ensure that the sensing tube does not come into contact with any electrical component either inside or outside the icebox. There is an insulating cover over the most exposed wire terminal and connector inside the plastic thermostat housing. An inspection must be made before mounting, to make sure that the entire terminal and connector is covered and that no metal parts are exposed. It must be confirmed, before mounting the thermostat, that the capillary tube is not in contact with any wire terminal, connector, or bare wire. If the sensing tube needs to be bent within the confines of the plastic thermostat housing, it must be done with great care, heeding the warnings above.

7:3 Operation
The thermostat knob is marked from 0 to 7 with 7 being the coldest setting. From this position the knob can be rotated counter-clockwise to setting 1, which is the warmest. On initial system start-up, it is recommended that you set the thermostat to number 4, letting the system run through a few cycles while monitoring box temperature before any adjustments are made. Once the right setting is found for your application there should be no need for the thermostat to be adjusted again.

The system should not be turned off and on from the thermostat. To turn the system off and on, use a panel-mounted breaker or install a switch in line with the power supply.

Chapter 7a

Spillover Installation Instructions

7a:1 Mounting
The Spillover Kit (with integral mechanical thermostat) should be installed on the barrier dividing the freezer and refrigerator sections, on the refrigerator side, about mid-height. Screws may be used after drilling holes in the plastic flange.

A 2.25" diameter hole needs to be cut through the barrier to allow air to flow to the fan; a piece of PVC pipe can be used for this purpose. This will also make a neat finish while sealing the hole from the ingress of moisture. The hole may be directly behind the evaporator in the freezer section, and this will not be detrimental to performance. If the stand-alone Spillover Fan is used, in conjunction with a Coastal or Carel digital thermostat, the Spillover Fan may be surface-mounted, or installed within the barrier.

A return air path must be established at the top of the barrier to allow air back into the freezer. This can either be in the form of a gap at the top of the barrier (1" should be sufficient) or 3 or more holes of the same size as the one behind the spillover fan. All other holes, gaps, etc, must be completely sealed, including drains.

7a:2 Electrical Connections
The Spillover Kit (with integral mechanical thermostat) must be powered by an independent 12v supply. This may be from a breaker on the electrical panel or via an in-line 2 amp fuse from the same supply that is feeding the refrigeration system. Do not power the Spillover Kit from the fan terminals on the controller. If using the stand-alone Spillover Fan and Coastal or Carel digital thermostat, refer to wiring diagrams included with these products.

7a:3 Operation
The temperature dial of the Spillover Kit must be set to the desired temperature in the refrigerator compartment. This may take some trial and error before the ideal temperature is achieved. A period of at least one day is suggested between changes in settings. The temperature dial is in degrees Celsius and the setting is read against an indent in the plastic housing at the six o-clock position, above the Frigoboat sticker. A setting of 5 is suggested initially and then adjusted accordingly as desired.

Chapter 9

Quick Connect Refrigerant Fittings

Each component of a Frigoboat system is fitted with one male and one female proprietary Quick Connect fitting that connects to a corresponding fitting on other components of the system. The Keel Cooler systems are comprised of three components, and special attention is required to avoid incorrect connections. The refrigerant tubes are color coded with red, yellow, and blue tape, and matching the colored tags will ensure correct connections. (The red plastic tubing on the Keel Cooler is to be considered as red tape). If a Keel Cooler is to be connected to a Capri air cooled condensing system in place of a K35 or K50, match the blue tagged couplings, then connect the red tagged tube on the Capri to the yellow tagged tube on the Keel Cooler. Finally, connect the red plastic covered tube from the Keel Cooler to the red tagged tube on the evaporator. All other air and water cooled systems have only two components, each with a male plus a female fitting, and therefore they cannot be connected incorrectly.

The individual items are pre-charged with the correct amount of refrigerant at the factory. When the Quick Connect fittings are joined together, they allow the refrigerant to flow through the system without leaking out into the atmosphere**. If needed, they can be uncoupled without loss of refrigerant** in order to re-run refrigerant lines, upgrade components or enable a faulty component to be removed and replaced. When they are uncoupled, immediately install dust plugs, (removed when originally installed and kept in a safe place) into the exposed female/male fittings.

Note: Never run compressor unless all components of system are correctly connected together.

9:1 Connecting the Quick Connect fittings

Leave the dust plugs installed until the very last moment when you are ready to connect the system together. Once the dust caps have been removed, it is imperative that the now exposed components and surfaces be kept free of dust, dirt, construction debris, etc. After you have removed the plugs, keep them in a safe place in case you need to remove or replace a component later.

Push the male and female fittings together and then carefully rotate the collar on the female fitting until it starts to thread onto the male thread, making sure that the fitting is not cross-threaded, the male end does not rotate, and the O-ring remains seated in its grove. Do not use any thread sealant or tape.

Continue rotating the collar of the female end, either by hand or with a 15/16" wrench, while preventing the male end from rotating by restraining it with a 13/16" wrench**. It is most important not to let the male end rotate at all during this whole process.**

Tighten the collar until it completely covers the threads on the male fitting and then “snug” with wrenches. Excessive tightening is not required as the O-ring makes the seal and making up the threads simply opens the internal valves and allows refrigerant to flow.

If there is a continuous hiss after the connection has been completed, quickly disconnect the fitting and check that the O-ring has not been damaged. If it has, carefully replace it with one of the spares provided that are taped to the compressor, and then re-make the fitting.

Chapter 10

Electrical

10:1 Power supply
The power supply to the electronic controller must be given particular attention to prevent nuisance problems and compressor non-operation, shutdown, or failure. All electrical connections should be either soldered or made with good quality crimpers and crimp connectors of the correct size and type. All switches, breakers, and connections must be in good condition and be designed and constructed for marine use. It is suggested that during the initial start-up the supply voltage be monitored at the terminals on the controller before, during, and after the compressor starts, to ensure that the voltage stays steady and does not fall appreciably. This test should be conducted with as many other DC loads turned on as is practical.

10:2 Wire size
Never use less than 10 gauge wire. If the sum of positive and negative cable lengths exceeds 30 feet, consult ABYC tables for appropriate wire size for 3% volt drop.

10:3 Overload protection
Use either a breaker or fast-blow fuse with **15 amp rating** for a 12v supply, or 7.5 amp for 24v.

10:4 Connections, power
Connect the power supply to the controller on the top two terminals, observing the correct polarity. Reversing the polarity at the terminals will prevent the compressor from running, but should not cause immediate harm to the controller if the correct fuse or breaker is installed.

10:5 Connections, mechanical thermostat
Connect the two slip-on connectors from the thermostat to the "C" and "T" terminals on the controller, color and polarity are not important.

On some models there is a speed selector board mounted on the lower terminals of the controller, and the "C" and "T" terminals are replicated on this board. The speed must be set to a speed specified for the system and size of evaporator, as outlined below, and the voltage switch set accordingly.

See separate instructions for systems using the Smart Speed Control (SSC) and the Coastal and Carel digital thermostats.

- Paris and "AEO" models
  These systems have no speed selection capability. The thermostat must be connected to terminals C and T on the controller.

- W35F and W50F
  The thermostat wires must be connected with one wire to the "T" terminal on the speed selection board of the controller, and the other to the vacant terminal of the high temperature cut-out on the condensing coil. There is a factory installed white wire connecting the "C" terminal to the other terminal on the high temperature cut-out.

Evaporator type	Compressor speed, refer	Compressor speed, freezer
80F	2000	----------
130H / 130F	2500	3000
160H / 160F / 180F-SS	2500	3500
200H / 200B / 200F/ 250B	3000	3500
340B/ 380F-SS	3500	3500

10:6 Connections, Fan
The wires from the fan on air cooled condensing units will be factory installed on the terminals marked “F” (Black or Blue), and “C” (Red). If the wires are reversed the fan will not run. The K50F and W50F models have a small oil cooler fan installed. On the W35F and W50F extra terminals are provided for the pump relay. Full instructions are included with the W35F and W50F.

10:7 Connections, Pump
The W35F and W50F model use a 12v pump that must be connected through a relay (PN E251002) that is activated from the fan terminals on the controller. If two or three W35F/W50F units are to share one pump, a Pump Interface (PN E51385) should be used. Full wiring instructions are included with the Pump Interface.

It is important to remember that the output voltage at the fan terminals will be 12v even if the supply to the controller is 24v, so a relay with a 12v coil must always be used.

The W35F and W50F have temperature sensors on the water cooled heat exchanger that is connected in series with the thermostat and will stop the system if the cooling water flow is insufficient. Full wiring instructions are included with the system.

Chapter 11

Troubleshooting Guide

Note (1) **Do not inject anything but unadulterated refrigerant R134a into this system. The addition of even a small amount of refrigerant oil, leak detecting fluid, "conditioner" or other substances may cause irreversible damage.**

(2) Voltage must be checked at the power terminals on the controller, with the supply wires attached.

(3) Start-up may occur up to one minute after power is supplied and thermostat is on. This will also occur after a fault condition has been cleared.

(4) Run **all** applicable tests before assuming controller or compressor to be faulty.

11:1 Compressor not running, no start attempt

	Probable cause	Action
1	Supply voltage too low	Check voltage with a multi-meter at the terminals on the controller. This must be 11.7v or more for a 12v supply, 24v or more for a 24v supply. Inspect power supply, ground connections and components for integrity. Check wire sizing. Charge batteries, if necessary.
2	Supply voltage too high	If a 12v supply is faulty and delivers over 17v, the compressor will not run. If it is over 24v, it will assume that it is a 24v supply and act accordingly.
3	Polarity incorrect	Check that the polarity is correct at the controller.
4	Faulty thermostat	Remove the thermostat wires and bridge the terminals that they were on. If the system then runs, make the connection permanent and control the system manually from the breaker on your supply panel. Replace thermostat as soon as possible.
5	Thermostat wired incorrectly, or faulty connections	Refer to the installation instructions to confirm that connections are as they should be. Ensure that the thermostat connectors are pushed firmly on to the terminals on the Controller.
6	Multi-speed board incorrectly installed (if fitted)	Check to make sure that the two connectors at the rear of the multi-speed board are attached to the C and T terminals of the controller.

	Probable cause	Action
7	Multi-speed board faulty (if fitted)	Remove board and jumper terminals C and T on the controller. Note: If the thermostat wires are connected directly to C and T on the controller, the compressor will run at its slowest speed.
8	Compressor plug not connected	Disconnect the controller by removing the retaining screw. Then ensure that the 3-pin plug is seated firmly on the pins of the compressor.
9	Faulty compressor	Remove the controller as above, unplug from the compressor. Check that ohm readings are the same across all terminals of the compressor. Do not attempt to connect power directly to compressor.
10	Heat sink overheated	Allow components to cool down before attempting re-start.
11	Compressor too cold	If compressor is below freezing temperature, allow to warm up before attempting re-start.

11:2 Compressor attempts to start, or starts then stops soon after.

	Probable cause	Action
1	Faulty or inadequate power supply	Monitor the supply voltage at the power terminals on the controller before, during, and after start attempts to ensure that it does not fall below threshold levels. If it does, check power supply, ground connections, and components for integrity. Check for correct wire sizing. Charge batteries, if necessary.
2	Faulty fan or pump relay or unauthorized component installed	Remove connectors from F and + terminals on controller and attempt re-start. Maximum current draw on these terminals is limited to 0.7 amps at 12v.
3	Quick Connect fittings not made	Check that all refrigerant fittings are properly connected.

11:3 System runs, box temperature too high.

	Probable cause	Action
1	Thermostat setting	Rotate mechanical thermostat knob clockwise to a higher number or adjust set point on Carel model.
2	Speed setting	Check that thermostat leads are connected to the speed setting recommended for the installed evaporator and for its intended use, i.e. refrigerator or freezer.
3	Thermostat type	If planning to convert icebox into freezer, or into a spillover system, a freezer thermostat (blue housing) must be used.

4	Evaporator type and size	If the evaporator has an even coating of frost, thermostat set on 7, and system is not cycling, evaporator may be too small. Either replace evaporator with a larger model, add insulation to the bottom of the box to reduce volume, or re-locate evaporator lower in box. The latter will probably cause the temperature at top of the box to be above acceptable levels.
5	Excessive frost build-up	If an excessive layer of frost is allowed to build up on the evaporator it will act as an insulator and adversely affect box temperatures. Defrost system by interrupting power supply at the breaker panel. Restore power when evaporator is free of frost. Never use any implement in an attempt to loosen the frost on the aluminum evaporator. Check that all drains are blocked and there are no other openings or gaps that will allow air to enter or leak from the box.
6	Incorrect refrigerant charge	If, after the compressor has been running for an appreciable length of time, the evaporator surface does not have an even coating of frost, or it is only cold and sweating to the touch, the system may be low on refrigerant or overcharged. Call Veco NA for advice or go to www.frigoboat.com "Technical Assistance".
7	Drain left unplugged	If your icebox is equipped with a drain in the bottom of the box, it is suggested that you block it off to prevent loss of cold air. The drain should only be used if you revert to melting ice, or after a major clean-up.
8	Tubing hole left unplugged	The hole that was drilled to allow the evaporator's copper tubes to pass through the box's side during installation must be sealed, as well as all other openings or gaps.

11:4 System runs, box temperature too low.

	Probable cause	Action
1	Thermostat setting	Rotate mechanical thermostat knob counter clockwise to a lower number or adjust-set point on Carel model.
2	Thermostat type	Check that you are using a refrigerator thermostat (white housing) for a refrigerator application.
3	Faulty thermostat	If system is running continuously and box temperatures are too low with thermostat set on the lowest number, first check for correct thermostat connections at the controller, then remove one connection. If compressor stops, turn off breaker, replace connection, and then control system manually from the breaker until the thermostat can be replaced.

4	Holding plate over-sized	If you are using a holding plate evaporator that is over-sized for the application, it will absorb more heat than enters the box through the insulation, and therefore lowers the temperature. Experiment by covering some of the plate surface with insulating material until you achieve correct box temperatures. This method will also increase hold-over times.
5	Poor spillover system construction	If you are running the evaporator as a freezer and cooling an adjoining refrigerator compartment with spillover air, there must be an adequate thermal barrier between the two. It also must be completely sealed down the sides and along the bottom to prevent unwanted air-flow. Temperatures in the refrigerator side should be controlled either with trial-and-error convection holes, or a thermostatically controlled fan, (Spillover Fan/Thermostat Kit, PN E26200). Two apertures are necessary, one high and one mid-height for adequate air circulation.

11:5 Excessive frost build-up

Note This is the result of moist air being allowed to enter the box. Problems are compounded when cold, dense air leaks from the lower area of the box through an open drain or door seal and is replaced by warm, humid air being drawn in elsewhere.

	Probable cause	Action
1	Drains and holes not plugged	Make sure all drains and holes in the floor and walls of the box are sealed.
2	Circulating fan	If a small fan is used to circulate air in the box, make sure that the cold air is not being blown towards and out of a door/lid seal. This could force cold air out of the box and set up a circulation pattern if the seals are leaking
3	Poor or damaged door/lid seals	Check seals and replace if necessary. A good seal will grip a $1 bill when inserted between the seal and door/lid when closed. A front opening door/top opening lid combination with poor seals is likely to result in excessive frost build-up on the evaporator and cause extended run times.

Limited Warranty Policy

Veco NA, LLC (Company) warrants that if any part of a new system that includes the accompanying product proves to be defective to the original user in material or workmanship within the limits of the schedule below, the company will, at the company's option, either replace or repair that part without charge.

Compressor (excluding Controller): ..... 5 years from date of purchase
Electronic components: ..... 2 years from date of purchase
Mechanical components: ..... 1 year from date of purchase

Note - Items sold individually, i.e. not as part of a complete system, carry a one year warranty only.
- Items replaced or repaired under warranty are covered only for the remainder of the term of the original warranty.

This warranty does not cover:

- Any field labor or other costs for inspection, testing, removal, transportation, or installation of any component unless pre-authorized by the Company and issuance of a Work Order number
- Damage, failure, or malfunction due to, or arising from, improper, faulty, or unapproved installation, servicing, and/or application, and from failing to follow the guidelines included with the equipment and in the Installation & Instruction Manual.
- Any component of a system that is not comprised solely of Frigoboat supplied refrigeration parts.
- Damage, failure, or malfunction resulting from accident, misuse, abuse, neglect, mishandling, alteration, modification, Acts of God, or service by personnel other than those pre-authorized by the Company.
- Damage, failure, or malfunction resulting from inadequate or faulty power supply to the system, or improper, faulty, or unsafe vessel wiring.
- **Damage, failure, or malfunction due to foreign substances being injected into the system, including, but not limited to, additional refrigerant oil and/or leak detecting liquid.**

No responsibility is assumed for any special, incidental, or consequential damages.

Note Some states do not allow the exclusion or limitation of incidental or consequential damages so the above exclusion or limitation may not apply.

In the event of a component failure or malfunction in North America or the Caribbean, please contact Veco NA, LLC at 301 352 6962. If requested, return faulty part, freight pre-paid, together with proof of purchase. No returns will be accepted without prior authorization and the issuance of an RMA number by Veco NA. Damage due to shipping is not covered in this warranty and so it is suggested that you insure the shipment. If the part(s) is found to be defective due to faulty materials or workmanship, it will be repaired or replaced free of charge and returned freight pre-paid.

If warranty service is required in areas other than North America and the Caribbean, please visit the manufacturer’s web site at www.veco.net.