


OTCW

For Chilled Water
Air Conditioning Systems

OPERATOR'S MANUAL

Technicold Marine Systems | www.technicold.com

TECHNICOLD
by NORTHERN LIGHTS





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OPERATOR'S MANUAL
for Chilled Water Air Conditioning

Read this operator's manual thoroughly before starting to operate your equipment.
This manual contains information you will need to run and service your new unit.

Table of Contents

Litho U.S.A. Publication number OTCW 4/11

SAFETY

General Overview

The installed Technicold equipment may be one component or a built-up system comprising of multiple components. The equipment can present a hazard due to pressures, temperatures, chemicals, weight and mass, moving parts, electrical components, and sharp or extruded edges. Only qualified service personnel are to install, service or repair this equipment.

Technicold products are designed to be as safe as possible, and for the owner to be able to perform most maintenance tasks. Nonetheless, some items require special equipment and knowledge. A qualified service company should be hired to perform specialized maintenance tasks. Most service companies also offer maintenance scheduling for routine maintenance in addition to seasonal or annual maintenance checks.

- Follow all safety instructions, regulations and signage on the equipment, in the manuals, on labels and tags.
- Also use appropriate safety equipment.
- Use the correct tools for the task.
- Never work alone.
- Never attempt a task that exceeds your technical or physical capabilities.

HAZARDS

Chemical Burns

Chemicals used for cleaning internal and external components may cause a chemical burn if they make contact with the skin. Follow product manufacturers' instructions for use and application of the product. Read all safety and first aid instructions prior to using any chemicals. Use protective clothing and equipment to avoid skin contact. If contact should occur, follow the first aid instructions provided by the product manufacturer. If first aid information is not available, seek medical attention immediately.

Chemicals used for cleaning can also cause damage to surrounding surfaces. Always protect surrounding areas when using active chemicals.

To prevent accidental contact and injury do not transfer chemicals into unlabeled containers.

Do not apply, mix or store chemicals using containers or equipment that is not compatible with the product used.

Dispose of spent or unused chemicals in a safe manner adhering to all regulations and guidelines.

Electrical Shock

Disconnect voltage to equipment before opening any electrical panel or cover. Some equipment may have two power sources; in this case, make sure both are turned off.

Tag, remove or lock-out any breaker, switch, fuse or disconnect that can be energized without the knowledge of the user during service.

All electrical or electronic equipment should be adequately grounded. All ground wires should be point-to-point and not "daisy chained". Ground wire connections should be tight on the posts/lugs for maximum safety and to prevent electrical noise.

Ground wires should be of the correct gauge to protect the operator and equipment.

Fire

Electric motors and heaters have internal and/or external thermal protection. Never operate the equipment with the thermal protective devices by-passed as this can create a fire hazard. The thermal protection device should be by-passed for troubleshooting purposes only. Upon completion of troubleshooting, replace the defective device before the equipment is placed back into operation.

Loose electrical connections can cause overheating and burning of wires and components. High amperage wires are especially susceptible to loosening; this is due to the heating and cooling of the wires and terminations when current flows and stops. Periodically check electrical wiring terminations to ensure a tight connection. With the power off, check wires for discoloration, inflexibility or brittleness, as these can be an indication of overheated wires. Fix the problem by replacing the wires and/or terminations.

Flooding

In most air conditioning, chilled water, refrigeration and load bank applications, water is a cooling or heating media. Pipes and hoses transport the water throughout the boat to supply the equipment. Clamps, flanges or compression types connect the equipment, pumps, hoses, pipes and fittings. Should the integrity of these components fail, localized flooding can occur. Periodic inspections can minimize the risk by identifying small leaks, loose connections or deteriorated components allowing preventive measures.

Route the discharge hoses that connect to the pressure relief valves to a safe location. This will prevent damage to equipment or injury should they discharge.

Some equipment, such as air handlers, produces condensate. Periodically check pans and drains to ensure proper drainage.

HAZARDS

Refrigerant
Chillers, refrigeration systems and direct expansion systems may contain pressurized refrigerant in liquid and gas form. Refrigerant vapor reduces oxygen available for breathing, which can cause rapid suffocation. Inhalation or misuse of the product can cause serious personal injury or death. Refrigerate may decompose on flame or extremely hot surfaces to produce toxic or corrosive materials. Contact with liquid refrigerant to skin or eyes can cause irritation or frostbite.

Wear proper eye and hand protection when handling components that carry refrigerant. Refer to the manufacturers' instructions regarding transportation and storage of refrigerant cylinders.

By national and international law, only certified technicians can handle or work on refrigerants.

High Pressure
When operating, pumps can produce significant high pressure. Do not disconnect hoses or open the system when a pump in operation.

Refrigerant circuits are under high pressure even when the component is not in operation. Only qualified and certified personnel should connect any equipment or gauge-set to the refrigerant circuit.

Rotating Machinery
Equipment such as pumps and blowers contain rotating parts that can cause serious injury upon bodily contact. Always guard all moving parts to prevent incidental contact with fingers or foreign objects.

Wait for rotating parts to come to a complete stop after removing power. Even when de-energized other external forces can cause fan blades and pumps to rotate. Lock blower wheels and isolate water flow to pumps before working on equipment.

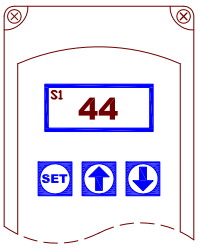
Never handle rotating equipment when connected to a power source.

Sharp Edges
Use caution and wear gloves when cleaning or installing equipment. Sharp edges can cause severe injuries.

TECHNICOLD TEMPERATURE CONTROL

Liquid Crystal Display (LCD)

The LCD display provides a constant readout of the sensor temperature if the control is energized. During the operation the S1 annunciator is constantly illuminated when the relay is energized. The display is also used in conjunction with the keypad to allow the user to adjust the setpoint temperature, differential and heating/cooling modes.



Control Setup

The temperature setpoint refers to the temperature at which the normally open (NO) contacts of the output relay will open. Determine the load(s) to be controlled and the operating mode required, cooling or heating (Figure 1). When the cooling mode is chosen, the differential is above the setpoint. The relay will de-energize as the temperature falls below the setpoint. When the heating mode is chosen, the differential is below the setpoint. The relay will de-energize as the temperature rises to the setpoint .

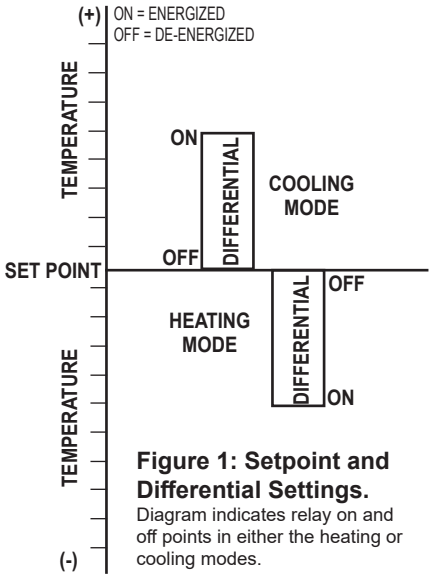


Figure 1: Setpoint and Differential Settings.
Diagram indicates relay on and off points in either the heating or cooling modes.

Programming Steps and Display

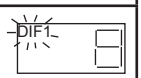
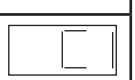
The Technicold Temperature Control (TTC) can be programmed in four simple steps using the LCD display and the three keys on the face of the control.

Step 1 - To start programming, press the **SET** key once to access the Fahrenheit/Celsius mode. The display will show the current status, in either Fahrenheit (F) or Celsius (C). Press either the up ▲ key or down ▼ key to toggle between the F or C designation.

Step 2 - Press the **SET** key again to access the setpoint. The LCD will display the current setpoint and the **S1** annunciator will blink on and off to indicate setpoint mode. Press either the up ▲ key to increase or the down ▼ key to decrease the setpoint to the desired temperature.

Step 3 - Press the **SET** key again to access the differential. The LCD will display the current differential and the **DIF1** annunciator will blink on and off to indicate that the control is in the differential mode. Press either the up ▲ key to increase or the down ▼ key to decrease the differential to the desired setting.

Step 4 - Press the **SET** key again to access the cooling or heating mode. The LCD will display the current mode, either **C1** for cooling or **H1** for heating. Press either the up ▲ key or down ▼ key to toggle between the **C1** or **H1** designation. Press the **SET** key once more and programming is complete.

Step	Annun-ciator	Description	Display
1	F or C	Fahrenheit or Celsius	
2	S1 (blinking)	Setpoint Temperature	
3	DIF1 (blinking)	Differential Temperature	
4	C1/H1	Cooling/ Heating Mode	

Note: The TTC will automatically end programming if no keys are depressed for a period of 30 seconds. Any settings that have been input to the control will be accepted at that point.

All control settings are retained in non-volatile memory if power to TTC is interrupted for any reason. Re-programming is not necessary after power outages or disconnects unless different control settings are required.

Lockout Switch

The TTC is provided with a lockout switch to prevent tampering by unauthorized personnel. When placed in the LOCK position, the keypad is disabled and no changes can be made. When placed in the UNLOCK position, the keypad will function normally.

To access the lockout switch, disconnect the power supply and open the control. The switch is located on the inside cover about 2 inches from the bottom (Figure 2). To disable the keypad, slide the switch to the left LOCK position. To enable the keypad, slide the switch to the right UNLOCK position. All TTC controls are shipped with this switch in the LOCK position.

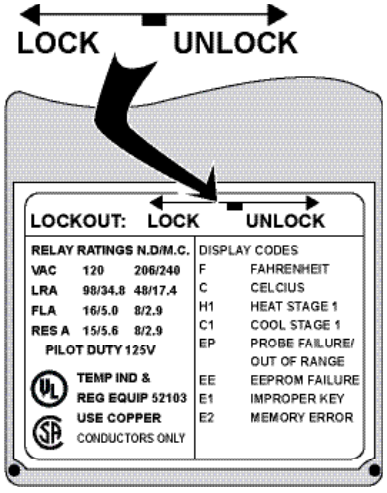


Figure 2: Lockout Switch

Troubleshooting Error Messages

Display Messages

E1 - Appears when either the up or down key is pressed when not in the programming mode.
To correct: If the E1 message appears when no keys are being pressed, replace the control.

E2 - Appears if the control settings are not properly stored in memory.
To correct: Check all settings and correct as needed.

EP - Appears when the probe is open, shorted or sensing a temperature that is out of range.
To correct: Check to see if the sensed temperature is out of range. If not, check for probe damage by comparing it to a known ambient temperature between -30^{O} F and 220^{O} F. Replace the probe if necessary.
Contact your Technicold representative for a replacement probe and installation instructions.

EE - Appears if the EEPROM data has been corrupted.
To correct: Replace the control.

CL - Appears if calibration mode has been entered.
To correct: Remove power to the control for at least 5 seconds. Reapply power. If the CL message still appears, replace the control.

Installation Instructions - Important

1. All TTC series controls are designed as operating controls only. If an operating control failure could result in personal injury or loss of property, a separate safety control and/or alarm should be installed.
2. The schematic drawings and other information included in these installation instructions are for purpose of illustration and general reference only.
3. These instructions do not expand, reduce, modify or alter the Technicold Terms in any way; and no warranty or remedy in favor of the customer or any other person arises our of these instructions.
4. Technicold TTC controls have been approved by Underwriter's Laboratories as UL listed; however, approval does not extend to their use for any other purpose. Technicold assumes no responsibility for any application of its control unless Technicold has approved such application in writing.
5. It is the responsibility of the installer and the user to assure that his or its application and use of all Technicold products are in compliance with federal, state and local requirements, including, without any limitation, all requirements imposed under the National Electric Code and any applicable codes and regulations.

Caution

To prevent possible electrical shock or equipment damage, disconnect electrical power to the unit before and during installation. DO NOT restore electrical power to unit until the control is properly installed and the cover is assembled. DO NOT locate the control in an explosive atmosphere as a safety hazard can result due to possible spark generation in the control. Controls are not to be located in areas of significant moisture, dirt or dust or in a corrosive explosive atmosphere. Use of control in such environments may result in injury or damage to the persons or property (or both) and are likely to shorten the control life; Technicold assumes no responsibility for any such use.

Control Remote Mounting

Mount the TTC to a bulkhead or other flat surface using a combination of two or more of the slotted holes located on the back of the control case. CAUTION: Do not damage circuit board when using the upper mounting holes for installation. Remove the circuit board to access the holes. The control's components are not position sensitive, but should be mounted so that they can be easily wired and adjusted. Do not mount in an environment of excessive of moisture, dirt and corrosive atmosphere.

The TTC has provisions for 1/2-inch conduit connections. The conduit hub should be secured to the conduit before securing the hub to the plastic housing of the control. When using the conduit entry in the rear of the case, a standard plug should be inserted into the conduit hold in the bottom. Caution should be exercised not to damage the control conduit board or wiring when installing a conduit connector.

Specifications

Input Voltage	120 or 208/240 VAC (24 VAC optional) 50/60 Hz
Temperature Range	-30^{o} F to 220^{o} F
Differential Range	1^{o} F to 30^{o} F
Switch Action	SPDT
Probe/Sensor	Thermistor, 2 in. long x 0.25 in. diameter with 8 ft. cable

CHILLED WATER TROUBLESHOOTING GUIDE

The following troubleshooting guide should be used in conjunction with the Chillers' Electrical Schematic.

On the top of the chiller evaporator plate there is a terminal strip protected by a stainless steel cover. All of the control and safety circuits are placed in a series along this terminal strip. Should the chiller go offline, the device that has stopped the chiller from running can be found by troubleshooting the terminal strip.

Once you have determined the device that has stopped the chiller from running, further investigation is needed to find out why it has shut the chiller down. Steps should be taken to rectify the problem so that the chiller can be brought back to normal operating status.

The following is a designation of the terminal strip connections as determined by wire colors:

Terminal Strip Position	**Device**	**Wire Colors**	**Device**
1	(Flow Switch)	White/Black	(VFD Trigger)
2	(Freeze Stat)	Brown/Red	(Flow Switch)
3	(Low Pressure)	Yellow/Brown	(Freeze Stat)
4	(High Pressure)	Black/Yellow	(Low Pressure)
5	(High Pressure)	Black/Orange	(Thermostat)
6	(Thermostat)	Orange/Black	(VFD Trigger)

Place a wire with terminal ends or an alligator jumper across the following terminals. Use the following sequence to find which control or safety device has shut off the chiller.

Jump TS1 to TS2	Comes on - Tripped on Flow Switch.
Jump TS2 to TS3	Comes on - Tripped on Freeze Thermostat.
Jump TS3 to TS4	Comes on - Tripped on Low Pressure Switch.
Jump TS4 to TS5	Comes on - Tripped on High Pressure Switch.
Jump TS5 to TS6	Comes on - Cycled on the Thermostat.
Jump TS6 to TS1	Comes on - Triggers the VFD by sending a signal to Terminals 1 and 11, indicating that more than one safety device has opened.

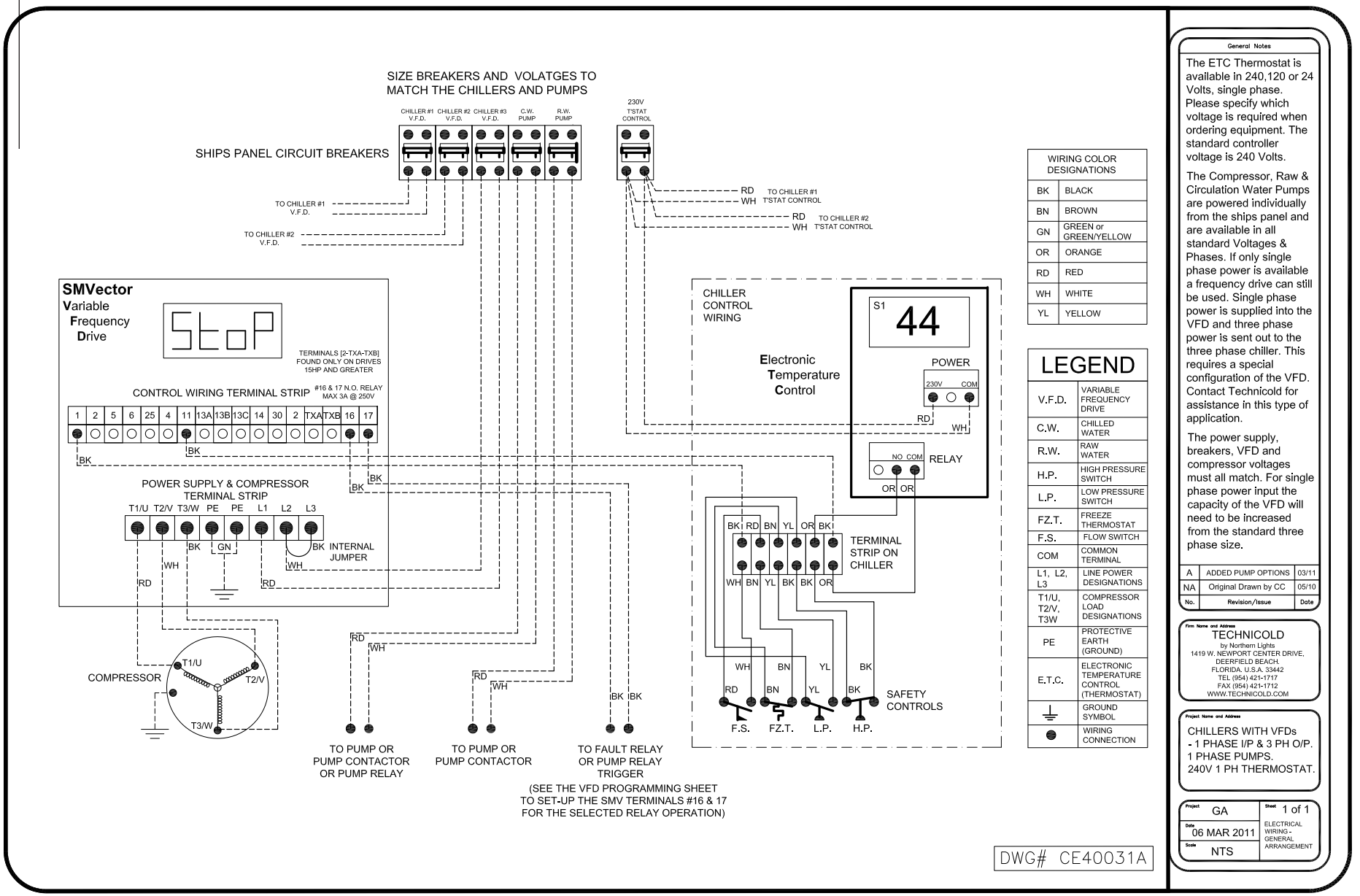
Possible Causes and Remedies for the Chiller Cycling Off

Fault	Cause	Remedy
Tripped on Flow Switch	Flow switch opened due to:	
	1. Loss of circulation water pressure.	• Check pressure gauge on suction side of the pump, fill as needed. • Check for leaks on circulation loop and fix. • Purge air from loop and equipment.
	2. Loss of circulation water flow.	• Check circulation pump for normal operation. • Check the pumps' rotation. • Make sure all service/shut-off valves are in the fully open position.
	3. Reed moved to the Normally Closed (NC) position.	• Loosen the two small screws holding the silver disc on top of the flow switch body. Slide the reed to the Normally Open (NO) position then tighten them back down.
	4. Failed Reed.	• Check for continuity. • If none then the reed has failed. Fully remove the two small screws and silver disc from the flow switch body to replace the reed. • The new reed wires can be butt-spliced or soldered to the existing wires.
	5. Loose or broken wire between reed and terminal strip.	• Check wiring for signs of damage for loose connections. Ohm out the wires to verify continuity.
	6. Flow switch paddle stuck due to particulate or has been field adjusted. Note: When the problem has been cleared the flow switch will automatically return to normal operation. No manual resetting is required.	• Isolate the loop where the flow switch is located. Remove the reed. Place a mark where the threads of the body enter the pipe. Relieve the loop pressure and back out the flow switch body taking note of the directional arrow on the body and how many full turns it was inserted into the pipe. Check for damage or particulate on the paddle. Measure the distance from the back of the pipe to the top of the threads. Measure the length of the paddle to the mark on the threads. Insert back into the pipe ensuring that the paddle does not touch the back of the pipe and the directional arrow is pointing the correct way. Install reed.
Tripped on Freeze Thermostat	The freeze thermostat has opened at 38^{O} F due to:	
	1. Low Water Pressure.	• Check pressure gauge on suction side of pump, fill system as needed. • Check for leaks on circulation loop and fix. • Purge air from loop and equipment.
	2. Restricted water flow.	• Check circulation pump for normal operation. • Check the pumps' rotation. • Make sure that all service/shut-off valves are in the fully open position.

CHILLED WATER TROUBLESHOOTING GUIDE

Fault	Cause	Remedy
Tripped on Freeze Thermostat (Continued)	3. Low load on circulation water NOTE: The freeze thermostat will reset at 48^{o} F 4. TTC has been set too low	• Turn on Immersion or Parastic Load Bank Heater to add load to cirulation water. • Turn on air handlers in high load areas. • Check setting and adjust as needed
Tripped on Low Pressure Switch	Unit is off on the low pressure switch: 1. Refrigerant (FREON®) loss.	• During normal operation the sight glass should be full of liquid refrigerant. If there is an excess of bubbles or only vapor in the sight glass then this can be an indication of a refrigerant loss. The chiller evaporator plate must not be frozen when using the sight glass for a refrigerant level check. Visually check the chiller for signs of damage on the refrigerant circuit or oil traces. • Pay close attention to fittings (low pressure control, service ports, pressure switched, TXV, etc.) for oil traces. If any fitting is loose, tighten using a back up wrench. If the refrigerant circuit has been breached and requires brazing or soldering. Consult a qualified refrigeration or air-conditioning tech.
	2. Low load on circulation water loop.	• Turn on Immersion or Parasitic Load Bank Heaters to add additional load to the circulation water. • Turn on air handlers in high load areas.
	3. Too large of a glycol to water ratio.	• Too high of a glycol percentage will not pump and affects the heat transfer of the evaporator. Drain off some of the Glycol/Water mixture and add additional water to dilute.
	4. Extremely cold ambient temperatures at chiller location during the initial start up or after the systems have been off for an extended period of time. NOTE: The low pressure switch will trip at 40 PSIG and automatically reset at 80 PSIG.	• Turn on heaters in the area where the chillers are located. Or, allow the compressor to start and trip two or three times. This will allow the compressor's shell to warm up enough that the back pressure will rise above the switch cut-out setting.
Tripped on High Pressure Switch	Unit is off on the high pressure switch: 1. Raw water flow is restricted.	• Check raw water strainer and thru-hull fitting and clean as needed. • Make sure all shut-off valves are fully open. • Inspect pump impeller for wear.
	2. Raw water condenser is dirty.	• Back flush or chemically clean as needed.

Fault	Cause	Remedy
Tripped on High Pressure Switch (Continued)	3. Unit has been serviced and now has an overcharge.	• Recover the refrigerant charge and recycle if needed. Evacuate the system and weigh-in the charge, or charge until the sight glass has cleared. If the system charge is a blend, there may be occasional bubbles in the sight glass. Charge blends as a liquid.
	4. Non-condensables have been introduced into the system. NOTE: The high pressure switch must be manually reset by depressing the red button on the switch body.	• Recover and reclaim the refrigerant charge. Evacuate the system. Using virgin refrigerant, weigh-in the charge, or charge until the sight glass has cleared at design conditions. If the system charge is a blend, there may be occasional bubbles in the sight glass. Charge blends as a liquid.
Cycled on the Thermostat	Cycling on the thermostat is normal. However, if the thermostat is cycling prematurely, check to see if the set points have been adjusted. The factory settings are shown in the remedy column. NOTE: If the thermostat is displaying a fault code then refer to the controls instruction sheet on page 3 for a detailed description and remedy.	Remove the cover of the thermostat by loosening the four screws on each corner. On the back of the cover there is a Lock/Unlock switch. Turn this to Unlock (See page 3). Adjust the temperature settings and differential by following the instructions on Page 5. The settings are: Stage 1: 44^{o} F set point, 8^{o} F differential. Stage 2: 46^{o} F set point, 8^{o} F differential. Stage 3: 48^{o} F set point, 8^{o} F differential. Stage 4: 50^{o} F set point, 8^{o} F differential. Stage 5: 52^{o} F set point, 8^{o} F differential. The switch should be moved back to Lock when programming has been completed and before the cover is put back on.
VFD Trigger Signal	1. No drive fault - This is normal. This is the trigger signal to tell the Variable Frequency Drive (VFD) to start. If one of the above safety devices opens, the signal to the drive is broken and the device stops. When the fault has cleared the circuit is complete and the drive is triggered to start. 2. If the thermostat is calling for cooling and the system will only come on when the VFD signal is jumped then this could indicate that two or more safety devices are open.	• Even though the trigger signal is present, the drive may still be locked out on a fault code. Fault codes for the drive will be displayed on the drives' LED and a list of these codes and remedies can be found in the drives' manual. Once the faults have been cleared the lock-out can be reset by pressing the Stop button on the front of the drive. • To find out which of the multiple devices are open, remove one of the wires from the terminal strip for each device. • Connect an ohm meter between the open wire and the one attached to the terminal strip for that device and check for continuity. • No continuity indicates an open device. • Continue this process for all of the devices.



WIRING COLOR DESIGNATIONS	
BK	BLACK
BN	BROWN
GN	GREEN or GREEN/YELLOW
OR	ORANGE
RD	RED
WH	WHITE
YL	YELLOW

LEGEND

V.F.D.	VARIABLE FREQUENCY DRIVE
C.W.	CHILLED WATER
R.W.	RAW WATER
H.P.	HIGH PRESSURE SWITCH
L.P.	LOW PRESSURE SWITCH
FZ.T.	FREEZE THERMOSTAT
F.S.	FLOW SWITCH
COM	COMMON TERMINAL
L1, L2, L3	LINE POWER DESIGNATIONS
T1/U, T2/V, T3W	COMPRESSOR LOAD DESIGNATIONS
PE	PROTECTIVE EARTH (GROUND)
E.T.C.	ELECTRONIC TEMPERATURE CONTROL (THERMOSTAT)
⏚	GROUND SYMBOL
●	WIRING CONNECTION

DWG# CE40031A

General Notes

The ETC Thermostat is available in 240,120 or 24 Volts, single phase. Please specify which voltage is required when ordering equipment. The standard controller voltage is 240 Volts.

The Compressor, Raw & Circulation Water Pumps are powered individually from the ships panel and are available in all standard Voltages & Phases. If only single phase power is available a frequency drive can still be used. Single phase power is supplied into the VFD and three phase power is sent out to the three phase chiller. This requires a special configuration of the VFD. Contact Technicold for assistance in this type of application.

The power supply, breakers, VFD and compressor voltages must all match. For single phase power input the capacity of the VFD will need to be increased from the standard three phase size.

No.	Revision/Issue	Date
A	ADDED PUMP OPTIONS	03/11
NA	Original Drawn by CC	05/10

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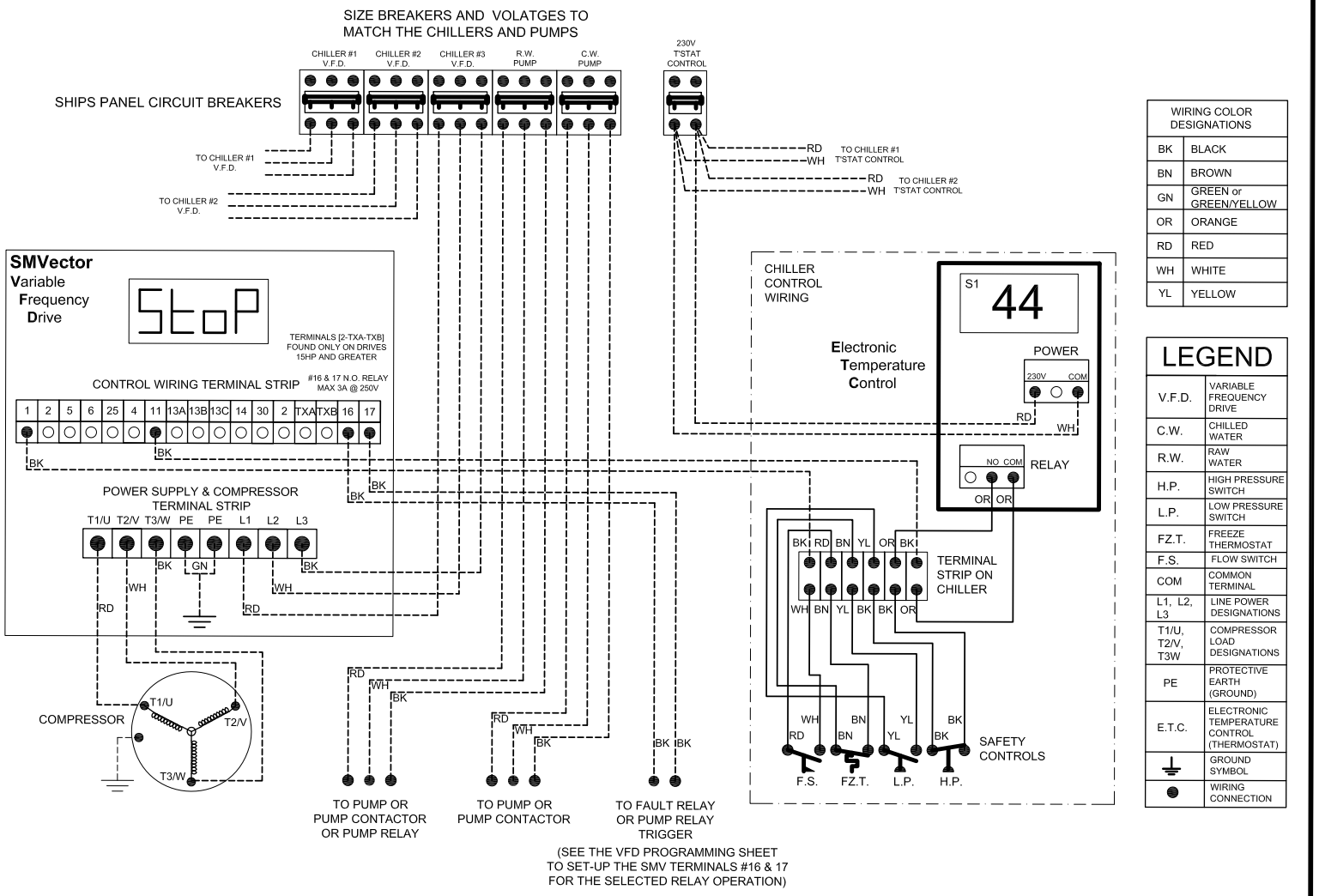
Project Name and Address
CHILLERS WITH VFDs
- 1 PHASE I/P & 3 PH O/P.
1 PHASE PUMPS.
240V 1 PH THERMOSTAT.

Project	GA	Sheet	1 of 1
Date	06 MAR 2011		ELECTRICAL WIRING - GENERAL ARRANGEMENT
Scale	NTS		



WIRING COLOR DESIGNATIONS	
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RD	RED
WH	WHITE
YL	YELLOW

LEGEND

V.F.D.	VARIABLE FREQUENCY DRIVE
C.W.	CHILLED WATER
R.W.	RAW WATER
H.P.	HIGH PRESSURE SWITCH
L.P.	LOW PRESSURE SWITCH
FZ.T.	FREEZE THERMOSTAT
F.S.	FLOW SWITCH
COM	COMMON TERMINAL
L1, L2, L3	LINE POWER DESIGNATIONS
T1/U, T2/V, T3W	COMPRESSOR LOAD DESIGNATIONS
PE	PROTECTIVE EARTH (GROUND)
E.T.C.	ELECTRONIC TEMPERATURE CONTROL (THERMOSTAT)
⏚	GROUND SYMBOL
●	WIRING CONNECTION

DWG# CE40047B

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Project Name and Address
CHILLERS WITH VFDs
- 3 PHASE I/P & O/P.
3 PHASE PUMPS.
240V 1 PH THERMOSTAT.

Project: GA	Sheet: 1 of 1
Date: 06 MAR 2011	ELECTRICAL WIRING - GENERAL ARRANGEMENT
Scale: NTS	

SMVector VARIABLE FREQUENCY DRIVE (VFD)

VFD Compressor Re-Programming Instructions

(Configured for Optional TB-16 & TB-17 Normally Open Relay Operations)

Most drives provided by Technicold leave the factory pre-programmed for their intended application. In the event that the customer receives a drive that has not been programmed the following steps will guide you through the process. Sometimes electrical disturbances or faulty programming may require resetting of the device back to default settings. The following instructions include that procedure as well.

When programming your drive the power must be applied without the start signal. At this time do not apply power to the drive. To disable the start signal, turn off the control circuit breaker feeding the ETC digital thermostat. This will turn off the thermostat and de-energize the trigger signal from its relay.

**Note* - Some applications use a single circuit breaker to feed the digital controls of multiple chillers. In these applications, turn off the breaker to disable all controls. Then remove the control wire from either terminal 1 or 11 on the terminal strip located inside the front access cover of the drive. Cover the loose wire with electrical tape and turn the control breaker back on to power up all digital controls. The other chillers will now be back in service. Turn on the power supply circuit breaker for the drive. The drive is now ready for programming.

Upon completion of programming the power supply circuit breaker should be turned off. The control circuit breaker should also be turned off and the wire connected back onto terminal 1 or 11. Place the terminal cover back on drive. Turn the power circuit breaker back on, then the control circuit breaker. When the control thermostat calls for cooling the drive ramps up to run the compressor.

NOTE: It is important that the VFD power supply breaker is turned on **before** the control breaker. Failure to comply will cause the drive to short cycle and trip the fault alarm.

NOTE: Once the power supply circuit breaker for the drive has been turned off, make sure that at least **three minutes** has elapsed before applying power back on the drive. This will prevent damage to the DC Bus capacitors inside the drive.

1	2	5	6	25	4	11	13A	13B	13C	14	30	2	TXA	TXB	16	17
Trigger Signal						Trigger Signal						These terminals used on 15HP or larger drives			Form C 2 amp N.O. Relay	

Control terminal strip found inside the cover of the drive.

VFD Compressor Re-Programming Instructions - Continued
(Configured for Optional TB-16 & TB-17 Normally Open Relay Operations)

The programmable parameters for the Compressor VFD are as follows:

Parameter		Name	Default Value	New Setting	Selection
P199	=	Program Selection (60 Hz)	0	**3**	Reset to 60Hz default settings
		Program Selection (50 Hz)	*0*	***4***	*Reset to 50Hz default settings*
P194	=	Password Protection (60 Hz)	0	**225**	Enable password protection
		Password Protection (50 Hz)	0	***225***	*Enable password protection*
P100	=	Start Control Source (60 Hz)	0	**1**	Terminal Strip
		Start Control Source (50 Hz)	*0*	***1***	*Terminal Strip*
P101	=	Standard Ref Source (60 Hz)	0	**3**	Preset #1
		Standard Ref Source (50 Hz)	*0*	***3***	*Preset #1*
P102	=	Minimum Frequency (60 Hz)	0	**60**	Match Compressor Hz
		Minimum Frequency (50 Hz)	*0*	***50***	*Match Compressor Hz*
P104	=	Acceleration Time #1 (60 Hz)	20	**5.0**	Ramp Time from 0 Hz to 60 Hz
		Acceleration Time #1 (50 Hz)	*20*	***5.0***	*Ramp Time from 0 Hz to 50 Hz*
P107	=	Line Volts Selection (60 Hz)	1	**1**	Leave at 1 for 60 Hz
		Line Volts Selection (50 Hz)	*1*	***0***	*Set to 0 for 50 Hz*
P110	=	Start Method (60 Hz)	0	**5**	Flying Start/Restart #1
		Start Method (50 Hz)	*0*	***5***	*Flying Start/Restart #1*
P131	=	Preset Speed #1 (60 Hz)	0	**60**	Match Compressor Hz
		Preset Speed #1 (50 Hz)	*0*	***50***	*Match Compressor Hz*
P140	=	Relay Output (60 Hz)	0	**0**	None
			0	**1**	Run
			0	**3**	Fault
			0	**4**	Inverse Fault
			0	**5**	Fault Lockout
		Relay Output (50 Hz)	*0*	***0***	*None*
			0	***1***	*Run*
			0	***3***	*Fault*
			0	***4***	*Inverse Fault*
			0	***5***	*Fault Lockout*

P140 Parameter Options

Setting	Selection	Function of T16 & T17 Normally Open Relay
0	None	Disables the relay output
1	Run	Relay closes when the drive is running
3	Fault	Relay opens when the drive trips, or when power is removed
4	Inverse Fault	Relay closes when the drive trips
5	Fault Lockout	Relay opens when the drive locks-out after restart attempts

Use selection #1 (RUN) for the trigger signal on a pump relay. It can also be used to power an LED, lamp or relay to indicate that the compressor is running.

Use selection #3, 4 or 5 (FAULTS) to power an LED, lamp or relay to indicate that there is a fault condition or that the drive has locked-out. It can also be used to show that the circuit breaker has tripped or is turned off.

SMVector VARIABLE FREQUENCY DRIVE (VFD)

VFD Compressor Re-Programming Instructions - Continued
(Configured for Optional TB-16 & TB-17 Normally Open Relay Operations)

There are six buttons on the front of the drive ▲ (Up), ▼ (Down), ↵ (Mode), ∩ (Rotation), ◯ (Stop), & | (Run).

Use only the Up ▲ , Down ▼ , and Mode ↵ buttons to program the drive.

If you scroll past a setting use the ▲ or ▼ to go back to the desired setting.

Once power is applied to the VFD the two-part Software Code is displayed for two seconds followed by the word **STOP**.

1. Press **Mode** and the word **PASS** will be displayed for one second then **0000**.
2. Use ▲ to scroll up to **225 (Security Code**).
3. Press **Mode** and **P100** will be displayed.
4. Use ▲ to scroll to **P199**.
5. Press **Mode** and **00** will be displayed.
6. Use ▲ to change it to **03 or 04** depending on the application.
7. Press **Mode** twice to return to **P199**.
8. Use ▼ to scroll to **P194**.
9. Press **Mode** and **0000** will be displayed.
10. Use ▲ to change to **225.**
11. Press **Mode** twice to return to **P194**.
12. Use ▼ to scroll to **P100.**
13. Press **Mode** and **00** will be displayed.
14. Use ▲ to change to **01**.
15. Press **Mode** twice to return to **P100**.
16. Use ▲ to scroll to **P101**.
17. Press **Mode** and **00** will be displayed.
18. Use ▲ to change to **03**.
19. Press **Mode** twice to return to **P101**.
20. Use ▲ to scroll to **P102.**
21. Press **Mode** and **0.0** will be displayed.
22. Use ▲ to change to **60.0/50.0** (depending on compressor Hz),
23. Press **Mode** twice to return to **P102**.
24. Use ▲ to scroll to **P104**.
25. Press **Mode** and **20.0** will be displayed.
26. Use ▼ to change to **5.0**.
27. Press **Mode** Twice to return to **P104**.
28. Use ▲ to scroll to **P107 .**
29. Press **Mode** and **01** will be displayed (for 60 Hz applications).
30. Use ▼ to change to **00** if unit is a 50 Hz application).
31. Press **Mode** twice to return to **P107**.
32. Use ▲ to scroll to **P110**.
33. Press **Mode** and **00** will be displayed.
34. Use ▲ to change to **05**.
35. Press **Mode** twice to return to **P110**.
36. Use ▲ to scroll to **P131**.
37. Press **Mode** and **0.0** will be displayed.
38. Use ▲ to change to **50.0/60.0 (depending on compressor Hz)**.
39. Press **Mode** twice to return to **P131**.
40. Use ▲ to scroll to **P140**.
41. Press **Mode** and **00** will be displayed.
42. Use ▲ to change to **01, 03, 04, 05** or leave at **00**.
43. Press **Mode** once to return to **STOP.**

After re-programming your VFD, apply the start signal. This can be done by turning on the control circuit breaker feeding the ETC, or re-connecting the control wire removed from either terminal 1 or 11 on the small terminal strip located inside the front access cover of the drive.

Troubleshooting Guides

The SMV variable frequency drive provides for surge less starting of the Chiller Compressor and inherent circuit/fault protection. See the VFD manual for a complete description of the drives operation and functionality, including programmable parameters. There are 18 Status/Warning, 2 Configuration and 25 Fault Messages. Sections 5.1, 5.2 and 5.3 provide a complete listing of these messages, their cause and remedy. A summary of the most common fault trips, their implications and remedies are listed below. Programmable Parameter, *P500* - Fault History will log the last 8 fault trips.

Code on LED Display	Reason	Solution
E r r	When entering the program mode an incorrect password has been entered, or an invalid command was attempted.	• The default password is "225." • Refer to the programming section or the VFD manual for programming instructions.
S P	When the drive is in fault condition this code (Start Pending) will flash between the restarts	• Fix fault condition.
L C	After five automatic restarts the drive will lockout (Lockout Condition) if the problem still exists.	• Manually reset the drive once the fault condition has been fixed. • Reset it by pressing the STOP button. If that does not unlock the fault condition turn off the power supply. Wait 3 minutes and then apply power back to the drive.
F _ A F	High Temperature Fault	• Check that the drives' cooling fan is running. • Check the cabinet cooling fan for operation and direction of flow. • If a filter is installed make sure it is clean. • If ambient conditions are too high relocate the drive to a cooler location.
F _ F1	The EPM chip to the left of the LED display is missing or damaged.	• If the EPM is missing replace with a new one and program per the instruction sheet. If EPM is in place then gently push down on it to ensure a firm seating. • Replace the EPM if it is in place and will not hold the programming.
F _ H F	High DC Bus Voltage.	• Line voltage is too high - check power supply to the drive.
F _ L F	Low DC Bus Voltage.	• Line voltage is too low - check power supply to the drive.
F _ U F	Start Command Fault.	Power turned on to drive with the start signal applied. Turn off the control circuit breaker for the chiller before applying power to the drive. Then turn the control circuit breaker back on. NOTE 1: Wait two minutes after power is applied to the drive before turning on the control circuit breaker. NOTE 2: When power is removed from the drive wait three minutes for the DC Bus Capacitors to discharge before applying power back to the drive.

ADDING GLYCOL TO A CHILLED WATER SYSTEM

WARNINGS

(!) Over the course of time, any product under pressure may corrode, weaken and burst or explode, causing serious or fatal personal injury, leaking or flooding and/or property damage. To minimize this risk, a licensed professional or experienced technician must install, periodically inspect and service the product.

General Information

In cooler operating climates it may be necessary to add glycol to the circulation water circuit. The following is a general guideline for the mixing the glycol/water solution. It is recommended that you consult with the manufacturer of the glycol solution for their mix rates to achieve the desired temperature.

Propylene Glycol (monopropylene glycol) also uses the acronym PG or MPG.

Ethylene Glycol (monoethylene glycol) also uses the acronym MEG.

The industry norm is to use Propylene Glycol rather than Ethylene Glycol as it is lower in toxicity. It is colorless, nearly odorless, clear, viscous liquid hygroscopic and miscible with water. Some manufacturers add non-toxic inhibitors, performance additives and tracer dyes. Select a type that best fits your application.

The freezing points of both glycols are depressed when mixed with water due to the disruption of hydrogen bonding.

The percentage of glycol by weight will differ for each type of glycol to obtain the same freeze point. Virgin glycol can be purchased at different concentrations (35%, 40%, 70%, 76%, 96% are common percentages) which will also vary the mix rates. Again, consult with the manufacturer to obtain the desired temperature.

Mixing to a 20°F temperature is sufficient for most systems.

Freezing Points of Propylene Glycol – Water Mixtures
@ ARI 590 Standard Conditions

Percent Propylene Glycol (wt. %)	Freezing Point (°F)	Freezing Point (°C)
0	32	0
10	26	-3
20	20	-7
30	10	-12
36	0	-18
40	-5	-20
43	-10	-23
48	-20	-29

Adding Solution to the Circulation Loop

There are three recommended methods for adding glycol to a new chilled water system, and two recommended methods for adding glycol to an existing system. Use the method that works best for you. In any case, once the system has been filled with the correct percentage of mixture it should be checked with a Glycol Refractometer.

NEW SYSTEM - CIRCULATION LOOP EMPTY

Method 1. a. Pre-mix the water and glycol in a clean container such as a 5 gallon bucket. Mix to a higher percentage of glycol than required as during the final filling stage you will only be adding fresh water. It may take numerous bucketfuls to fill the system.

b. Use a submersible pump such as a Technicold TE500A (115V) and connect a hose fitting and hose to the discharge of the pump. Put an 115V plug on the pump cord. Submerge the pump into the container and connect the discharge hose to the circulation water loop at the highest location in the boat. To do this, find the most accessible air handler in the sky lounge or pilothouse. Remove the air handler circulation water inlet hose from the isolation valve. Place the hose in the pre-mix container. Connect the discharge hose from the pump to the isolation valve.

c. Go to each air handler and make sure all isolation valves are open. In addition to this, manually open all 3-way valves to allow the glycol/water solution to enter the coils. Make sure all the other isolation and shut-off valves are open to allow the solution to fill the entire system.

d. Plug in the pump and fill the system. To prevent the pump from running dry, turn off the pump when the level of the solution gets low. Replenish the solution level and continue to fill the loop. When the pre-mix solution has filled the circulation loop and air handlers the solution will discharge out of the hose and back into the pump container. At this time the pump can be shut off and disconnected. The hose from the air handler can now be connected back on the isolation valve.

e. Go to the fresh water fill assembly and turn on the fresh water supply. Purge the air at each chiller and air handler. Once all the air has been purged, turn off the fresh water fill and shut off the isolation valve. Turn on the circulation water pump to mix and circulate the solution and to displace any trapped air. After a short while turn off the pump, fill and purge the system again. Repeat as needed until the circulation loop is free of air.

f. Take a sample of the solution in the circulation water loop and test with a Refractometer to verify the level of protection required has been obtained. If not, drain and capture some solution then add more glycol or fresh water to acquire the correct reading. Each draining and filling should be followed by an air purge procedure.

Method 2: Employ the same method as above but fill by hand instead of using a pump. This can be done by substituting the pump for a funnel and pitcher. The solution should still be pre-mixed in a container but fed into the funnel by a smaller pitcher. This is an arduous task and may add many hours to the fill process in comparison to the pump method.

ADDING GLYCOL TO A CHILLED WATER SYSTEM

Method 3: Estimate the total volume of the circulation loop including air handlers and chillers. Measure out the quantity of pure glycol needed to be diluted with water in order to obtain the temperature reading required. Add the pure glycol at a convenient location in the circulation water loop, using a funnel if necessary. Follow the procedure in 'Method 1' for adding water and purging air from the loop. Test with a Refractometer and add more glycol or water to obtain the concentration required.

EXISTING SYSTEM - CIRCULATION LOOP FULL

Method 1. a. Estimate the total volume of the circulation loop including air handlers and chillers. Measure out the quantity of pure glycol needed to be diluted with water in order to obtain the temperature reading required then add another 10% of the solution. Place the glycol in a clean container.

b. Shut off the chiller(s) and circulation water pump. Open one of the bleeders on the chiller to relieve the pressure down to zero pounds gage.

c. Find the most accessible air handler in the sky lounge or pilothouse. Close both isolation valves for this air handler. Remove the air handler circulation water inlet hose from the isolation valve and place it in an empty container or into the drain pan. Drain off any excess water from the air handler. Place another hose on the inlet water isolation valve and the other end into the container with the glycol. Open the inlet water isolation valve.

d. Have an assistant down by the chiller with two-way communication. Tell them to drain off some of the fresh water from the loop. The suction created by the draining of the water should draw the glycol into the system. When there is 10% of the solution left in the container tell your assistant to stop draining the system. Close the isolation valve and remove your hose. Connect the air handler hose back on the valve and open both valves. Fill and bleed the system as needed. Turn on the circulation pump to distribute the solution evenly throughout the system.

e. Take a sample of the solution in the circulation water loop and test with a Refractometer to verify the level of protection required has been obtained. If not, drain and capture some solution then add more glycol or fresh water to acquire the correct reading. Each draining and filling should be followed by an air purge procedure.

Method 2: a. Shut off the chiller(s) and circulation water pump. Open one of the bleeders on the chiller to relieve the pressure down to zero pounds gage.

b. Obtain a submersible pump such as a Technicold TE500A (115V) and connect a hose fitting and hose to the discharge of the pump. Put an 115V plug on the pump cord. Place the pump into a clean container such as a 5 gallon bucket. Fill the container with pure glycol to a level above the pump inlet and mark this level. Estimate the total volume of the circulation loop including air handlers and chillers. Measure out the quantity of pure glycol needed to be diluted with water in order to obtain the temperature reading required. Place this additional glycol into the same container as the glycol and pump.

c. Connect the pump discharge hose to the circulation water loop at the highest location in the boat. To do so, find the most accessible air handler in the sky lounge or pilothouse. Close both the circulation water inlet and outlet isolation valves for this air handler. Remove the air handler circulation water inlet hose from the isolation valve and place it in an empty container. Drain off any excess water from the air handler, and secure the hose in the container. Connect the discharge hose from the pump to the isolation valve. Open the inlet and outlet water isolation valves.

d. Plug in the pump and fill the circulation loop with glycol. Turn off the pump when the marked level is reached above the pump inlet. As the system is filled with glycol the fresh water from the other side of the loop will discharge into the empty container. When complete close the isolation valves and remove your hose. Connect the air handler hose back on the valve and open both valves. Fill and bleed the system as needed. Turn on the circulation pump to evenly mix and distribute the solution throughout the system.

e. Take a sample of the solution in the circulation water loop and test with a Refractometer to verify the level of protection required has been obtained. If not, drain and capture some solution then add more glycol or fresh water to acquire the correct reading. Each draining and filling should be followed by an air purge procedure.

NOTE: Any unused or captured glycol or glycol/mix should be disposed of in an environmentally safe manner; and in accordance with local, state and federal regulations.

FRESH WATER FILL ASSEMBLY

WARNINGS

(!) When installing, servicing and operating any pressurized system, safety gloves and goggles should be worn at all times!

(!) When testing the safety valve be sure that the water being discharged will not cause property damage or personal injury to those in the vicinity.

General

Due to possible health and contamination risks, the fresh water supply should not be permanently connected to the fill assembly and left open. Due to the possibility of seepage into the potable water supply and therefore is not allowed as a permanent hook up. The check valve assembly inside the regulator and shut-off valve cannot guarantee a one directional flow or system isolation. If a permanent hook up is needed then a backflow preventer must be installed.

Make sure the fresh water supply pump is turned on prior to starting the filling process. Flush out the fresh water supply line to clear it of chips, dirt, scale, etc. prior to hook-up on the fill assembly and filling.

If there is a concern that the fresh water supply may contain harmful particulate then a temporary or permanent in-line filter screen should be installed prior to connection.

An additional in-line filter screen is recommended for the main circulation water loop. It should be installed prior to the circulation water pump suction connection. This screen will catch any particulate that may have entered the piping during construction, and prevent fouling of the pump or chillers. It should have isolation valves on either side for removal and cleaning. The screen should be checked frequently upon initial filling and start-up of the system.

The fresh water regulator assembly must be mounted in a horizontal position.

Sufficient clearance must be provided to operate the fast fill and purge lever.

Install a shut off valve upstream of the regulator.

If installing an optional backflow preventer, it must be installed upstream of the regulator and after the shut off valve.

When installing the regulator make sure that the arrow on the valve body is pointing in the direction of flow. If reversed the system cannot be filled due to the check valve, if filling with a water pressure above 30 Psig the relief valve will release and discharge water out of the drain. Install a drain fitting and hose to the relief valve drain connection. Route it to an area where it will not injure personnel or damage equipment should it discharge. As most systems provide heating in addition to cooling the discharge could be hot or cold water and, any additive such as glycol mixed in with it.

IMPORTANT

Do not install a valve of any kind in the relief valve drain line. No portion of the drain line should be above the regulator. The drain pipe and fitting must not be smaller than the connection. The relief valve is non-adjustable and set to release at 30 Psig.

Operation

To fill the system connect the clean fresh water supply to the shutoff valve connected upstream of the regulator.

Turn on the fresh water and supply and open the shutoff valve. The water now flows through the regulator to the pressure relief valve and then into the system.

The water pressure being fed in to the system is reduced down to 12 Psig (factory default) and can be adjusted to 15 Psig should the application require it.

Inside of the regulator there is also a check valve and filter screen.

The check valve stops the backflow of water into the potable water system should there be a loss of water pressure. This safety feature is not designed as a backflow preventer so as soon as the loss of pressure is discovered, the shutoff valve should be closed immediately.

The filter screen is designed to catch and residual particulate that may have been left inside the freshwater fill hose after purging.

As the system fills with fresh water the installer visits all air handlers and opens the water valves and purges air from the air bleeders. The chillers and pumps are also purged of air. Once the air bleeders start to discharge a steady stream of water they are closed and the system circulation pump can be started briefly to displace any hidden air pockets. The pump is turned off and the air handlers, chillers and pumps are again purged. This continues until all air is removed from the system. The fresh water fill shut off valve is then closed and the fresh water supply turned off.

To speed up the initial filling of the system the regulator has a fast fill lever. When this lever is in the vertical position the pressure regulator is bypassed and the system fills at the pressure of the supply water.

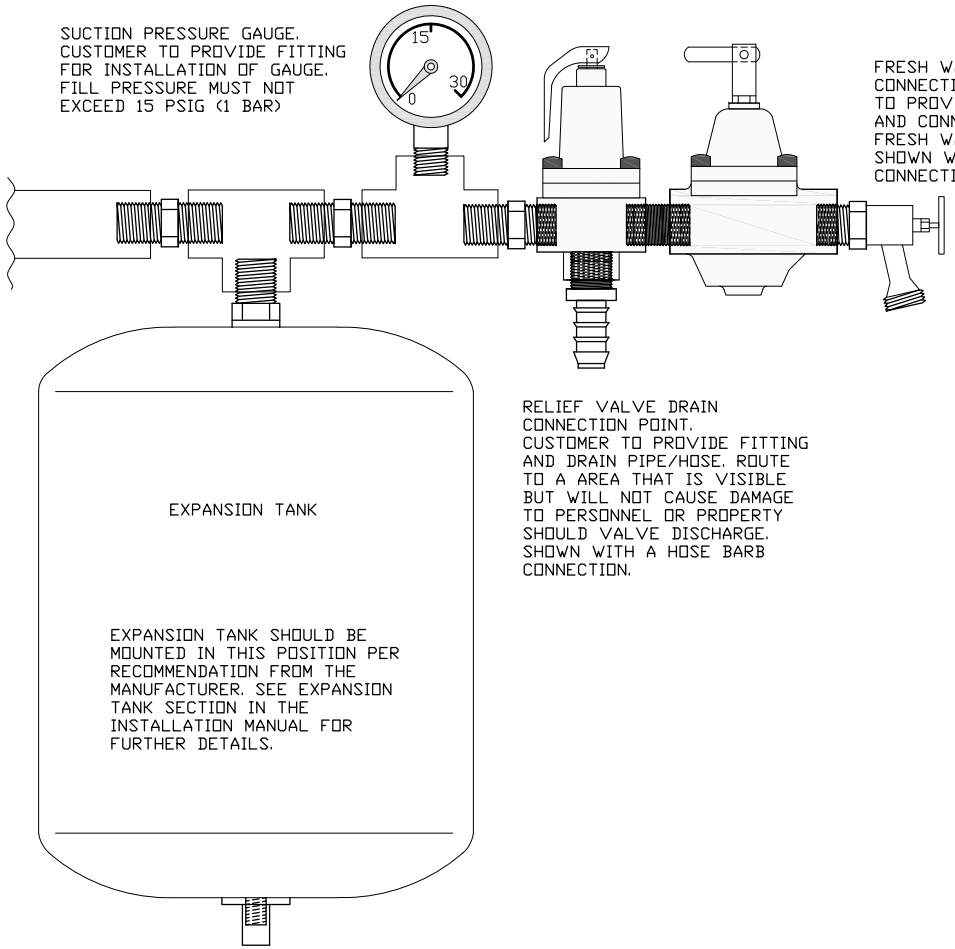
IMPORTANT
Extreme caution should be used when fast filling as the supply water pressure can sometimes exceed the 30 Psig pressure relief rating causing the valve to open. The valve and system pressure should be monitored when fast filling. Once the system is 90% full the fast fill lever should be put back to the regulated horizontal fill position

The lever on the pressure relief must be manually operated once a year to ensure that the valve is functional and the water flow is unrestricted.

The valve should be removed and disassembled once a year and all the parts flushed out.

The regulator filter screen should be checked and cleaned after initial filling of the system.

NOTE
An isolation valve should be installed after the fill assembly. This will allow access to the fill assembly without having to drain the circulation water loop.



DWG# CM40011A

General Notes

ALL DIMENSIONS IN INCHES

COMPONENTS MUST BE PROPERLY SECURED AND MOUNTED TO THE BULKHEAD OR OTHER SUPPORT STRUCTURES. MOUNTING HARDWARE AND FASTENERS MUST BE RATED TO SUPPORT THE WEIGHT OF THE COMPONENTS, FITTINGS AND WATER.

No.	Revision/Issue	Date
A	ADDED TO NOTATIONS	05/11
NA	ORIGINAL (Drawn by CC)	03/10

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Project Name and Address

FRESH WATER FILL COMPONENTS -ASSEMBLED

Project	Sheet
GA	Sheet 1 of 1
Date: 19 Mar 2010	
Scale: NTS	

WARNINGS

(!) Read all instructions before operation.

(!) Turning off the thermostat does not remove power from inside the heater control box. Both the heater and hi-limit circuits still have voltage at their connections.

(!) The 6 kW immersion heater operates between 208VAC and 240VAC. Operating at 208V delivers 4500 watts of power and at 240V, 6000 watts of power. Applications with voltages above 207V require a separate 30-amp contactor for use in conjunction with the high limit thermostat. Heater Contactor Control Boxes or individual contactors are available from Technicold.

(!) Make sure heater terminations are not exposed to water or other liquids. Make sure that no dripping from condensation on cold water pipes or other sources can fall on any exposed electrical wiring connections or components.

(!) All wiring connections should be tight using approved connections. A loose connection will result in over-heating at the connection and could lead to premature failure. Where possible, use a wrench or pliers to prevent twisting of terminals during installation.

(!) Heater and control wiring should be performed per the diagrams provided. Do not exceed 105% of the rated voltage. Higher voltages result in higher wattage outputs, which could damage the heater, system, or medium heated.

(!) Do not use the thermostat as a power disconnection means for the heater assembly! The thermostat only breaks one leg of power leaving the other leg and safety circuit Live! Disconnect the Heater and Circulation Water Pump breakers before accessing the Contactor or Heater Control Boxes.

(!) When replacing the Heater Control Box cover check to ensure that the gasket has seated properly. A properly installed gasket will ensure the water resistant integrity of the terminal box.

(!) Use wiring of the correct gage, temperature rating and type suitable for the environment/application in which it is located.

(!) Circuit Breakers or Disconnects should be located within line of sight of the heaters and contactor box. They should be capable of being locked in the open position for safety during service or maintenance. For applications where this is not possible, they should be tagged. In addition, removal of the fuses in the Heater Contactor Control Box will disable/isolate the Heater Contactor, Flow Switch and Hi-Limit Thermostat circuit. Disconnect the power before removing the fuses.

(!) A licensed electrician should perform all electrical service. Refer to supplied wiring diagrams. Disconnect all power to heater before servicing.

(!) Bleed the circulation loop of any air before applying power to heater.

IMMERSION HEATERS

Purpose and Use

Technicold immersion heaters can be used as individual 6 kW modules or manifolded together for higher capacities. Whether used individually or in multiple applications all safety devices must be connected and a flow switch installed. The heaters are designed for heating liquid and must be filled at all times. Care should be taken to avoid air entrapment or pockets; therefore, the heaters should be mounted vertically. Several manifold design options are available to allow installation in the tightest of locations.

Immersion heaters are installed in the circulation water loop used for cooling the vessel. The air handlers in the cabins are used for chilled and hot water applications. These air handlers can be installed with optional supplemental electric heat strips, or “chill-chasers” as they are commonly referred to. The supplemental heat strips work in conjunction with the immersion heaters for rapid heating of the cabins. The heat strips shut down once the circulated hot water has reached its normal operational temperature.

Although your immersion heater assembly utilizes a centralized Contactor Control Box, each heater incorporates an individual thermostat and high temperature safety device.

There is a thermostat control and ON/OFF indicator lamp on the side of the heater control box. The lamp illuminates when power is applied to the heater and the thermostat is turned on. When the thermostat is satisfied, the lamp turns off. The thermostat has five positions indicated but only two are used for normal operation.

The first position is (NO HEAT) which turns off the heater locally. This can be useful if you want to limit heater usage in multiple heater applications. If the heater(s) are to be shut down for an extended period then their breaker(s) should be turned off.

Second position is (HI) which allows the heaters to reach their maximum capacity. For normal operation, the thermostat should be turned to this setting.

General Guidelines

A properly installed heater should have the minimum guidelines met for effective operation:

1. A minimum flow rate of 15 GPM is required for 240V operation.
2. Heater cannot be run dry, do not energize without water flow.
3. Heaters operated at 208V or greater require the use of contactors.
4. A qualified electrician in accordance with Articles of the National Electric Code, ABYC or other regulatory agencies that apply, should make electrical connections.
5. Thermostats are for heater control only and not used for control of motors or other components. When not in service the heater should be turned on/off via the supply breaker or switch.
6. Plumb the heater vertically to prevent air locking.
7. Disconnect the power supply to the heater when draining the circulation loop.
8. The electrical supply power must be single phase.
9. The heater must be protected by a circuit breaker or fused disconnect switch.

Troubleshooting/Repair

A qualified technician should perform Troubleshooting or repairs. Incorrect diagnosis or repairs could lead to damage of the equipment and injury to personnel.

PROBLEM – Power to the heater but no heat output.
SOLUTION – (a) Turn on the thermostat located on the heater electrical box.
(b) Check the wiring connections on the heater.

PROBLEM - High Limit Thermostat opens.
SOLUTION - Disconnect power and determine the cause before resetting thermostat. Check for inadequate water flow, low water pressure, or possible air that may have accumulated in the system.
A water temperature of 90F is required at the heater before the thermostat will reset.

PROBLEM – Flow Switch Open (Initial Start-Up).
SOLUTION – (a) Check pump operation.
(b) Check reed position on the flow switch, it should be pushed forward to the Normally Open (N.O.) position.
(c) Check to see if the heater has been installed in the correct direction.
(d) Has the circulation water loop been filled?
(e) Is the circulation water loop pressure correct?
(f) Make sure all isolation valves are open.

PROBLEM – Flow Switch Open (After the system has been in service).
SOLUTION – (a) Check pump operation.
(b) Check the circulation water loop pressure.

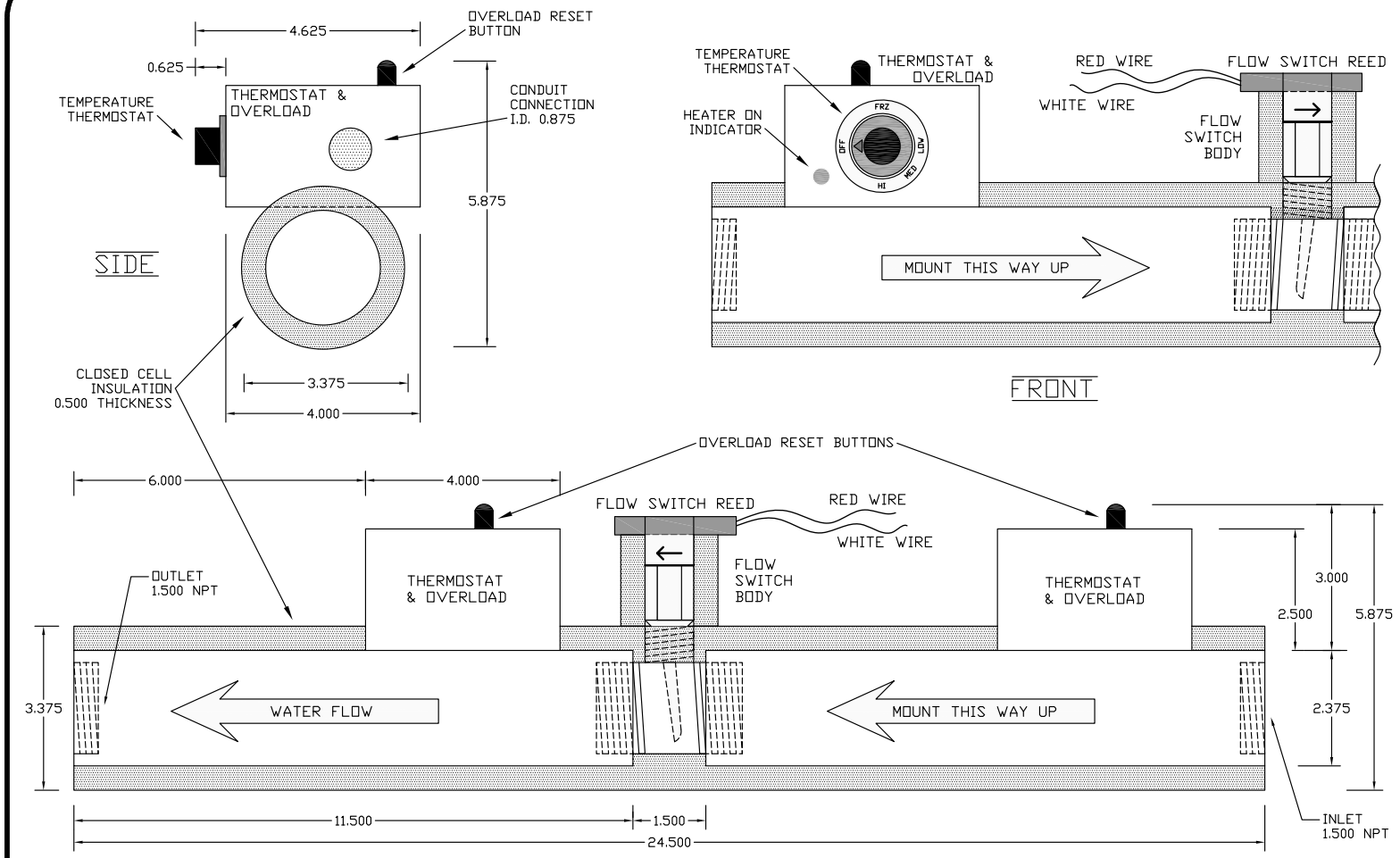
Replacement Parts

For heaters assemblies and controls that are beyond factory warranty, replacement components are available.

NOTE: replacement elements are not available for HR-6 heaters. Warranty coverage requires complete assemblies be returned to Technicold for disposition. All returned heaters are subject to the terms and conditions of the manufacturer's warranty.

NOTE: Using the heater in an application other than directed will void the warranty. U.L. RECOGNITION
All HR-6 heaters are UL recognized. File E80296 UL Standard 1030, and UL Standard 1563 File E76221.

IMMERSION HEATER PARTS	PART NUMBERS
6kW Immersion Heater	20-48904
Control Thermostat	22-40578
Manual Reset High Limit Thermostat	Consult Factory
Brass Flow Switch Body with Reed Switch	22-40547
Replacement Reed Switch	22-98982
IMMERSION HEATER ELECTRICAL CONTROL BOX	
Contactor (ILH-1B, ILH-2B)	45EG20AG
Contactor (ILH-3B)	42CF35AG
Contactor (ILH-4B)	42BE25AG
Fuse 0.5A 250VAC Time Lag	MDL 1/2
MOV Surge Suppressor	22-98981



ALL DIMENSIONS ARE IN INCHES

CAUTION! HEATERS MUST BE INSTALLED VERTICALLY.
FAILURE TO DO SO WILL CAUSE AIR-LOCKING OF THE HEATERS, TRIPPING OF THE SAFETY DEVICES AND POSSIBLE FAILURE OF THE HEATER!

DWG# CP40013

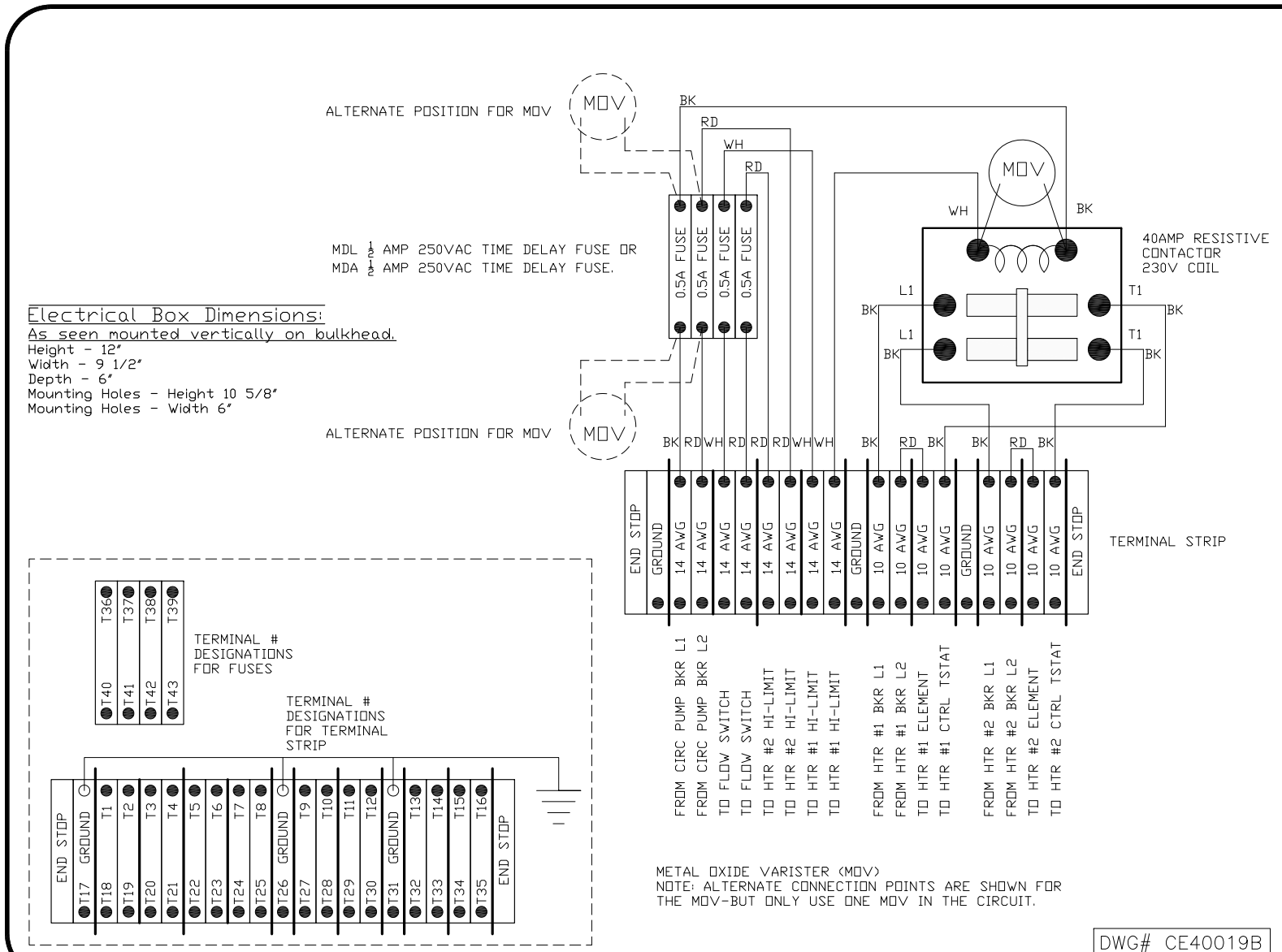
General Notes

No.	Revision/Issue	Date
NA	ORIGINAL (Drawn by CC)	02/10

Firm Name and Address
TECHNICOLD
by Northern Lights
230 SW 27th Street,
Fort Lauderdale,
FLORIDA. U.S.A. 33315
Tel (954)764-6192
Fax (954)764-7259
www.technicold.com

Project Name and Address
2-STAGE IMMERSION HEATER WITH FLOW SWITCH

Project	GENERIC	Sheet	1 of 1
Date	11 FEB 2010		ASSEMBLY DRAWING
Scale	NTS		



General Notes

Maintenance:
Periodically, as defined by usage. All electrical connections should be checked and tightened as needed.

No.	Revision/Issue	Date
B	Added Electrical Box Dimensions	02/10
A	Terminal Designation Chng & Add Wire Colors	09/09
NA	ORIGINAL (Drawn by CC)	07/09

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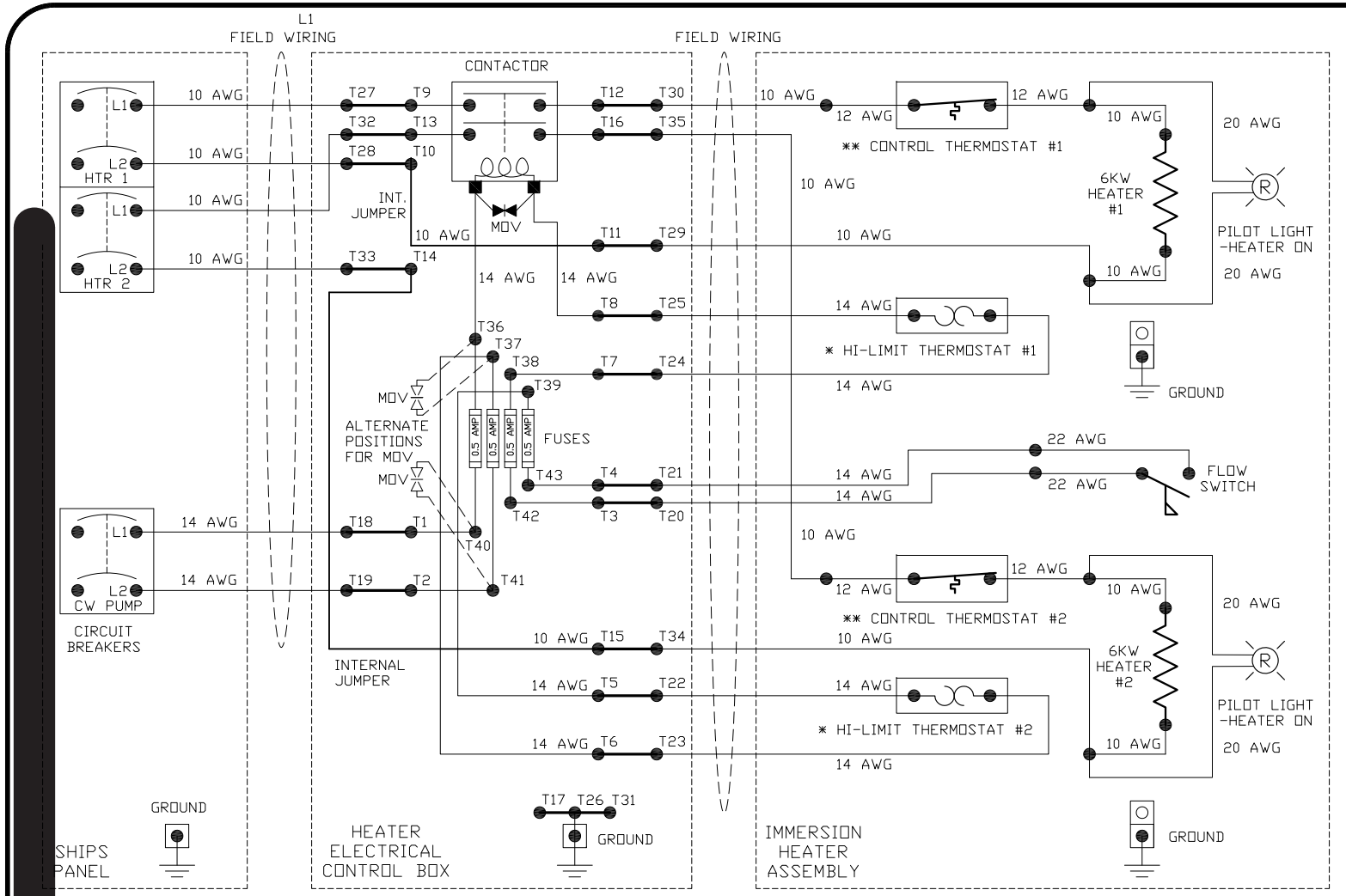
Project Name and Address
2 - STAGE
IMMERSION HEATER
ELECTRICAL BOX
WIRING LAYOUT.
12kW/240V/50A

Project	GENERIC
Date	03 FEB 2010
Scale	NTS
Sheet	1 of 1
	ELECTRICAL BOX LAYOUT



RATED WATTAGE	RESULTING WATTAGES AT APPLIED VOLTAGES			
6000W	5510W	5042W	4594W	4167W
240V	230V	220V	210V	200V
25A	24A	23A	22A	21A
BREAKER SIZE SHOULD 125% OF MAXIMUM OPERATING AMPERAGE				

* HI-LIMIT 135 DEG F +/- 10 DEG F.

** MAXIMUM CONTROL TEMPERATURE 115 DEG F.

● WIRE CONNECTION

AWG AMERICAN WIRE GAUGE

⋈ METAL OXIDE VARISTER (MOV)
NOTE: ALTERNATE CONNECTION POINTS ARE SHOWN FOR THE MOV-BUT ONLY USE ONE MOV IN THE CIRCUIT.

DWG# CE40017A

General Notes

1. FIELD WIRING SIZES SHOWN ARE MINIMUM AWG.

2. SOME FIELD CRIMP CONNECTIONS AND ELECTRICAL BOX TERMINALS ARE NOT SHOWN FOR CLARITY. SEE ELECTRICAL BOX DRAWING FOR COMPONENT LAYOUT AND TERMINAL STRIP DESIGNATIONS.

3. MAX. HEATER ELECTRICAL LEAKAGE TO GROUND AT RATED VOLTAGE AND IN WATER AT 110 DEG F WILL NOT EXCEED 100 MICROAMPS.

4. HI-POT TESTED AT 1500 VAC FOR 1 SECOND AT ROOM TEMPERATURE.

5. HEATER IS U.L. CONSTRUCTION AND CANNOT BE ALTERED.

No.	Revision/Issue	Date
A	New Wiring Designations	09/09
NA	ORIGINAL (Drawn by CC)	02/09

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Project Name and Address
2 - STAGE IMMERSION HEATER WIRING DIAGRAM. 12kW/240V/50A

Project: GENERIC	Sheet: 1 of 1
Date: 02 JUL 2009	Electrical Drawing
Scale: NTS	

DAILY MAINTENANCE

RAW WATER STRAINER

Raw water strainers are mandatory for all Technicold systems. Check the raw water strainer daily. A visual inspection through the sight-glass housing is usually sufficient for daily inspections. See the "Weekly Maintenance" section (below) for instructions and weekly inspection and servicing of the raw water strainer.

CIRCULATION WATER STRAINER

Construction debris can contaminate water piping. Careful storage of piping and fittings, cleaning of assembled components and sealing of pipe openings during the boat build may not entirely eliminate particulate from entering the system.

Upon completion of the piping installation, flush the system to remove contaminants. Flushing of the piping should be done prior to connecting the air handlers, chillers or pumps. A temporary bypass loop can be installed at those locations to facilitate the procedure. As this procedure still might not remove all of the particulate, we recommend that you install a strainer.

Locate the strainer before the pump inlet. Install the strainer with isolation valves for ease of service. Check the strainer hourly for the first day. Thereafter, extend the time interval to daily if the contamination is minimal. The frequency of checks and cleaning will diminish over time as the contamination level drops.

Check the strainer at least once a year even when the system seems free from contamination.

SOUND CHECKS

Familiarize yourself with the sounds of normal equipment operation during routing checks and maintenance. Abnormal sounds - including clicks, grinding, rubbing, vibration, pulsation, gurgling or short cycling - can be the first indication of a problem that needs attention. Consult the factory for more exact diagnosis.

WEEKLY MAINTENANCE

RAW WATER STRAINER

Open the strainer and inspect at least once a week or if debris build up is noted. Make sure to close the thru-hull valve prior to opening the strainer for service.

Remove any debris from the strainer sight-glass housing and strainer basket. Flush the strainer basket and clean out the housing prior to returning the basket into the housing. Some strainer sight-glass housings incorporate a drain plug for this purpose.

Some applications use a "Sea Chest" for raw water supply. The strainer for the Sea Chest use large mesh that does not filter small particulate. Install a strainer between the Sea Chest and the raw water pump inlet to filter out this small particulate.

Replace the strainer basket immediately if it is showing signs of decay or damage. Do not operate the system with the strainer basket removed. Inspect the housing and tie rods for cracks or other signs of deterioration. Replace defective parts immediately to prevent flooding.

Gaskets or o-rings are used to seal the strainer and can fall into the bilge when the lid is removed. Always check to ensure that the seals are in place prior to closing up the strainer. Prior to tightening the retaining bolts or clips, check the seating of the seals. Replace loose or damaged seals. Use caution, as overtightening retaining bolts and clips can crack the housing or strip the threads.
Cracks in the sight-glass housing or a poor seal can cause a suction leak. This can allow air to enter the inlet of the pump. Air bubbles in the pump head can cause cavitations that erode the impeller and head or damage the shaft seal of metal pumps. This can also lead to impeller binding on pumps with plastic heads.

Check bonding lugs for corrosion and tightness on metal strainers. Clean and replace connections as needed.

HUMIDITY MODE

When leaving the vessel unoccupied for an extended period of time the air handlers controls can be set to Humidity Mode; also referred to as Moisture Control, or Away Mode. This will ensure that the water valves and blowers operate every four hours in addition to controlling the humidity levels inside the boat.

When shutting down air handlers for an extended period, make provisions to have them turned back on and operated for one hour each month. This will keep the parts lubricated and prevent the motors and valves from "Mechanically Freezing".

AIR FILTERS

Check air handler's filters once a month. In some low traffic areas, it may be possible to extend the cleaning interval to every two months, but check them nonetheless. In high traffic areas, dusty environments such as laundry rooms, or when using Technicold Electrostatic Air Filters, it may be necessary to check them on a more frequent basis.

Inspect the coils during filter maintenance. Remove light dust build up with a soft hand brush, or a vacuum cleaner with a brush attachment, using care not to bend or damage the fins on the coil. Do not move the brush across the coil surface, use a linear up and down movement. A fin comb can be purchased from Technicold to fix bent fins.

Excessive dirt build up on the coil may require chemical cleaning. We recommend that this service be performed only by certified technicians.

GAUGE PRESSURE

Technicold chilled water systems feature a circulation pressure gauge located on the suction side of the circulation water pump. The gauge pressure should read 12-15 PSIG when the chillers are operating in cooling mode and the pump is off. If the gauge pressure is low then this is a good indication that there is a water leak in the piping, connections or pump shaft seal. Once the leak is located and repaired, fill the system back up to the design pressure. The gauge pressure can reach up to 20 PSIG when the immersion heaters are in operation.

CHILLERS

When shutting down the chillers for an extended period, make provisions to have them turned back on and operated for an hour each month. This will keep the internal parts of the compressors lubricated and prevent the parts and motors from "Mechanically Freezing." Make the same provisions to operate the chillers in cooling when using immersion heat for an extended period.

QUARTERLY MAINTENANCE

CIRCULATION WATER STRAINER
Check the circulation water strainer each quarter for the first year of service on a new system. See daily maintenance requirements on page 36.

CONDENSATE DRAINS
To test the integrity of the condensate drains, pour a quart of water into the air handler condensate pans. If they do not drain quickly then check the drain pan for blockages. All Technicold drain pans have two drain fittings.

ELECTRICAL CONNECTIONS
Heat and vibration can cause connections to loosen, causing poor contact and voltage drops. This can lead to arcing, burnt wires and nuisance tripping of the breaker.

Inspect electrical connections and tighten as needed. **Remove electrical power and lockout prior to performing any electrical checks.**

HOSE CLAMPS
Check the hose connections on air handlers, chillers, pumps and all ancillary equipment. In most situations, a nut-driver or screwdriver will provide ample torque to tighten a clamp. Use caution when using a socket set, as it is easy to overtighten the clamp and strip the threads.

Never use power tools to tighten hose clamps.

INSULATION
Inspect insulation for tears or open seams. Replace or repair damaged sections as needed.

FANS, NOISE, DIRT
Wipe dirt off fan motors to prevent overheating. Remove dirt accumulation inside motor housings using dry compressed air. Compressed air cans used to clean inside computers and keyboards work well. The area must be well ventilated when performing this task, and the fan must be turned off.

Do not use flammable cleaning chemicals on fan motors. Flammable vapors or residue can ignite on the hot motor when it is in operation.

Dirt can accumulate on the fins of the blower wheel over time, causing an imbalance of the wheel and vibration. If vibration noise is noted, remove the ducting and inspect the blower wheel. Clean or replace as needed. To prevent personal injury turn off the power supply to the blower prior to inspecting the wheel.

SENSORS
Check placement of sensors for air handlers and chillers. Firmly secure and insulate sensors to the water inlet pipe on the air handler. Firmly secure and insulate water sensors to the piping that they are sensing. Those used to probe wells should be inserted fully into the wells. Fill the wells with thermal mastic and seal.

If using a return air sensor, it must be in the return air stream. Make sure that the return air sensor does not touch a hot or cold surface. Secure all sensors so they cannot be pulled from their location.

QUARTERLY MAINTENANCE

THRU-HULL FITTINGS

Debris including plastic bags can be sucked onto thru-hull fittings causing a restriction of water flow. The build up of marine growth can also cause a problem. Inspect thru-hulls and clean before the restriction becomes severe. Severe water restrictions diminish the capacity of the system and can cause pump failures.

FIRST STAGE COMPRESSOR

On a staged chiller, the first stage is always the first to come on and the last to turn off. To even the run times of the chillers, rotate their staging. The set points for all stages can be changed from the front panel of the TTC control. Adjust each stage upwards by two degrees F except the last stage, which should be dropped own to 44 degrees F.

On chillers with PLC controls, the stages are rotated automatically.

ANNUAL MAINTENANCE

MOTORS

Use SAE No. 20 (twenty weight) non-detergent or electric motor oil for lubricating the blower and pump motors. Fasco Motors require 2-3 drops annually and Dayton Motors require 30 drops annually. Some motors have sealed bearings, which require no lubrication, and therefore have no lubrication ports.

CONDENSER COILS

Back flush condenser coils annually, or more frequently depending on water quality. Periodically chemical cleaners are needed to remove marine growth or scale. Consult the condenser coil cleaning section for instructions on chemically cleaning the coils. We recommend that certified technicians perform this service.

METAL HEAD PUMPS

Inspect pump heads for leaks and corrosion. Open pump heads and check the impeller for signs of wear. Replace with the same size impeller if worn, do not change the impeller size without first consulting Technicold.

Excessive wear and pitting of the impeller and pump head can be an indication of cavitations or erosion/ corrosion. To prevent a repeat occurrence, investigate the cause and fix. (See Raw Water Strainer, page 37).

Connect all metal pump heads to the ship's bonding system.

STAINLESS STEEL

Technicold equipment is manufactured with 316L stainless steel. It leaves the factory dressed and sealed for added protection of the surface.

While discoloration or rust spots occur over time, the finish can be restored with some minor prep work. Wipe off excess dirt with a clean soft cloth. Dress the surface in a circular motion with a Scotchbrite type plastic scrubber, lightly dampened with water. Add a small amount of mild soap for heavy soiling. There are also commercial stainless steel cleaners which can be used. Use a dry cloth to finish cleaning then seal with CorrosionX brand type oil, or an alternate dressing for stainless steel.

FAHRENHEIT/CELSIUS TEMPERATURE CONVERSION

The numbers in bold -face in the center column refer to the temperature either in Celsius or Fahrenheit, which is to be converted to the other scale. If converting Fahrenheit to Celsius the equivalent temperature will be found on the column on the right.

Temperature			Temperature			Temperature			Temperature		
Celsius	C or F	Fahrenheit	Celsius	C or F	Fahrenheit	Celsius	C or F	Fahrenheit	Celsius	C or F	Fahrenheit
-40.0	**-40.0**	-40.0	-6.7	**+20**	+68.0	+26.7	**+80**	+176.0	+60.0	**+140**	+284.0
-39.4	**-39**	-38.2	-6.1	**+21**	+69.8	+27.2	**+81**	+177.8	+60.6	**+141**	+285.8
-38.9	**-38**	-36.4	-5.5	**+22**	+71.6	+27.8	**+82**	+179.6	+61.1	**+142**	+287.6
-38.3	**-37**	-34.6	-5.0	**+23**	+73.4	+28.3	**+83**	+181.4	+61.7	**+143**	+289.4
-37.8	**-36**	-32.8	-4.4	**+24**	+75.2	+28.9	**+84**	+183.2	+62.2	**+144**	+291.2
-37.2	**-35**	-31.0	-3.9	**+25**	+77.0	+29.4	**+85**	+185.0	+62.8	**+145**	+293.0
-36.7	**-34**	-29.2	-3.3	**+26**	+78.8	+30.0	**+86**	+186.8	+63.3	**+146**	+294.8
-36.1	**-33**	-27.4	-2.8	**+27**	+80.6	+30.6	**+87**	+188.6	+63.9	**+147**	+296.6
-35.6	**-32**	-25.6	-2.2	**+28**	+82.4	+31.1	**+88**	+190.4	+64.4	**+148**	+298.4
-35.0	**-31**	-23.8	-1.7	**+29**	+84.2	+31.7	**+89**	+192.2	+65.0	**+149**	+300.2
-34.4	**-30**	-22.0	-1.1	**+30**	+86.0	+32.2	**+90**	+194.0	+65.6	**+150**	+302.0
-33.9	**-29**	-20.2	-0.6	**+31**	+87.8	+32.8	**+91**	+195.8	+66.1	**+151**	+303.8
-33.3	**-28**	-18.4	0	**+32**	+89.6	+33.3	**+92**	+197.6	+66.7	**+152**	+305.6
-32.8	**-27**	-16.6	+0.6	**+33**	+91.4	+33.9	**+93**	+199.4	+67.2	**+153**	+307.4
-32.2	**-26**	-14.8	+1.1	**+34**	+93.2	+34.4	**+94**	+201.2	+67.6	**+154**	+309.2
-31.7	**-25**	-13.0	+1.7	**+35**	+95.0	+35.0	**+95**	+203.0	+68.3	**+155**	+311.0
-31.1	**-24**	-11.2	+2.2	**+36**	+96.8	+35.6	**+96**	+204.8	+68.9	**+156**	+312.8
-30.6	**-23**	-9.4	+2.8	**+37**	+98.6	+36.1	**+97**	+206.6	+69.4	**+157**	+314.6
-30.0	**-22**	-7.6	+3.3	**+38**	+100.4	+36.7	**+98**	+208.4	+70.0	**+158**	+316.4
-29.4	**-21**	-5.8	+3.9	**+39**	+102.2	+37.2	**+99**	+210.2	+70.6	**+159**	+318.2
-28.9	**-20**	-4.0	+4.4	**+40**	+104.0	+37.8	**+100**	+212.2	+71.1	**+160**	+320.0
-28.3	**-19**	-2.2	+5.0	**+41**	+105.8	+38.3	**+101**	+213.7	+71.7	**+161**	+321.8
-27.8	**-18**	-0.4	+5.5	**+42**	+107.6	+38.9	**+102**	+215.6	+72.2	**+162**	+323.6
-27.2	**-17**	+1.4	+6.1	**+43**	+109.4	+39.4	**+103**	+217.4	+72.8	**+163**	+325.4
-26.7	**-16**	+3.2	+6.7	**+44**	+111.2	+40.0	**+104**	+219.2	+73.3	**+164**	+327.2
-26.1	**-15**	+5.0	+7.2	**+45**	+113.0	+40.6	**+105**	+221.0	+73.9	**+165**	+329.0
-25.6	**-14**	+6.8	+7.8	**+46**	+114.8	+41.1	**+106**	+222.8	+74.4	**+166**	+330.8
-25.0	**-13**	+8.6	+8.3	**+47**	+116.6	+41.7	**+107**	+224.6	+75.0	**+167**	+332.6
-24.4	**-12**	+10.4	+8.9	**+48**	+118.4	+42.2	**+108**	+226.4	+75.6	**+168**	+334.4
-23.9	**-11**	+12.2	+9.4	**+49**	+120.2	+42.8	**+109**	+228.2	+76.1	**+169**	+336.2
-23.3	**-10**	+14.0	+10.0	**+50**	+122.0	+43.3	**+110**	+230.0	+76.7	**+170**	+338.0
-22.8	**-9**	+15.8	+10.6	**+51**	+123.8	+43.9	**+111**	+231.8	+77.2	**+171**	+339.8
-22.2	**-8**	+17.6	+11.1	**+52**	+125.6	+44.4	**+112**	+233.6	+77.8	**+172**	+341.6
-21.7	**-7**	+19.4	+11.7	**+53**	+127.4	+45.0	**+113**	+235.4	+78.3	**+173**	+343.4
-21.1	**-6**	+21.2	+12.2	**+54**	+129.2	+45.6	**+114**	+237.2	+78.9	**+174**	+345.2
-20.6	**-5**	+23.0	+12.8	**+55**	+131.0	+46.1	**+115**	+239.0	+79.4	**+175**	+347.0
-20.0	**-4**	+24.8	+13.3	**+56**	+132.8	+46.7	**+116**	+240.8	+80.0	**+176**	+348.8
-19.4	**-3**	+26.6	+13.9	**+57**	+134.6	+47.2	**+117**	+242.6	+80.6	**+177**	+350.6
-18.9	**-2**	+28.4	+14.4	**+58**	+136.4	+47.8	**+118**	+244.4	+81.1	**+178**	+352.4
-18.3	**-1**	+30.2	+15.0	**+59**	+138.2	+48.3	**+119**	+246.2	+81.7	**+179**	+354.2
-17.8	**0**	+32.0	+15.6	**+60**	+140.0	+48.9	**+120**	+248.0	+82.2	**+180**	+356.0
-17.2	**+1**	+33.8	+16.1	**+61**	+141.8	+49.4	**+121**	+248.8	+82.8	**+181**	+357.8
-16.7	**+2**	+35.6	+16.7	**+62**	+143.6	+50.0	**+122**	+251.6	+83.3	**+182**	+359.6
-16.1	**+3**	+37.4	+17.2	**+63**	+145.4	+50.6	**+123**	+253.4	+83.9	**+183**	+361.4
-15.6	**+4**	+39.2	+17.8	**+64**	+147.7	+51.1	**+124**	+255.2	+84.4	**+184**	+363.2
-15.0	**+5**	+41.0	+18.2	**+65**	+149.0	+51.7	**+125**	+257.0	+85.0	**+185**	+365.0
-14.4	**+6**	+42.8	+18.9	**+66**	+150.8	+52.2	**+126**	+258.8	+85.6	**+186**	+366.8
-13.9	**+7**	+44.6	+19.4	**+67**	+152.6	+52.8	**+127**	+260.6	+86.1	**+187**	+368.6
-13.3	**+8**	+46.4	+20.0	**+68**	+154.4	+53.3	**+128**	+262.4	+86.7	**+188**	+370.4
-12.8	**+9**	+48.2	+20.6	**+69**	+156.2	+53.9	**+129**	+264.2	+87.2	**+189**	+372.2
-12.2	**+10**	+50.0	+21.1	**+70**	+158.0	+54.4	**+130**	+266.0	+87.8	**+190**	+374.0
-11.7	**+11**	+51.8	+21.7	**+71**	+159.8	+55.0	**+131**	+267.8	+88.3	**+191**	+375.8
-11.1	**+12**	+53.6	+22.2	**+72**	+161.6	+55.6	**+132**	+269.6	+88.9	**+192**	+377.6
-10.6	**+13**	+55.4	+22.8	**+73**	+163.4	+56.1	**+133**	+271.4	+89.4	**+193**	+379.4
-10.0	**+14**	+57.2	+23.3	**+74**	+165.2	+56.7	**+134**	+273.2	+90.0	**+194**	+381.2
-9.4	**+15**	+59.0	+23.9	**+75**	+167.0	+57.2	**+135**	+275.0	+90.6	**+195**	+383.0
-8.9	**+16**	+60.8	+24.4	**+76**	+168.8	+57.8	**+136**	+276.8	+91.1	**+196**	+384.8
-8.3	**+17**	+62.6	+25.0	**+77**	+170.6	+58.3	**+137**	+278.6	+91.7	**+197**	+386.6
-7.8	**+18**	+64.4	+25.6	**+78**	+172.4	+58.9	**+138**	+280.4	+92.2	**+198**	+388.4
-7.2	**+19**	+66.2	+26.1	**+79**	+174.2	+59.4	**+139**	+282.2	+92.8	**+199**	+390.2

A/C DEFINITIONS AND FACTS

1. Cooling is the transfer of heat from an area where it is not wanted to an areal where it is not objectionable.
2. Heat always flows from a warmer to a cooler area.
3. "Ambient Air" is the temperature of air surrounding an object (i.e. room temperature)
4. Three types of heating or cooling:
   a. Conduction
   b. Convection
   c. Radiation
5. Insulation slows the rate of heat flow.
6. Capacity of cooling systems is the heat removal rate produced and is measured in British Thermal Units (B.T.U.) per hour.
7. A BTU is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
8. One ton of cooling equals 12,000 BTU per hour, which equals the amount of heat required to melt one ton of ice in 24 hours. (288,000 BTU)
9. One Watt of electric energy equals 3.42 BTU. One horsepower equals 746 Watts equals 2545 BTU.
10. Air flow circulated in an area is expressed in cubic feet (CFM).
11. Air flow required to provide adequate heat or cool in an area is equal to 450 CFM per 12,000 BTU.
12. Warm air holds more moisture (water vapor or relative humidity) than cold air.
13. Water vapor collects (condenses on a cold surface.
14. One gallon of water equals 8.3 lbs.
15. One Foot Head equals 2.31 lbs pressure.
16. Water flow required to condense high pressure refrigerant gas equals 1.5 gal/min. at 75^{o} F water per 12,000 BTU; Equals 3.0 gal/min. at 85^{o} F water per 12,000 BTU.
17. Latent heat is heat added or removed that cannot be measured by a change in temperature, but accomplishes a change of state: solid to liquid to vapor.
18. Water not under pressure flows downhill.

TECHNICOLD By Northern Lights
LIMITED WARRANTY

The Limited Warranty applies to the following product lines:

TECHNICOLD Air Conditioning and Refrigeration Products

Technicold manufacturerer NORTHERN LIGHTS, INC. (herein "NLI") extends to the purchaser and user (herein "Owner") of the product the following limited warranty (herein "Warranty"). Please read it carefully.

Technicold Air Conditioning and Refrigeration Products	
	Warranty Period
Product	12 months
Parts + Labor	12 months
Parts	24 months

NLI'S WARRANTY AND RESPONSIBILITIES

Subject to the terms and conditions set out below, NLI warrants the product and its factory installed parts to be free from defects in material and workmanship under normal use and service.

If the product is purchased for and used primarily in a commercial endeavor, the Warranty period shall extend from the date of delivery to the original end user for a period of twelve (12) months with no limit on hours of use. If the product is purchased for and used primarily in personal, family or household use, the warranty period shall extend from the date of delivery to the original end user for a period of twelve (12) months with no limit on hours of use. Original parts shall be warrantied for a period of twenty-four (24) months from date of delivery.

The obligation of this Warranty shall be limited to repairing or replacing any part of the product which NLI agrees is defective in materials or workmanship under normal use and service during the warranty period. If during the warranty period the product or any of its parts are found to be defective because of workmanship or materials, it will be repaired or replaced without charge if the Owner prepays the transportation charges and returns the item to NLI's authorized warranty dealer. To find the location of the nearest NLI authorized warranty dealer, contact NLI at the address, e-mail address, or telephone or fax numbers on the following page.

Upon request by the Owner and agreement by NLI, repair of product or replacement of parts under this Warranty may be completed at a place other than at an NLI authorized warranty dealer. See "Owner's Responsibilities" below.

NLI'S WARRANTY AND RESPONSIBILITIES

Within thirty (30) days of purchase, Owner or authorized agent of Owner must complete, sign and deliver to NLI the Warranty Registration Card in order to validate this warranty. Owner must break in unit as described in the "Operating Procedures" section of the Operator's Manual.

At the time of presentation of product for service under this Warranty, the Owner or authorized agent must present evidence of the date of original purchase of the product.

If pre-approved repair of product or replacement of parts under this Warranty is completed at a place other than an NLI authorized warranty dealer, Owner shall pay NLI's or its authorized dealer's reasonable travel expenses.

Owner shall pay costs of any labor required to remove and reinstall the product and/or parts thereof, any premium for overtime labor requested by the Owner and costs for transporting the product and/or parts thereof to and from the place where warranty work is performed.

TECHNICOLD by NORTHERN LIGHTS
1419 West Newport Center Drive
Deerfield Beach, FL 33441
www.technicold.com

WARRANTY LIMITATIONS

This warranty will not apply to equipment put into service more than twenty-four (24) months from date of shipment from factory, and will not apply in any country with which trade is restricted or banned by the U.S. Department of State, at or after the time of sale or claim.

If the product is used primarily in a commercial endeavor, neither NLI nor any company affiliated with NLI will be liable for general damages, including bodily injuries, except as set forth above, or for incidental consequential damages, including, but not limited to, loss of use, loss of profits, loss of production, expense of substitute equipment or other commercial loss or for damage to property in which equipment is installed. The same limitations shall apply to a product used for personal purposes with respect to all non-personal injuries, general, incidental and consequential damages.

Some countries or states do not fully allow the above exclusions or limitations of general, incidental or consequential damages, so the above exclusions or limitations may not apply to you.

This Warranty extends only to the original parts, accessories and products.

This Warranty is transferrable to a new Owner during the warranty period. No transfer forms or fees are required.

This Warranty does not extend to failure resulting from an accident or disaster or from Owner or operator abuse or neglect (such as operating without proper maintenance of equipment, including pumps, filters and electrical connections.)

Service parts worn out by usage and not due to defects in workmanship or material are not covered by this Warranty.

NLI is not responsible for failure resulting from improper repair or use of defective parts or parts not approved by NLI.

NLI is not responsible for failure of product or parts resulting from improper installation or unauthorized modifications.

NLI is not responsible for failure caused by negligent handling or abuse in installation or storage in improper environment which results in corrosion or freezing damage to equipment.

NLI is not responsible for failure caused by any third party's transportation damage to NLI's product.

NLI is not responsible for damage if any warning alarm system is ignored.

NO REPRESENTATIONS AND LIMITATIONS OF IMPLIED WARRANTY

This written Warranty is in lieu of all other express warranties, obligations or limitations. If this equipment is used primarily in a commercial endeavor, no implied warranty, including that of merchantability and fitness for a particular purpose is extended. If the product is used primarily in personal, family or household use, any implied warranty, including that of merchantability and fitness for a particular purpose, shall be limited to twelve (12) months.

Some countries or states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.

No person is authorized to make any representations or promised on behalf of NLI or to modify the terms or limitations of this Warranty in any way except in writing and signed by an authorized employee of NLI.

This warranty gives you specific legal rights, and you may have additional statutory rights which vary from one country or state to another.

NOTES

www.technicold.com

1419 W. Newport Center Drive, Deerfield Beach, FL 33442
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