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FOR REFERENCE ONLY

FLOWRITE
RECIRCULATING COOLING SYSTEM

INSTALLATION AND OPERATION MANUAL

MODEL NO. : RPC2/28W-RNB

M and W Systems
ISO 9001 Certified

Rev. 7 4/08/96

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1.0 INTRODUCTION

The M and W Systems Flowrite Temperature Control Unit, Model **RPC2/28W-RNB**, is a self-contained, compact, mobile liquid heating-cooling system designed for temperature control of two independent channels. This dual channel unit can operate within a wide temperature range and is a closed loop system with no back pressure and deionized bypass "polishing loops" which provide for continuous deionization of the heating-cooling liquids. Hermetically sealed refrigeration compressors and heat exchangers provide for long uninterrupted service. The two temperature control channels are modular in concept and can be easily removed for maintenance. All flow and pressure setpoints are preset at the factory.

1.1 GENERAL NOTES

⚠ ATTENTION

1. BEFORE ANY ELECTRICAL HOOK-UP IS MADE, MAKE SURE THAT SUPPLY VOLTAGE IS IDENTICAL TO VOLTAGE SPECIFIED FOR THIS EQUIPMENT.

2. IN THE CASE OF THREE PHASE EQUIPMENT, IT IS VERY IMPORTANT THAT THE THREE PHASES ARE HOOKED UP FOR PROPER ROTATION OF THE PUMPS.

3. ANY ERRORS MADE IN HOOK-UP PROCEDURES THAT RESULT IN DAMAGE TO EQUIPMENT (PUMPS, COMPRESSORS, ETC.), ARE NOT COVERED BY ANY MANUFACTURERS WARRANTY AND ARE THE SOLE RESPONSIBILITY OF THE CUSTOMER AND/OR HIS AGENT, CONTRACTOR, ETC.

4. ALL LOCAL AND/OR ELECTRICAL AND/OR PLUMBING CODES HAVE TO BE OBSERVED WHEN INSTALLING THIS EQUIPMENT.

1.2 SYSTEM DESCRIPTION

The Flowrite Dual Channel Temperature Control Unit (TCU) contains two independent heating-cooling loops which each include a reservoir, a circulating pump, a heat transfer system, various flow and temperature sensing safeguards, and controls to maintain coolant conditions. The refrigeration units used on the system are sized to dissipate approximately 2.8kW @ 18°C coolant temperature (700 watts @ -20°C) for low temperature processes. Stainless steel heaters are used to heat the heating-cooling liquids for high temperature processes. The temperature of the heating-cooling liquid in each channel can be adjusted from -20°C to +80°C (-4°F to +180°F) within ± 1.0°C of the setpoint.

The operator interface which is located on the front panel of the TCU (See Figure 1, Page 5) contains controls and displays which fall into four distinct function categories: the Control Section, the Display Section, two Temperature Control Sections, and two System Alarm Sections.

1.2 SYSTEM DESCRIPTION (CONTINUED)

Control Section - This section is located on the left hand side of the Operator Interface Panel and contains the power on and off buttons, an emergency off button, and two lights which display whether the system is running or in failure.

Display Section - Three LED digital displays are provided on the top portion of the Operator Interface Panel to show the TEMPERATURE, FLOW, and RESISTIVITY of the heating-cooling liquids. A toggle switch on the right hand side of the displays determines from which heating-cooling loop (Upper Channel or Lower Channel) these three displays are reflecting a reading.

Temperature Control Sections - These sections are identical, one for Upper Channel and one for Lower Channel. They contain a temperature alarm system that is triggered by high and low temperature setpoints determined by the user and programmed by set screws. The temperature alarm is visible through the use of two red indicator lights and can be switched from audible to silent depending on user preference. Also on this section of the panel is a temperature set screw which can be used to set the fluid temperatures when the system is in a Local mode (disconnected from the Rainbow etcher or connected with the etcher off). When the TCU is in the Remote mode (connected to the Rainbow etcher with the etcher on), the temperature of each individual channel is determined by a setpoint programmed on the Rainbow Chamber Recipe Page. The "Top Electrode Temperature" parameter controls the temperature for Upper Channel. The "Bottom Electrode Temperature" parameter controls the temperature for Lower Channel.

System Alarm Sections - These sections of the Operator Interface Panel are also identical, one for Upper Channel and one for Lower Channel. Green and red indicator lights in these sections reflect either RUN (green) conditions or FAILURE (red) conditions for the compressor, heater, water flow, resistivity, and water level of the heating-cooling loops. Failure conditions produce the following system effects:

1) Compressor failure - visual warning (red LED) and **SYSTEM SHUTDOWN**
2) Heater failure - visual warning (red LED) and **SYSTEM SHUTDOWN**
3) Low flowrate - visual warning (red LED)
4) Improper heating-coolant resistivity - visual warning (red LED)
5) Liquid level below what is safe for the TCU (LEVEL/SHUTDOWN) - visual warning (red LED) and **SYSTEM SHUTDOWN**
6) Low liquid level, first warning (LEVEL WARN/FILL) - visual warning first (red LED)

NOTE: When the red LED warning lights 1,2, or 5, illuminate, a TCU fail signal will be sent to the etcher to alert the user to check the TCU.
When the red LED warning lights 3,4, or 6, illuminate, a TCU warning signal will be sent to the etcher to alert the user to check the TCU.

1.3 STANDARD SYSTEM FEATURES

The Flowrite Dual Channel TCU comes equipped with the following features:

2/28	Two independent 2.8kW refrigeration systems.
W	Water-cooled refrigeration.
2/D	Flowrate 0-4 GPM total output of pump.
DI	This system is designed for the circulation and cooling of deionized water. All parts in this system are stainless steel or plastic materials that are compatible with DI water.
10"	Four 10" deionizer cartridges (two in each loop) to provide for continuous deionization.
LI	A liquid level switch to monitor the reservoir level.
CMII	A resistivity meter to monitor the water quality.
DT	A solid state close tolerance temperature controller with a linear sensor. Temperature stabilities of ±1.0°C may be achieved.
HE	A heater to provide the heating part of the heating-cooling option.
AA	An automatic alarm system. Both audio and visual alarms are triggered if operating conditions are deviating from set parameters.

1.4 SYSTEM SPECIFICATIONS

Temperature	+40°F to 120°F (+5°C to 50°C) operating -10°F to 140°F (-20°C to 60°C) non-operating
Humidity	0% to 99% operating 0% to 100% non-operating
Altitude	Sea level to 12,000 feet / 3658.5 meters
Electrical	208/230 VAC ±10%, 50/60 Hz 3Ø
Power Requirements	30 Amps 208/230 VAC, 50/60 Hz 3Ø power circuit
Housewater Requirements	Minimum 6 GPM @ 40PSI minimum w/20 PSID between supply and return
Dimensions	23"W x 36"L x 55.5"H (58.4cm **W** x 91.4cm **L** x 141cm **H**)
Heat Exchange Capacity	2.8 kW @ 18°C coolant temperature
Flow Rate	0-4 GPM per channel
Flow Pressure	0-100 PSI
Temperature Regulation	-20°C to +80°C (+4°F to +180°F) ± 1.0°C

1.5 SITE REQUIREMENTS

1. House water supply. Water-cooled compressors require up to 6 GPM of house cooling water for heat removal. The water pressure should be 40 PSI minimum with 20 PSID between supply and return.

2. Grounded electrical receptacle, properly fused. 50/60 Hz - 230 VAC.

   NOTE: 60 Hz systems can operate within a range of 180-253 VAC; 230 VAC is recommended.
   50 Hz systems can operate within a range of 180-253 VAC; 230 VAC is recommended.

3. Deionized water and ethylene glycol for heating-coolant mixture. Mixture should contain 50% D.I. water (10 MΩ or higher in resistivity) and 50% ethylene glycol for both the Channels, even if they are to run above 0° C.

FIGURE 1

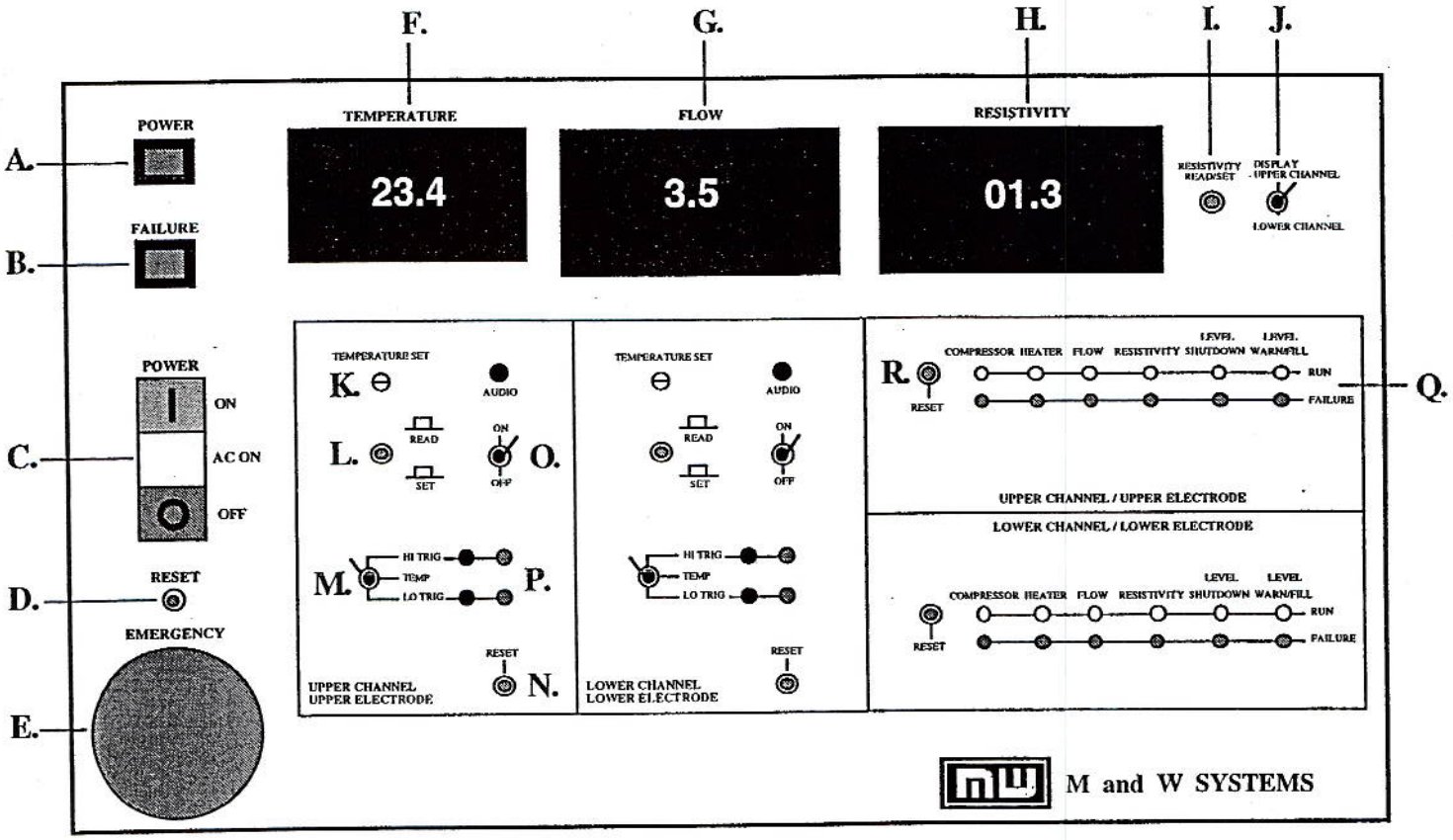


Figure 1
Front Panel Operator Interface

Control Section

A. POWER LIGHT - Illuminates when the TCU has been turned on by use of the AC ON button.

B. FAILURE LIGHT - Illuminates when the TCU has stopped running due to some sort of system failure.

C. AC ON AND OFF BUTTONS - Turns the TCU on and off. They do not affect etcher power.

D. RESET BUTTON - Resets the system after the Emergency OFF button has been pressed.

E. EMERGENCY OFF BUTTON - Connected to the EMO circuitry of the etcher. **Activation will shut down all Rainbow systems!**

Display Section

F. TEMPERATURE DISPLAY - Displays the operating temperature of the heating-cooling liquids. This display will vary from Channel to Channel by use of the DISPLAY toggle switch (J.). It can also be manipulated to display the following:

Temperature Setpoints - Displayed when the READ/SET button (L.) is pressed.

Alarm High Temperature Trigger Setpoint - Displayed when the HI/LOW TRIG toggle switch (M.) is toggled to HI.

Alarm Low Temperature Trigger Setpoint - Displayed when the HI/LOW TRIG toggle switch (M.) is toggled to LO.

G. FLOW DISPLAY - Verifies that the heating-cooling liquid is flowing through the system. Sensor is located in the water line returning from the etcher electrode. The flow parameter is preset at the factory. This display is not a linear readout but is given to alert the user of any flow problems. It should always reflect a number above 2.5.

H. RESISTIVITY DISPLAY - Displays the absolute resistivity of the heating-cooling liquids. The absolute setpoint for water resistivity is preset at the factory at .8 meg Ohm. The number on this display should always be above that setpoint.

I. RESISTIVITY READ/SET BUTTON - Allows the user to verify the absolute preset resistivity setpoint by depressing this button.

J. DISPLAY CHANNEL SELECTOR TOGGLE SWITCH - Determines from which Channel the display sensors are taking a reading.

Temperature Control Section

K. TEMPERATURE SET SCREW - Used to set the temperature of the heating-cooling fluids for Local control operation. Is by-passed when the TCU is connected to the etcher and the etcher is on.

L. TEMPERATURE READ/SET BUTTON - Displays the temperature setpoint when depressed. Reflects the Electrode Temperature Parameter on the Rainbow Recipe Page when the TCU is connected to the etcher. Reflects the Temperature Set Screw setpoint when the TCU is disconnected from the etcher or if the etcher is turned off.

M. TEMPERATURE ALARM HIGH AND LOW TRIGGER TOGGLE SWITCH - Displays the maximum and minimum temperature setpoints for the heating-cooling liquid before there will be an alarm. These setpoints are determined by adjusting the set screws in the holes next to this toggle switch.

N. TEMPERATURE ALARM LIGHT RESET BUTTON - Resets the HI and LOW TRIG alarm lights. Once these alarm lights are activated, they will remain lit even when the cause for the alarm has been rectified. This button must be depressed to turn them off.

O. TEMPERATURE AUDIO ALARM SELECTOR SWITCH - Determines whether the temperature alarms will be audible (ON) or silent (OFF).

P. TEMPERATURE ALARM LIGHTS - Will illuminate when the heating-cooling liquid has exceeded its setpoint parameters.

System Alarm Section

Q. SYSTEM ALARM LIGHT PANEL - This panel contains a series of lights which alert the user to the condition of the TCU and which provide visual warnings. The green lights on this panel indicate there are no problems and a "RUN" condition. The red lights are warning lights and indicate some sort of "FAILURE." These failures can either elicit just a warning or may cause a system shutdown. They are outlined as follows:

Compressor failure - visual warning and **system shutdown**
Heater failure - visual warning and **system shutdown**
Low flowrate - visual warning
Improper heating-coolant resistivity - visual warning
Liquid level below what is safe for the TCU (LEVEL SHUTDOWN)- visual warning and **system shutdown**
Low liquid level (LEVEL WARN/FILL) - visual warning first

R. SYSTEM ALARM LIGHT RESET BUTTON - Once the system alarm lights are activated, they will remain lit even when the cause for the alarm has been rectified. The user must press this button to see if the alarm situation has been corrected and there is a green "RUN" condition once again.

2.0 INSTALLATION AND OPERATION

Use the following procedures as a guide to help locate and install the TCU. Four system pictorials (Figures 2 - 5) are provided at the end of this section to aid in identifying system components. **Do not start the TCU until all of Section Two has been followed.**

2.1 SET-UP

CAUTION: DO NOT HOOK-UP TO POWER UNTIL STEPS 1-4 IN THE FOLLOWING PROCEDURE HAVE BEEN FOLLOWED. DO NOT FILL WITH LIQUID UNTIL THE ENTIRE SET-UP PROCEDURE HAS BEEN FOLLOWED.

1. Uncrate and locate the unit as desired. Note that the temperature control unit should have a 24" front and rear clearance and be within 50 feet of the Rainbow etcher.

2. Level the unit so that it doesn't rock.

3. Once the unit is placed and leveled, lock the front wheel locks.

4. If the unit has been shipped from a long distance, remove the outer skins and make sure that all the interior assemblies are tight, especially the pumps. (The pump and pump motor are mounted flush together with a V-clamp. **Make sure that the V-clamp is secure so that the pump is not misaligned.)**

5. Press the white reset button (High Pressure Reset on the High Pressure Switches) located on the right hand side of both pump motors. Refer to Figure 4, Page 13.

6. Connect the unit to a 30 amp, 208/230VAC, 3 phase circuit. If you have removed the outer skins, either replace them or pull out all of the panel interlock switches to the service position. Turn on circuit breakers CB1 to CB6 to power up the system instrumentation. This will illuminate the readout displays and the small RUN/FAILURE lights on the TCU operator interface.

CAUTION: IF THE UNIT HAS BEEN EXPOSED TO COLD TEMPERATURES (STORED OUTSIDE, SHIPPED FROM A DISTANCE, ETC.), ALLOW THE UNIT TO SIT FOR ABOUT 12 HOURS BEFORE TURNING IT ON. THIS WILL ALLOW THE UNIT PARTS TO COME TO A PROPER OPERATING TEMPERATURE AND HELP PROTECT THE COMPRESSOR.

7. Adjust the local TEMPERATURE SET set screws on the Operator Interface Panel to reflect the Rainbow operating temperatures set on the Rainbow Recipe Page. This will ensure that the TCU maintains the heating-cooling fluids at their proper temperatures if the unit should become disconnected from the etcher or if the etcher turns off. To adjust the screw, hold down the black SET button in order to set the setpoint on the TEMPERATURE display and turn the screw with a screwdriver.

2.2 HOOK-UP

CAUTION: NEVER OPERATE THE TEMPERATURE CONTROL UNIT WITHOUT THE SYSTEM SUPPLY AND RETURN LINES CONNECTED. THE JUMPER HOSES SHIPPED WITH THE SYSTEM MAY BE USED FOR FILL AND TEST PURPOSES BEFORE ACTUAL HOOK-UP TO THE RAINBOW SYSTEM.

NOTE 1: In any start-up of a pressure system, it is advisable to open the return lines before opening the supply valves. This will prevent the system and its components from being subjected to shock or water hammer.

NOTE 2: Care should be taken to not overtighten any valves either clockwise or counterclockwise.

1. Connect hoses from the back of the temperature control unit to the etcher as follows:

   Upper Tank Supply - goes to Rainbow Upper Electrode
   Upper Tank Return - returns from the Rainbow Upper Electrode

   Lower Tank Supply - goes to Rainbow Lower Electrode
   Lower Tank Return - returns from the Rainbow Lower Electrode

2. Coolant connections are to be made with 1/2" OD nylon Fast-n-tite nuts with special O-rings (ensure that the O-rings are orange in color).

3. To insure proper flowrates, do not reduce the line size from the unit.

4. Connect the house water to the Housewater supply and return fittings.

5. Connect the EMO cable (72P2-71P4) and the interface signal cable (72P1-71B1P7) provided with the Rainbow system from the TCU to the Rainbow RF Generator Cart.

6. If you plan to run the system for inspection/test without it being hooked-up to the Rainbow system, you must put a jumper wire between pins 5 and 6 on the 72J2 circular connector on the rear of the electrical chassis.

2.3 FILLING AND START-UP

CAUTION: IF THE COOLANT RESERVOIRS ARE OVERFILLED, FLUID WILL OVERFLOW THROUGH THE VENT LINES ON THE TOP OF THE TANKS. THE TANK CAPACITY IS APPROXIMATELY 4 GALLONS (15 LITERS).

CAUTION: THE REFRIGERATION UNITS ARE HERMETICALLY SEALED AND NOT USER SERVICEABLE. ONLY TRAINED AND LICENSED REFRIGERATION PERSONNEL SHOULD WORK ON THIS EQUIPMENT.

NOTE: It is best to fill the TCU when it is at room temperature.

1. Remove the fill plugs from the reservoir fillports. Note that the fillports have threaded holes. A threaded spout may be useful to avoid spillage.

2. Slowly fill each tank with approximately 4 gallons of a mixture of 50% D.I. water (10 MΩ or higher in resistivity) and 50% ethylene glycol. The LEVEL WARN/FILL green light turns on when the tank is full.

   NOTE: Note that when the system instrumentation is first powered on, the RUN/FAILURE indicator lights on the operator interface panel are all activated. The LEVEL WARN/FILL and the LEVEL SHUTDOWN lights for both Channels will be red indicating that there is not enough fluid in the reservoirs to properly operate the system. As you are filling each reservoir, watch the LEVEL WARN/FILL lights and discontinue filling each tank when the green WARN/FILL light illuminates. This will indicate that the proper level of fluid is in the reservoir.

3. Press the RUN/FAILURE indicator light RESET buttons. The lights for the LEVEL SHUTDOWN should now be green.

4. Set the audible alarm switches (AUDIO) on the temperature control sections of the operator interface panel to the OFF position and press the temperature control RESET buttons.

5. Press the RESET button above the emergency off button. This should illuminate the AC ON light indicating that the TCU can be turned on.

6. Turn on the TCU by pressing the POWER ON button. The POWER indicator light should now be activated.

   NOTE: When the system is turned on for the first time, the heating cooling liquids [illegible]

2.3 FILLING AND START-UP (CONTINUED)

A. Carefully add more water to the reservoir(s) and perform step B while holding down the START button. Holding down the button will override the shutoff feature.

NOTE: In the next steps, it is important to note that the indicator lights for FLOW and LEVEL SHUTDOWN will not change status once they are red until their RESET buttons are pressed (only the LEVEL WARN/FILL lights on the system alarm panels change status by themselves).

B. On the front panel, press the RESET buttons for the RUN/FAILURE indicator lights from time to time while observing the FLOW and LEVEL SHUTDOWN lights. When the green FLOW indicator lights illuminate, the heating-cooling liquids will have travelled through the system (the FLOW sensors are located in the electrode return lines). When the green LEVEL SHUTDOWN indicator lights illuminate, the reservoirs should be full enough to prevent system shutdown.

C. When both the green FLOW and green LEVEL SHUTDOWN lights for the reservoirs have illuminated, discontinue filling the reservoirs and release the START button.

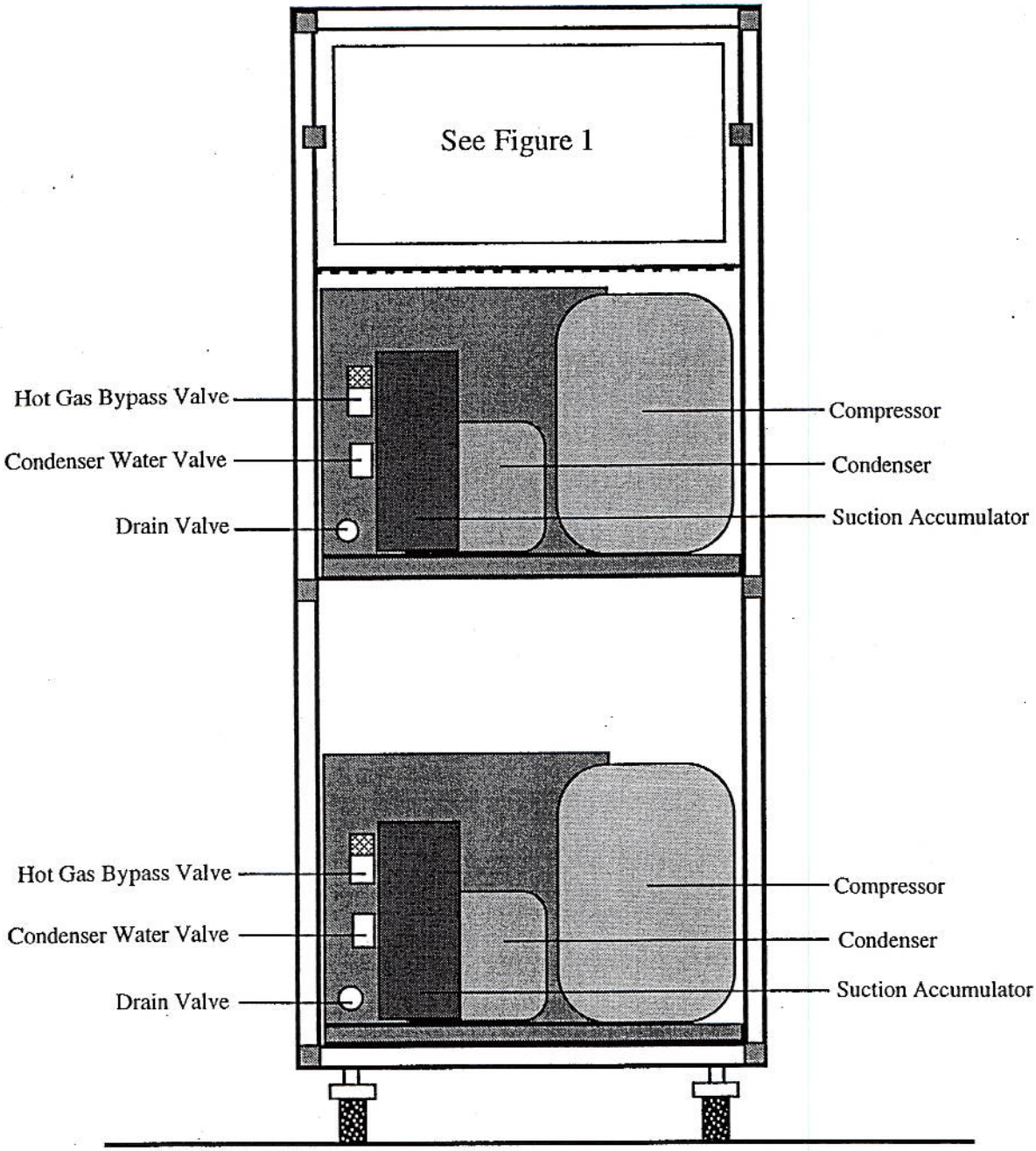
D. Observe the LEVEL WARN/FILL indicator lights. If the red lights are illuminated, continue filling the reservoirs, a little at a time, until the green lights are illuminated.

7. Replace the fill plugs in the fillports.

NOTE: At this point the TCU should continue to run smoothly. If a system shutdown occurs, check the RUN/FAILURE indicator lights to see what might be causing the shutdown. Remember, the system will not run if the compressors fail, the heaters fail, or the liquid in the reservoirs falls below the shutdown level.

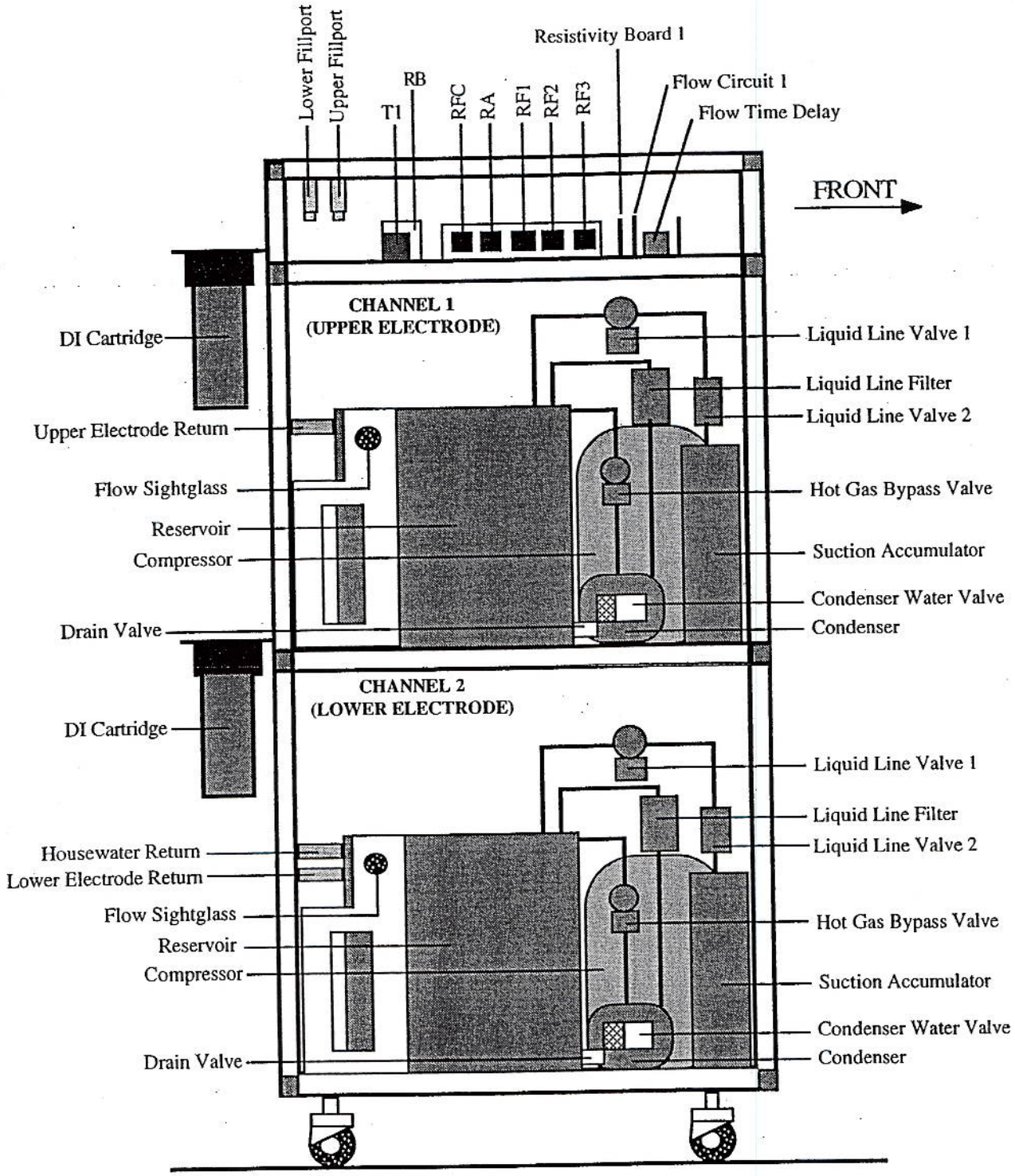
8. On the temperature control sections of the operator interface panel, adjust the alarm HI TRIG and LO TRIG set screws with a screwdriver to the desired alarm trigger setpoints. These setpoints will become visible on the TEMPERATURE display when the toggle switch next the set screw holes is toggled from TEMP to either HI TRIG or LOW TRIG.

9. When the system is running properly and the heating-cooling liquids have had time to reach their desired setpoint levels, set the temperature alarm switches for an audible alarm (AUDIO - ON) if desired.



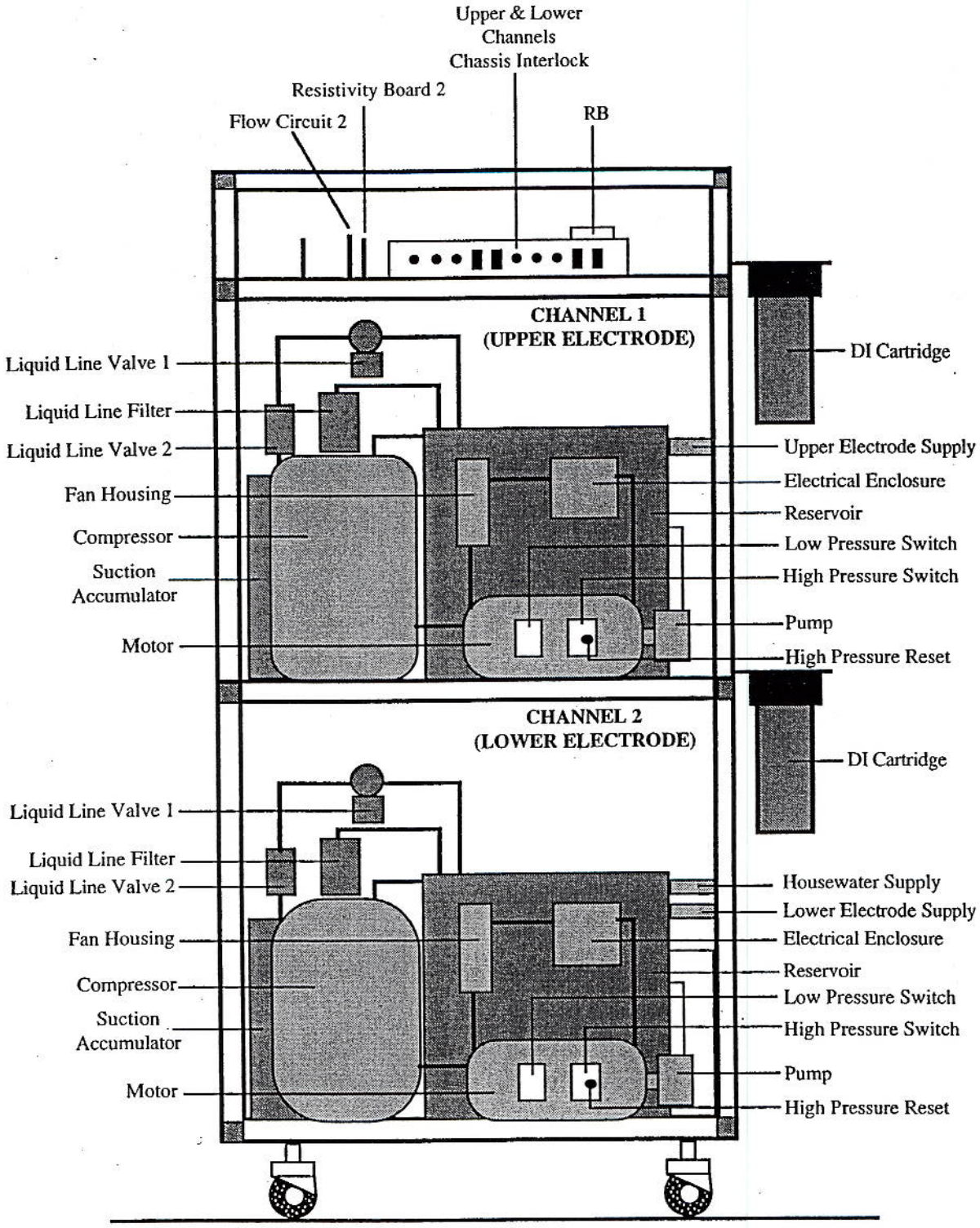
FRONT VIEW

Figure 2
Front View (Lower Panel Removed)



LEFT SIDE VIEW

Figure 3
Left Side View (Side Panel Removed)



RIGHT SIDE VIEW

Figure 4
Right Side View (Side Panel Removed)

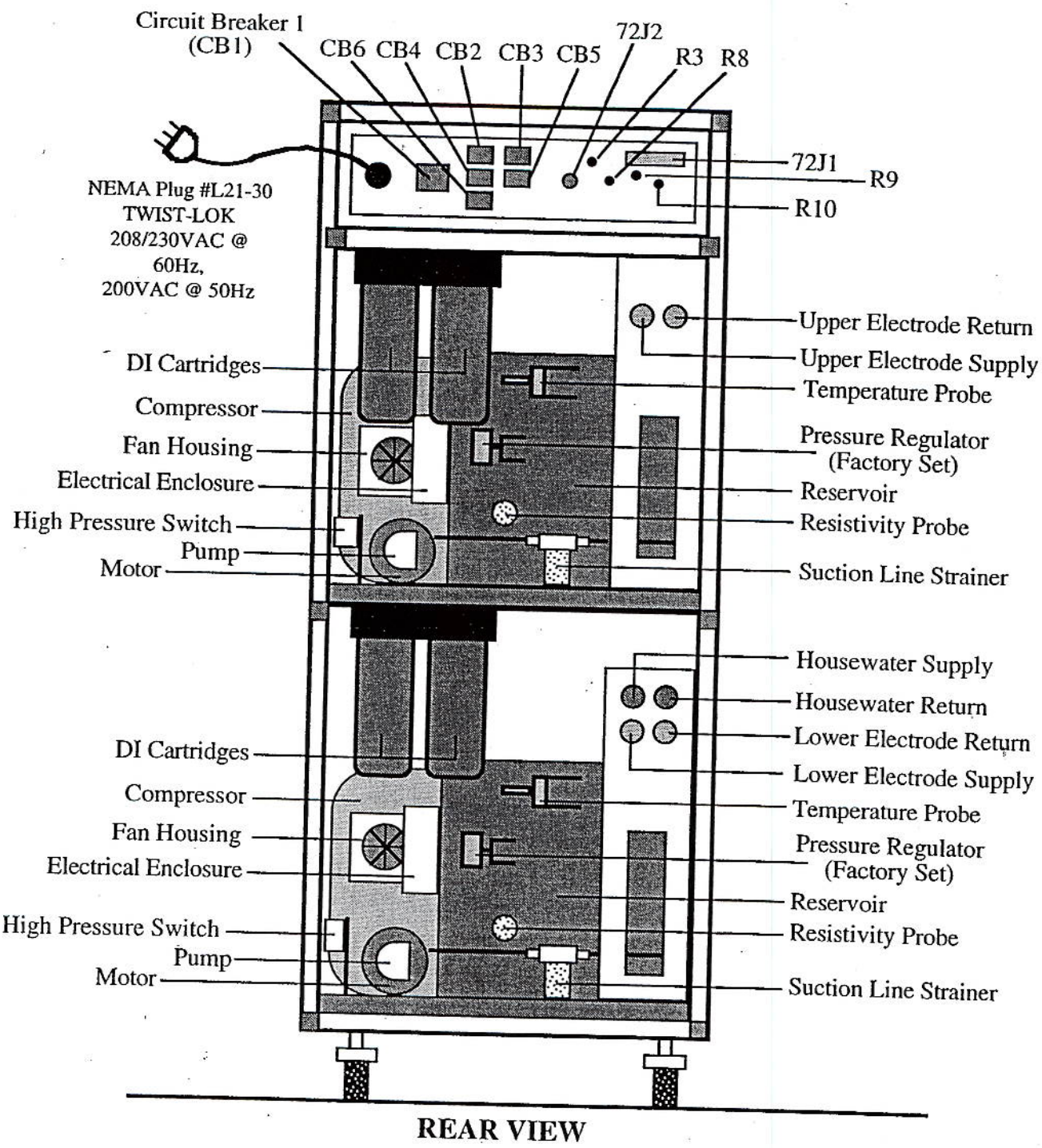


Figure 5
Rear View (Rear Panel Removed)

3.0 SAFETY

Every attempt has been made to make the Flowrite TCU safe for the user, but care should still be taken when performing maintenance on the system. This section lists some of the safety features and gives some cautionary notes.

3.1 SAFETY FEATURES

1. All of the removable outer skins of the TCU are interlocked so that the system will turn off when they are removed. Pull-out interlock switches (6) are provided to override this interlock when maintenance and testing need to be performed.

2. Every component and panel in the TCU is grounded to the chassis.

3. Three independent features have been provided to keep the system from overheating:
   a. the heater sheaths are monitored
   b. the water level of the reservoirs is monitored
   c. temperature controls provide visual, audible and contact control through interface board as a warning of high temperature.

4. All pressure fittings go through the top of the unit to help prevent leaks.

5. All electrical components are on the top of the system and away from the reservoirs. The reservoir heaters are located on top of the tanks.

3.2 SAFETY PRECAUTIONS AND WARNINGS

1. The refrigeration system discharge line, from the compressor to the condenser coil, may reach temperatures up to 300°F when operating at high ambiences. Use care when working in this area to avoid burns.

⚠ **CAUTION: THE REFRIGERATION UNITS ARE HERMETICALLY SEALED AND NOT USER SERVICEABLE. ONLY TRAINED AND LICENSED REFRIGERATION PERSONNEL SHOULD WORK ON THIS EQUIPMENT.**

2. The operator is protected from uninsulated portions of the electrical power circuitry by interior covers that are not safely interlocked. Should troubleshooting require testing with the power on, care must be exercised when working around and with exposed wires.

⚠ **WARNING: THE VOLTAGES ENCOUNTERED IN THE TCU CAN BE FATAL. ONLY TRAINED, QUALIFIED PERSONNEL SHOULD REPAIR THIS UNIT.**

4.0 MAINTENANCE

The Flowrite TCU is designed to provide long term operation with a minimum of service. The system allows for ready access to any of its components and the components used are readily available from industrial hardware or refrigeration supply houses. The cabinet should be cleaned every six months (or more often if local conditions demand) to remove any buildup of dust and dirt.

4.1 PREVENTIVE MAINTENANCE VISUAL CHECKLIST

1. Lamps and LED's

    a. Power Lamp -- **ON.**
    b. Failure Lamp -- **OFF.**
    c. "AC ON" Lamp -- **ON.**
    d. All 12 Warning indicators green.
    e. Temperature alarm indicators **NOT** lit.
    f. Confirm that the Temperature Setpoint matches actual temperature.
    g. Valid flow reading.
    h. Valid Resistivity reading.

2. Circuit Breakers

    a. CB1 is in "up" position.
    b. CB2 to CB6 are in the left "I" position.

3. Miscellaneous

    a. Fill caps tight.
    b. Cables not loose.
    c. No fluid on floor. (NOTE: Please distinguish between glycol and condensation, or water).
    d. Panel screws are in place.

4.2 PREVENTIVE MAINTENANCE DURING SCHEDULED SHUTDOWN

In order that the TCU continues to operate up to its specifications, it is suggested that the following steps be taken as preventive maintenance:

CONTINUOUS

1. Keep the system clean.
2. Wipe up any spills.

SIX MONTH INTERVALS

1. Check all water fittings for leaks.
2. Check pump drive pin and motor shaft for wear. (Replace pin if wear is evident.)
3. With a nut driver, check and tighten the V-Band clamps that secure the pump to the pump motor.
4. Check for 50/50 mix of ethylene glycol & DI water.
5. Check the filter/strainer on the suction side of the pump.

TWELVE MONTH INTERVALS

1. Check all the water fittings and tighten if needed.
2. Change the circulation pumps and drive pins.

4.3 D.I. CARTRIDGE REPLACEMENT

NOTE: When the RESISTIVITY display starts to show low resistivity (less than .8 megOhm), the D.I. cartridges should be replaced. Follow the procedure given below:

1. Turn off the TCU.
2. With a strap wrench, remove the canisters.
3. Remove the D.I. cartridges from the canisters and discard them.
4. Clean all film and sediment from the inside of the canisters and rinse them with deionized water.
5. Clean the underside of the filterheads.
6. Place a new D.I. cartridge into each canister.
7. Replace the canisters and tighten them. **Make sure the O-rings are seated correctly before screwing them on.**
8. Turn on the system and check for leaks.
9. Clean up any spilled heating-cooling liquid.
10. Check the WARN/FILL indicator lights on the operator interface panel to see if more fluid needs to be added to the reservoirs.

4.4 CHECKING THE REFRIGERANT LEVEL

Should the TCU show signs of improper cooling, a refrigerant leak may have developed. To determine how much refrigerant is in the system, perform the following:

1. Turn off the system and remove the left side panel.

2. Leave the system off and at rest for a few minutes.

3. Override the panel shutoff interlock by pulling out the interlock switch.

4. Turn on the system.

5. Set a temperature setpoint that will put the TCU in a cool down mode.

6. While the TCU is in the cool down mode, observe the refrigerant sightglasses (located above the reservoirs) and check the refrigerant.

   a. The refrigerant dot indicator should be green. If it is yellow or white the refrigerant has been contaminated.

   b. If it bubbles continuously while the system is in the cool down mode, the refrigerant level is low.

7. If a leak is suspected or the refrigerant level is low, call a competent refrigeration technician to check for leaks and refill the refrigerant.

CAUTION: THE REFRIGERATION UNITS ARE HERMETICALLY SEALED AND NOT USER SERVICEABLE. ONLY TRAINED AND LICENSED REFRIGERATION PERSONNEL SHOULD WORK ON THIS EQUIPMENT.

4.5 PUMP SUCTION STRAINER CLEANING

FOLLOW PROCEDURE LIST BELOW:

A. Shut off unit.
B. Remove rear panel.
C. Drain reservoir.
D. Remove clear canister on pump suction line.
E. Rinse out the internal screen with distilled water.
F. Rinse out the canister.
G. Replace the screen, canister and tighten.
H. Refill reservoir.

4.6 CALIBRATION PROCEDURE FOR TEMPERATURE CONTROLLER 42-0011

Perform this procedure if the Temperature Control Unit (TCU) temperature probe or the temperature control board 42-0011 needs to be replaced. (See Figure 6, Page 20.)

A. Equipment Required:

1. Precision thermometer (electronic or mercury) with a resolution 0.05°C accuracy (0.05°C at 0°C and 25°C).
2. Digital Voltmeter (DVM).
3. Ice water bath in a thermally insulated container, well stirred. Minimum 250 ccm, 3" level.
4. Water bath 30°C, well stirred. Minimum 250 ccm, 3" level.

B. Procedure:

1. Turn on the TCU.
2. Hook up the DVM to the Temperature Controller as follows (See Figure 6, Page 20):

   a. Negative lead to P9.
   b. Positive lead to P10 pin 1.

3. Set the DVM to a 2VDC range.
4. Place the precision thermometer into the ice bath and verify that the temperature is 0°C ± 0.05°C.
5. Place the TCU temperature probe into the ice bath. Wait for one minute while stirring the bath.
6. Adjust Trimmer VR1, 0 Adjust, to read 0.00 on the DVM.
7. Place the TCU temperature probe into 30°C bath. Wait for one minute while stirring the bath.
8. Place the precision thermometer in the same bath and adjust VR2, (SLOPE) until the reading on the DVM matches the temperature of the bath. (example: 3.0VDC = temperature 30.0°C)
9. Disconnect DVM, reinstall temperature probe into tank, and tighten.
10. Repeat the above procedure for the other channel if necessary.

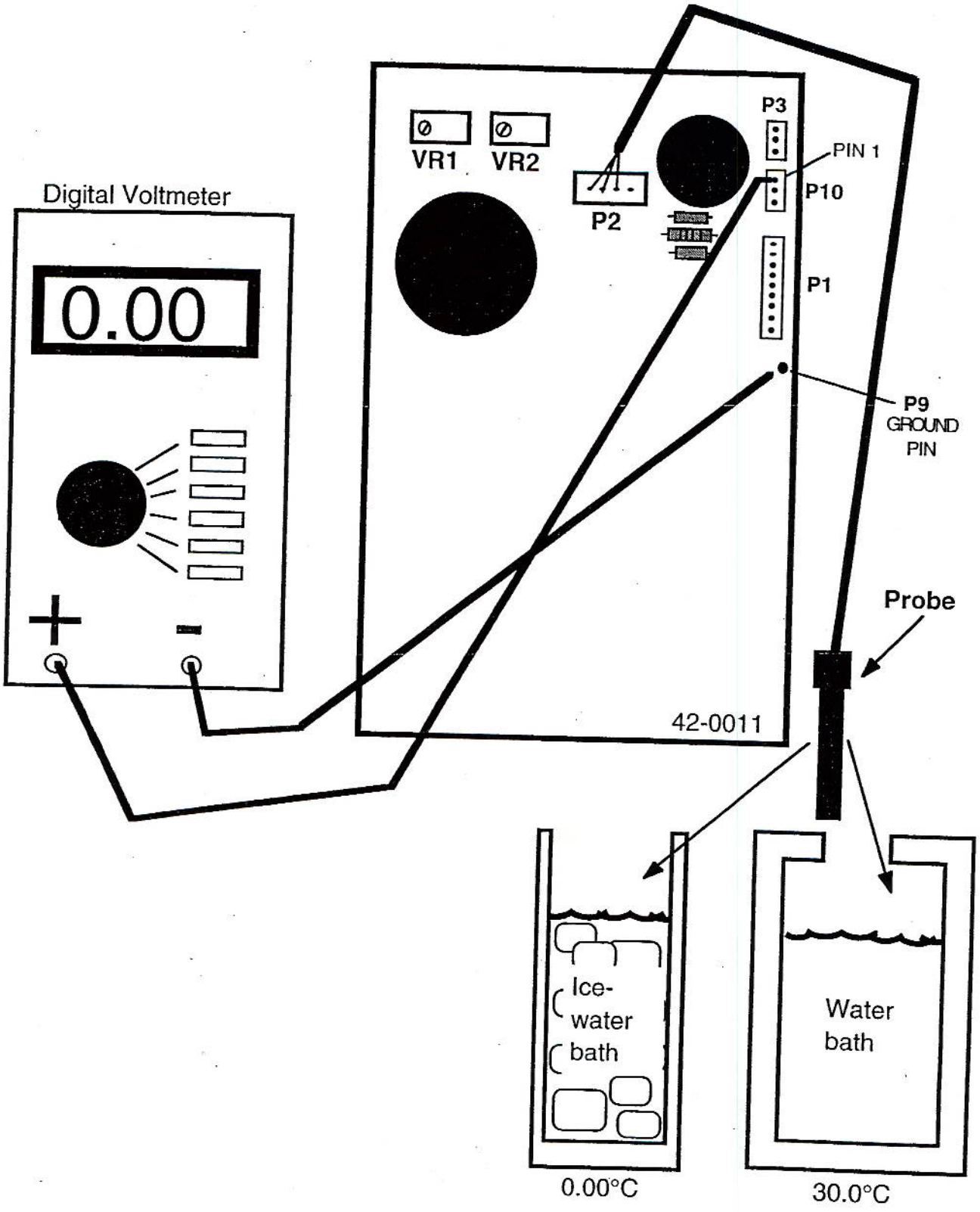


Figure 6
Calibration of the Close Temperature Controller

4.7 CALIBRATION PROCEDURE FOR THE RESISTIVITY CONTROLLER

Calibrating the controller consists of comparing the readings with a known standard and adjusting R 20 to agree with the standard. R 14 and R 15 are factory set and should not need adjustment in the normal course of operation.

Perform this test first to verify the need for resistivity controller calibration. Unplug the two pin molex connector from the resistivity probe sensor (see Figure 5, page 14). Connect a 140K ohm 1% resistor in place of the probe sensor. This should give a readout of 20 meg ohms on the resistivity display. If not proceed with calibration.

A. Equipment Required:

1. A True RMS Digital Voltmeter
2. A 140 K Ohm 1% Resistor

B. Calibrating Board Procedure:

(See Figure 7 on page 22 for location of R14, R15 and R20 on the circuit board,)

1. Connect a digital RMS Voltmeter between pins 5 and 9 of the terminal strip. A resistivity probe must be in place.

   a. Positive lead to pin 9
   b. Negative lead to pin 5

2. Adjust R 15 for a reading of 0.480 volts, D.C. +/- 0.005 volts.

3. Switch the voltmeter to A.C. volts. Adjust R 14 for a reading of 6.000 mV, rms +/- 0.300 mV,rms.

4. Drain tank and remove resistivity sensor. Place 140K ohm resistor across the resistivity probe sensor elements. The sensor must be clean and dry. Now, adjust R20 for a readout on front panel of 20 meg ohms exactly.

5. Remove resistor and re-install the resistivity probe sensor into tank and tighten.

6. Repeat the above procedures for the other electrode if necessary.

pin 10 - pin 18

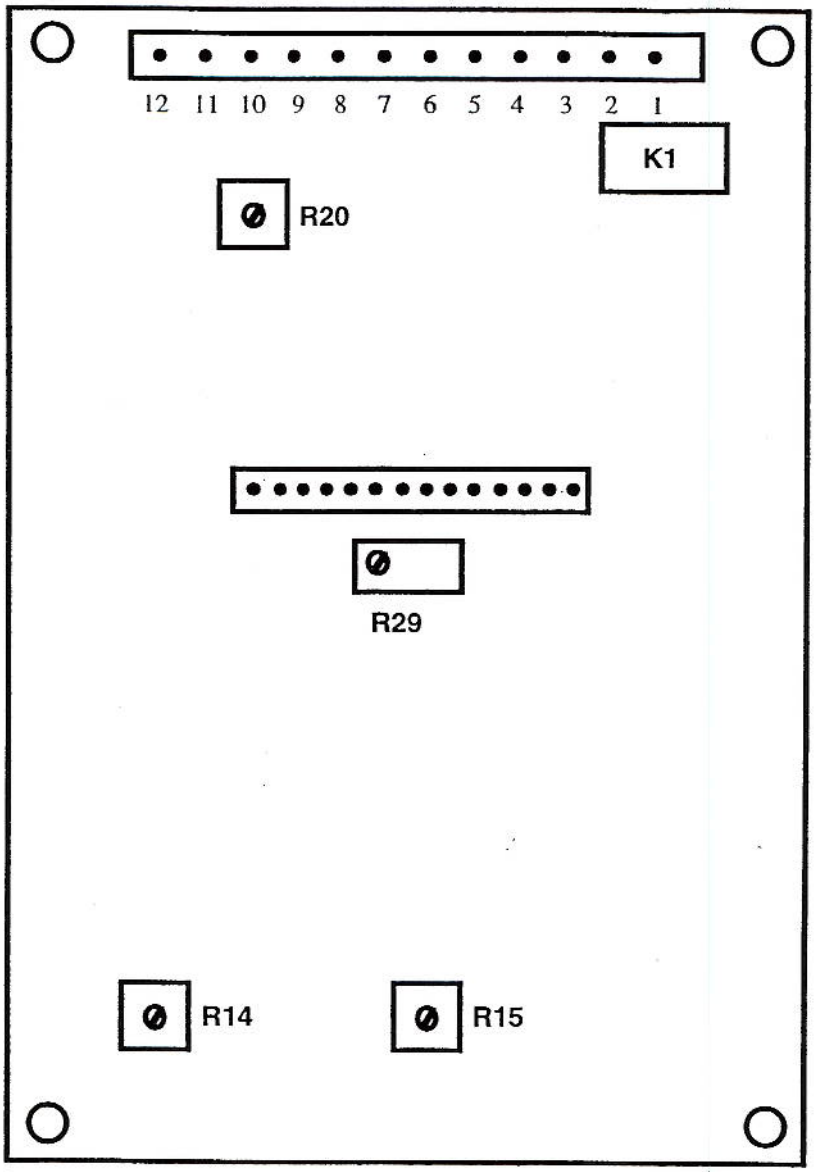


Figure 7
Resistivity Board Diagram

4.8 CALIBRATION PROCEDURE FOR THE FLOW CONTROLLER

Perform this procedure if the TCU Flow control board needs to be replaced. See Figure 8 on page 24 for a pictorial guide.

A. Equipment Required:

1. One Small 3/32" slot screw driver.
2. One 1/2" or 3/8" Flowmeter which reads up to 2 GPM.
3. Two 1/2" Nyloseal tubing approximately 3' long
4. Two Female connectors 1/2" x 1/2" or 1/2" x 3/8"

B. Procedure:

1. Connect the test loop from supply to return on the channel which needs to be calibrated.

2. Bring Tank Temperature of 50/50 mixture or DI water to 25° C before adjusting calibration. Once at that temperature calibration can begin.

3. Adjust flowmeter on the test loop to read 0.5 GPM

4. Reset flow LED on the front panel to green

5. Slowly adjust R 8 counterclockwise raising the trip point. Stop when the flow LED on the front panel goes red.

6. Verify this by opening up the test loop to 3.5 GPM. Then reset flow LED on the front panel to green.

7. Slowly lower the flow on the test loop until flow failure LED on the front panel goes red. Then stop and read flow on the test loop; is it at 0.5 GPM?

8. If not, adjust R 8 clockwise to lower the trip point or counterclockwise to raise the trip point. Repeat steps 6 and 7 until it reads 0.5 GM.

9. Once trip point has been set correctly adjust flowmeter on the test loop to 3.5 GPM. Make sure the channel being calibrated reads 3.5 GPM. If not adjust RP1 Trimpot to read 3.5 GPM on the front panel to match the flowmeter on the test loop.

10. Repeat the above procedure for the other channel if necessary.

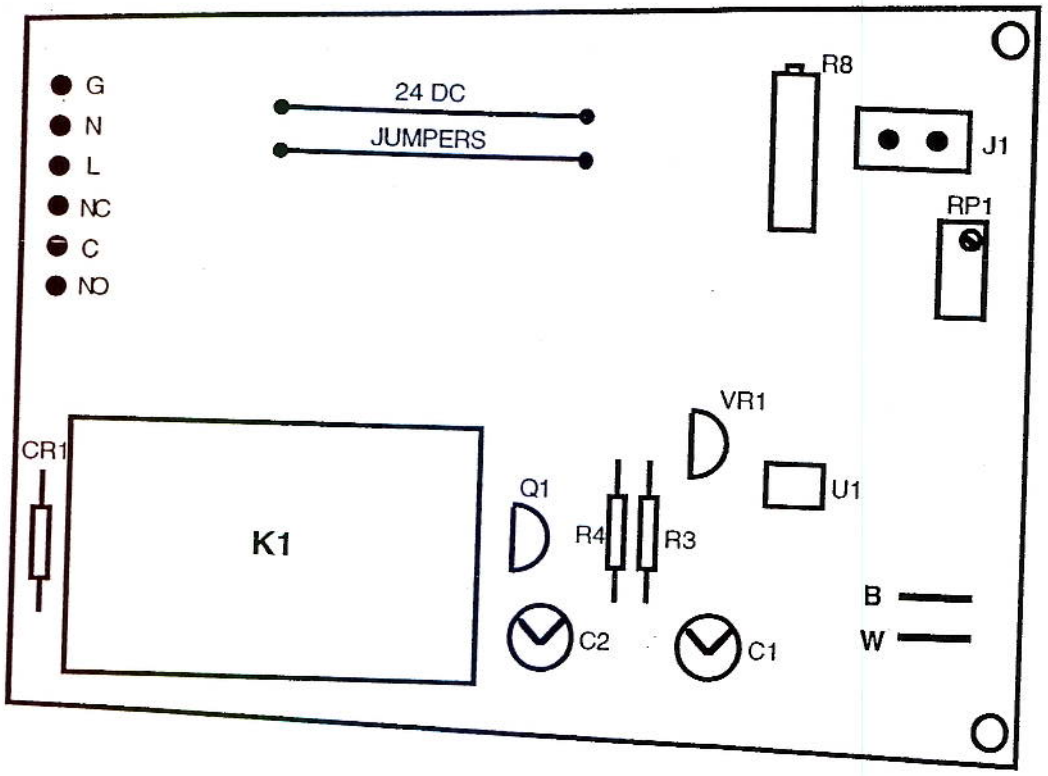


Figure 8
Flow Board Diagram

4.9 TROUBLESHOOTING GUIDE

The Flowrite Temperature Control Unit has been designed for continuous duty. All components have been chosen for highest reliability, but as in all cases with mechanical devices, a problem could occur. This troubleshooting guide is divided into sections so the operator may check the specific problem quickly. If any problems occur that are not immediately obvious, check to be certain that it is the TCU that is malfunctioning and not the etcher.

	PROBLEM	CAUSE	CHECK
A	Complete unit will not turn on.	No power.	1. Check power conduit. Is cord plugged in? 2. Check all circuit breakers (CB1 to CB6). 3. Check 6 interlock panel switches. 4. Check jumper on pins 5 & 6 of **72J2** connector (See Figure 5, Page 14), or check for a closed loop through the Tool for pins 5 and 6. 5. Press reset switch above EMO switch.
B	Power on, unit will not pump.	Pump not rotating.	1. Alarm systems must be reset. 2. Pump defective; Replace. 3. Circuit breakers CB2 or CB4 tripped; Reset. 4. Motor defective; Replace. 5. Power plugs from module to electrical chassis are not fully inserted, causing no contact. 6. Pump drive pin worn or broken.
C	Pump working but no circulation.	Water lines not connected correctly, or major blockage in lines.	1. Check that the lines are hooked up correctly. 2. Check for blockage in lines going to the Tool. 3. Check in-line strainer on pump suction line for blockage. (See Figure 5, Page 14)
D	Pump working but no circulation.	No coolant.	1. Check level shutdown on Front Panel System Alarm Section. 2. Fill tank until Level Warning light goes green.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
E	Pump operates but no pressure.	Relief valve out of adjustment, or slight blockage in suction line.	1. Adjust pressure relief valve on tank (Pressure is factory set at 60 PSI). 2. Check for slight blockage in strainer on pump suction line. (See Figure 5, Page 14)
F	Cooling unit will not turn on.	Refrigeration system shutdown.	1. Refrigeration high pressure switch must be reset thru right side panel. Check for adequate housewater flow 6 GPM @ 40 PSI and 20 PSID. 2. Press reset button (See Figure 1, R) on front panel warning systems. 3. If the refrigeration system has lost refrigerant the pressure switch will not allow the system to run even if you hit RESET.

NOTE: The next two sections, G & H, should be done with the unit running in the local mode. That is to say, the chiller should not be receiving any temperature setpoints from the tool. To ensure that the unit stays in local mode, remove the 72J2 connector from the rear and install a jumper on pins 5 and 6 to allow the chiller to run without any input from the tool. See additional note at the end of section H.

G	Cooling unit runs but will not cool.	Glycol mixture not correct to allow full range cooling.	1. Check for 50/50 mixture of Ethylene Glycol and DI water.
		Low refrigerant.	1. With system in a cool down mode, check the condition of the refrigeration sightglass. The glass should be completely full, or at least 3/4 full and clear. If you see less than 3/4 full, or if you see constant bubbles rushing past, the system is low on refrigerant. **NOTE:** During heat-up, you will see a low sightglass volume and/or bubbles in the sightglass. Make sure you do your checking with the system in a constant cool down mode.

4.9 TROUBLESHOOTING (CONTINUED)

PROBLEM	CAUSE	CHECK
G cont.	Temperature control circuitry defective.	1. Check temperature setpoint. Is chiller supposed to be cooling? 2. Switch off the power to the heating controls by switching off CB3 or CB5 respectively for upper channel or lower channel. If the system starts to cool when you switch off the circuit breaker, then the controls that energize the heater and hot gas by-pass valve are malfunctioning. 3. Check operation of hot gas by-pass/heater circuit by toggling the setpoint around the actual temperature. You should hear the solenoid coil of the by-pass valve clicking on and off. If you don't hear the clicking, the solid state relay (RH1, RH2) which controls the operation of the heater and by-pass valve may be stuck in a closed position, there-by making the system heat and never cool. 4. If the solid state relay is always closed, next you need to determine why. There could be two reasons: 1.) The relay itself has shorted the contacts together and they're always closed; or 2.) The control relay on the temperature control board, which controls the input coil voltage to the solid state relay, is shorted together there-by causing the solid state relay to stay energized. 5. Put a volt meter across the two switching terminals of the solid state relay. When the system calls for heating, you should read near zero volts across the terminals. When the system calls for cooling, you should read full line voltage across the terminals. Again, toggle the setpoint back and forth around the actual temperature, you should see the full line voltage be switched on and off. If the full line voltage is always off while you toggle the setpoint, then the relay is always closed.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
G cont.			6. Pull the two pin connector off of the little green AC/DC PC board on the relay. If the full line voltage stays off, then the relay itself is defective. If the full line voltage appears when you remove the two pin connector, then the control board is malfunctioning and sending a constant heat command to the solid state relay. This heat command is a 24 VAC signal that is switched on and off by the temperature control board. When the system calls for heating, a 24 VAC signal is applied to the two pin connector on the AC/DC PC board. When the system calls for cooling, the 24 VAC is switched off. Verify this operation by checking the voltage across the two pin connector. If you always see a 24 VAC signal, even when you turn the setpoint down to cool, then the temperature control board is defective.
H	Cooling unit runs and always cools. (will not heat)	Circuit breakers for heating circuit switched.	1. Check that CB3 and CB5 are both in the on position.
		Hot gas by-pass refrigerant flow inadequate.	1. Carefully mark the position of the hot gas by-pass needle valve knob and then close the valve. It should have been between 3/4 and 1 1/4 turns open. If it was less than 3/4 of a turn open, the system was not getting enough flow of hot gas refrigerant. Open the valve again where it was before you turned it, or open it to at least 3/4 of a turn open. The purpose of this valve is to achieve the ±1°C stability at any given setpoint.

4.9 TROUBLESHOOTING (CONTINUED)

PROBLEM	CAUSE	CHECK
H cont.	Temperature control circuitry defective.	1. Follow the troubleshooting guide in part G to determine the correct operation of the solid state relays. (RH1, RH2)
	Heater not working.	1. If the temperature control circuitry is functioning correctly, the last part to check is the operation of the heater itself. Inside the electrical enclosure, that is above the pump motor on each module, you will find two mechanical thermostats. One T-stat has smaller 18 AWG wires on it and the other has larger 14 AWG wires on it. You'll need to put a clamp style amp meter around one of the blue 14 AWG wires. This is where you read the amperage that the heater is using. It should be approximately 6.5 to 7.5 amps. **NOTE:** The purpose of the mechanical thermostat is to disable the operation of the heater below near 0°C. At this temperature it is not necessary for the heater to work. Above 0°C (approximately), the heater resumes operation as controlled by the temperature control circuitry. If your actual temperature is above 0°C, and the system calls for heating, and you don't read any amperage on the heater, the t-stat may be defective or misadjusted. If you jumper or wire together the two 14 AWG wires on the t-stat, you enable the heater to function at any temperature. If you do see amperage after making the jumper, then remove the jumper and put the wires back in their original position. Turn the t-stat pin with pliers counterclockwise, as if you were looking at the head of the pin. If you see the amperage appear, the t-stat was misadjusted; otherwise, the t-stat is defective. To re-adjust the t-stat, set the temperature setpoint

4.9 TROUBLESHOOTING (CONTINUED)

PROBLEM	CAUSE	CHECK
H cont.		to -5°C. Let the temperature stabilize at -5° and then set the setpoint to 0°C. While the system is heating, turn the t-stat pin back and forth, and watch the amperage on the heater go on and off. Turn the pin very slowly and stop when you see the change. Do this about three times until you get the feel of the t-stat switching, and then stop when the amperage is off. You need to do this procedure while the system is in a constant heat mode from -5°C to 0°. If the system reaches 0° before you're finished with your adjustments, the heat function will stop and you'll be confused as to whether you or the temperature control board stopped the heater. Repeat the procedure if necessary. When you are confident of your adjustment, heat the system to about 10°C. Watch the amperage on the heater. The heater should start to function somewhere between 0° and 5°C. If the system heats to 10° and the heater still hasn't come on, you need to either re-adjust the t-stat again, or replace it due to intermittent or defective set ability.

NOTE: If you find that the chiller works normally in the local mode, but has a problem during operation in the remote mode, then you have a problem with the interface board. Proceed to section Q.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
I	Cooling unit shuts off, will not restart	High pressure switch cutout.	1. Press high pressure reset switch thru side panel (See Figure 4, Page 13).
		No water to condenser.	1. Check condenser water supply. Unit requires approx. 6 GPM @40 PSI and 20 PSID.
		Condenser water too hot.	1. Condenser water should be under 85° F supply temperature.
		Low Refrigerant.	1. Check system for leaks; repair & recharge if necessary.

The following section is for checking warning system alarms. The theory for all alarms is that a closed loop in the wiring, for any given alarm, will show a good condition. That being the case, a loose wire could cause an alarm indication. When checking any alarm indication, put a jumper across the sensor that triggers the alarm. If the alarm clears, then the alarm indication is valid. If the alarm does not clear when you jumper the sensor, the problem is a loose wire.

J	Resistivity light illuminated.	Low resistivity of D.I. water.	1. Exchange cartridges. 2. Ensure that D.I. water used is of high grade quality.
		Water not polishing.	1. Check for flow thru the cartridges and back into the reservoir. Be very careful not to lose, or misposition the 2 filter screens and the flow restrictor on the D.I. polishing loop.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
J cont.		Wiring circuitry open or loose connection.	1. If the wiring circuitry for the resistivity probe opens, or if the probe is disconnected, you will see a readout in the high twenties or more. This is an abnormally high resistivity reading so you'll know that either there is a loose connection or the probe is defective. To check the continuity of the circuitry, unplug the resistivity probe and install a 140K-ohm 1% resistor across the connector. You should read 20.0 on the resistivity read-out. This confirms that the connections are complete and that the resistivity board is reading correctly. If you do not read 20 on the DPM, adjust R20 on the resistivity board until the display reads 20.0. If you can't adjust the readout to 20.0 you should ohm-out the connections to ensure continuity from the plug to the board. The two wires for the resistivity probe go to pins 11 and 12 on the longer of the two connectors, on the resistivity board.
		Resistivity Probe dirty.	1. Drain tank and remove resistivity probe. Clean any foreign matter that may be stuck to or in the probe elements.
K	Compressor light illuminated.	High pressure switch cutout.	1. See sections F and I on refrigeration shut-down.
L	Heater light illuminated.	Heater internal switch tripped.	1. The heater has an internal overtemp switch which is not exchangeable. If the switch is open, the whole heater must be replaced.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
M	Flow light illuminated and/or low, or no flowrate readout on front panel DPM.	Low flowrate.	1. See sections C, D, & E on flow problems.
		Paddlewheel flow sensor is jammed (won't spin), or sensor doesn't produce a signal.	1. If you know there is flow but the paddlewheel is not spinning, then some debris has jammed the wheel. If the wheel is spinning, remove the 2 pin in-line connector from its receptacle and measure the signal being generated by the flow transducer by putting your voltmeter on AC volts and attaching the leads to the two wires in any order. While the wheel spins, a very small AC voltage signal is generated. If you turn the system off, the paddlewheel slows down and stops. You'll see a gradual decline in the voltage as the wheel stops. When you restart the unit, the voltage starts low and then quickly goes high as the wheel reaches full speed again. If no voltage is generated, the flow paddlewheel is defective. If voltage is present but the readout shows no valid value, then ohm-out the two wires individually from the flowswitch to the connector on the flow board. The two flowswitch wires go to B & W on the flow board (See Schematic). If the circuit is complete, follow the calibration procedure listed in the manual.

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
N	Level light(s) illuminated.	Low level.	1. Check water level in reservoir. Top off as needed. DO NOT OVERFILL! Sometimes small amounts of floating debris in the tank can cause a level switch to stick. Then you must remove the switch, clean it, and replace it.
O	Temp. alarm light(s) illuminated.	Temperature out of range.	1. Check the settings of the low and high trigger on each channel's temperature control board. These setpoints create a window, and if the actual temperature goes out of this range, the alarm will trigger.
P	Temperature DPM reading invalid or strange numbers.	Temperature probe defective.	1. If the electrical connections on the temp. probe short together, you will see invalid or a very high reading on the DPM, approximately 140 or higher. If the electrical connections become disconnected, or if the connector is pulled apart, the reading on the DPM will be very low, around -140. Unplug the temp. probe and use a spare probe to check the circuitry. If the spare probe gives the same indications, then you either have an open connection somewhere along the wires, or you have a defective temp. control board. The two temp. probe wires go to P2 on the temp. control board (See Schematic).

4.9 TROUBLESHOOTING (CONTINUED)

	PROBLEM	CAUSE	CHECK
Q	Interface board malfunction.		1. When the system is in the remote mode, the tool can remotely set the desired temperature setpoint as well as read the actual temperature and monitor the condition of the alarm system. To check the interface board functions, first make sure that the tool is enabling the remote capabilities by checking for a 24 VAC signal on pins 3 and 4 of the 72J2 connector. The 24 volt signal energizes relay RI on the electrical chassis; therefore, the coil of this relay (RI) is a good place to measure the voltage. The coil is on pins 13 and 14 of the relay base itself. When this relay is energized, it closes two sets of contacts, one for each temperature control board. When these contacts close, it tells the temperature control board to disregard the setpoint that has been set on the front panel and to accept the setpoint that is being input by the tool. This can be checked very easily by pressing the read/set button on the front panel. 2. When you press the read/set button, you will see what the setpoint is. By removing the RI relay from its socket, you are effectively making the unit go back to a local mode so you can verify the local setpoint. Then, carefully re-insert the relay and the setpoint on the display should change back to what is being sent by the tool.

4.9 TROUBLESHOOTING (CONTINUED)

PROBLEM	CAUSE	CHECK
Q cont.		3. If the setpoint changes but does not match exactly what is being sent by the tool, then the interface board needs to be exchanged. If you get no change at all, then the control board is not reading the remote setpoint due to either the contacts on RI are not closing, or there is a loose connection somewhere between RI and connector P3 pins 3 and 4 (See Schematic) on the temperature control board. If setpoint reads 0° when you change from local to remote, that means that the temperature control board is enabled to read the remote setpoint, but there is no setpoint being input so the board defaults to 0°. (Or this could mean that the setpoint being entered is 0°. Verify at this time what is being sent by the tool.)

SUGGESTED SPARE PARTS LIST

FLOWRITE TEMPERATURE CONTROL UNIT

MODEL NO: RPC2/28W-RNB

NO.	QTY.	DESCRIPTION	PART NO.
1.	*	Board, Flow Limit (FL1, FL2)	228-022-1519
2.	*	Board, Interface	228-022-1705
3.	*	Board, Resistivity (RMB1, RMB2)	228-022-1720
4.	2	Board, Temperature Controller	228-022-0011
5.	*	Condenser Water Regulator Valve	228-022-5019
6.	1	Condenser Water Regulator Valve Rebuild Kit	228-022-5020
7.	2	D.I. Filter Cartridge, 10" Long (Blue)	228-022-0241
8.	1	Flow Transducer	228-022-0710
9.	*	Level Sensor, Reservoir	228-022-0602
10.	4	O-Ring, Flange	228-022-0416
11.	4	O-Ring, Union	228-022-0418
12.	1	Pump Motor, 1/3hp, 230/208V, 50/60Hz	228-022-5013
13.	1	Pump, Recirculating 4 GPM SS w/Flange	228-022-0255
14.	6	Pump Drive Pin	228-022-5009
15.	*	Pump Suction Strainer, 1/2 mpt	228-022-0025
16.	*	Relay, Compressor (RC1, RC2)	228-022-1503
17.	*	Relay, DPDT 24VAC Coil (RA, RF1, RF2, RF3)	228-022-1507

SUGGESTED SPARE PARTS LIST

NO.	QTY.	DESCRIPTION	PART NO.
18.	*	Relay, Heater Solid State (RH1, RH2)	228-022-1509
19.	#	Reservoir Heater, Stainless Steel	228-022-1915
20.	*	Resistivity Probe 44-1007	228-022-0392
21.	1	Temperature Probe/Sensor (Solid State)	228-022-0336
22.	*	Board, Power Supply	228-022-4000
23.	*	Board, Warning System	228-022-1700
24.	2	Restrictor	228-022-0160
25.	2	D.I. Screen	228-022-0165
26.	*	Circuit Breaker, 30 AMP	228-022-2730
27.	2	Reservoir Black Fill Caps	228-022-4688
28.	1	Bulb, Indicator Lights	228-022-1606
29.	~~1~~ 1	~~Bulb, AC-ON Light, INC.~~ Bulb, AC-ON Light, LED	~~228-022-3000~~ 228-022-3088

* Stock for 4 or more chillers on site.

\# Stock for 10 or more chillers on site.

Please specify Model No., Voltage and Hz when ordering parts.

PARTS LIST
FLOWRITE TEMPERATURE CONTROL UNIT
MODEL NO: RPC2/28W-RNB

A. REFRIGERATION

NO.	QTY	DESCRIPTION	PART NO.
1.	2	Compressor, Black	228-022-5514
2.	2	Compressor, Blue	228-022-5515
3.	2	TXV	228-022-5010
4.	2	Liquid Line Filter	228-022-5926
5.	2	Solenoid Valve, Liquid Line	228-022-5914
6.	2	Solenoid Valve, D.I.HX, Reservoir Vent	228-022-5916
7.	2	Sightglass, Liquid Line	228-022-5115
8.	2	Solenoid Valve, Hot Gas Capital Air stock	228-022-5915 33.05
9.	2	Heat Exchanger	228-022-5960
10.	2	Heat Exchanger, D.I.	228-022-5961
11.	2	Heat Exchanger, Vent	228-022-5962
12.	2	Crankcase Pressure Regulator	228-022-5950
13.	2	Condenser, Water-cooled	228-022-5099
14.	2	Receiver	228-022-5920
15.	2	Low Pressure Switch	228-022-5825
16.	2	High Pressure Switch	228-022-5830
17.	2	Accumulator	228-022-5990
18.	2	Condenser Water Regulator Valve	228-022-5019

PARTS LIST

A. REFRIGERATION (CONTINUED)

NO.	QTY	DESCRIPTION	PART NO.
19.	2	Motor, Pump , GE MOTOR [redacted]	228-022-5013 118.55
20.	2	Plate with mounts, Motor Base	228-022-5018

Please specify Model No., Serial No., Voltage, and Hz when ordering parts.