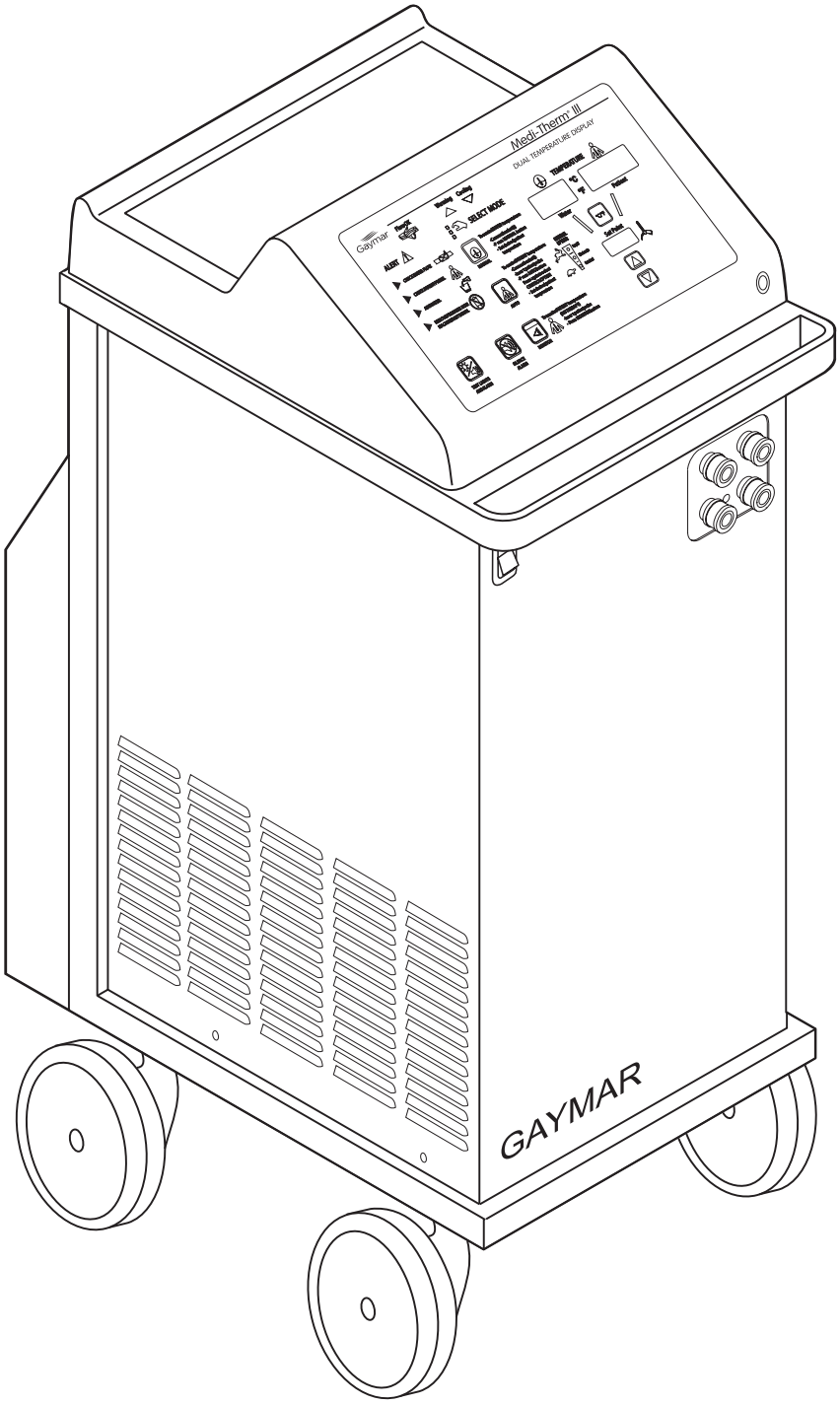
Gaymar
Your patients. Our commitment.

MEDI-THERM® III

HYPER/HYPOTHERMIA MACHINE
MTA7900



303L CLASSIFIED C UL US

SERVICE MANUAL

P/N 101251000 Rev A 04/10

SAFETY PRECAUTIONS

⚠ WARNING

- Repairs should be performed only by qualified personnel such as cert5ified biomedical electronics technicians or certified clinical engineers familiar with repair practices for servicing medical devices and in accordance with the Medi-Therm III Service manual.
- Always perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3, p. 20) after making repairs and before returning the Medi-Therm® III machine to patient use.

Improper repair may result in death or serious injury, equipment damage, or malfunction.

⚠ CAUTION

Federal law restricts this device to sale by or on the order of a physician.

RECEIVING INSPECTION

Upon receipt, unpack the Medi-Therm III machine. Save all packing material. Perform a visual and mechanical inspection for concealed damage by removing the wraparound from the chassis (see page 75). If any damage is found, notify the carrier at once and ask for a written inspection. Photograph any damage and prepare a written record. Failure to do this within 15 days may result in loss of claim.

Refer to section 7.0 of this *Medi-Therm III Service Manual* for additional details.

Do not return the Medi-Therm III machine to Gaymar Industries without first contacting Gaymar's Technical Service Department for assistance.

Telephone: Direct (716) 662-2551
Toll Free 1 800 828-7341

IMPORTANT
Before operating the Medi-Therm III machine, remove the compressor shipping braces. See p. 88, figure B.

OPERATING INSTRUCTIONS

For more information on operating the Medi-Therm III machine, refer to the Medi-Therm III Operator's Manual.

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TABLES

ILLUSTRATIONS

1.0 PATIENT SAFETY

Use the Medi-Therm III Hyper/Hypothermia machine only under the direction of a physician.

Review the following precautions and procedures prior to each application:

⚠ DANGER

Do not use the Medi-Therm III machine in the presence of flammable anesthetics. **Risk of explosion can result.**

⚠ WARNING

- If the patient's temperature is not responding or does not reach the prescribed temperature in the prescribed time or deviates from the prescribed temperature range, notify the attending physician promptly. **Failure to notify the physician promptly may result in death or serious injury.**
- Power interruption will cause the Medi-Therm III machine to go into a standby mode, resulting in no therapy to the patient. Follow instructions for desired mode to resume operation. **Failure to resume therapy could result in death or serious injury.**
- The Medi-Therm III machine is provided with a means of checking rectal/esophageal temperature probes. When performing the probe check, use a disposable protective sheath (Becton-Dickinson catalog 3700 oral sheath or equivalent) on the probe. **Failure to use sheath could result in cross-contamination.**
- When using the rate controlled Auto Moderate or Auto Gradual modes for warming, switching to other modes, e.g. Auto Rapid or Manual, or changing the temperature set point during the therapy will cause the Medi-Therm to reset the therapy. **Alternating the Mode or Temperature set point may impact the overall duration of the therapy.**
- A physicians order is required for use of equipment. Check the integrity of the skin according to department protocol when regulating temperature with external devices. Frequency of assessment and documentation will vary depending upon the individual response of the patient. **Failure to monitor patient may result in skin damage or inappropriate patient temperature.**

  PEDIATRICS—The temperatures of infants and children are more responsive to surface heating and cooling than adults. The smaller the patient, the more pronounced the effect because of the patient's higher ratio of skin contact area to body mass.

  TEMPERATURE-SENSITIVE PATIENTS—Patients with impaired peripheral blood circulation caused by vascular diseases and patients who are incapacitated may be more sensitive to temperature changes than patients with more normal circulation.

  OPERATING ROOM PATIENTS—Patients with poor circulation associated with inadequate heart function, reduction in blood volume, and constriction of peripheral blood vessels may deviate from the normal response to the external application of heat and cold.

1.0 PATIENT SAFETY (continued)

⚠ WARNING

- Avoid placing additional heat sources between the patient and blanket/body wrap. **Skin damage can result.**

  Heat applied by the blanket/body wrap can result in a rise in skin temperature at the areas of contact. The additional heat rise due to electrosurgical currents flowing to the dispersive electrode could be sufficient to cause tissue injury. Each thermal effect by itself may be completely safe, but the additive effect may be injurious.[1] Keep additional heat sources from between the patient and the blanket/body wrap.

- Prevent excessive and/or prolonged tissue pressure and shearing forces, especially over boney prominences. **Skin damage may result.**

  Localized skin injury due to tissue compressed between boney prominences and fluid-filled channels has occurred during prolonged cardiovascular procedures at water temperatures well below the scientifically established epidermal burn injury threshold.[2]

  Local ischemia can follow the application of pressures exceeding capillary pressure resulting in tissue necrosis. This local effect may be enhanced by generalized impairment of the circulation, local shearing forces and increased metabolic demand because of temperature elevation. Pathological changes may begin in two (2) hours.

- Keep the area between the patient and the blanket/body wrap dry. **Excessive moisture may result in skin damage.**

  The application of heating or cooling may affect the toxicity of solutions. Prep solutions have been reported to injure the skin when allowed to remain between patients and water circulating heating blankets/body wraps during prolonged procedures.[3]

⚠ CAUTION

- Place a dry absorbent sheet between the patient and the blanket when using the plastic-like side of any blanket.

  A dry absorbent sheet placed between the patient and the Hyper/Hypothermia Blanket will absorb perspiration. Vinyl blankets and body wraps with nonwoven fabric surfaces do not require an absorbent sheet when using the nonwoven side toward the patient.

- **Federal law restricts this device to sale by or on the order of a physician.**

REFERENCES

1 Gendron, F. G. *Unexplained Patient Burns*. chap. 5, p. 87, Quest Publishing Co., 1988.

2 Scott, Stewart M. *Thermal Blanket Injury in the Operating Room*. Arch. Surg., vol. 94, p. 181, Feb. 1967; Crino, Marjanne H. *Thermal Burns Caused by Warming Blankets in the Operating Room*. Clinical Workshop, vol. 29, pp. 149-150, Jan-Feb 1980; Gendron, Francis G. Journal of Clinical Engineering, vol. 5, no. 1, pp. 19-26, January-March 1980; Moritz, A. R. and Henriques, Jr., F.C. *Studies of Thermal Injury II. The Relative Importance of Time and Surface Temperature in the Causation of Cutaneous Burns*. Am. J. Path., 23:695, 1947; Stoll, Alice M. and Chianta, Maria A. *Method and Rating System for Evaluation of Thermal Protection*. Aerospace Medicine, vol. 40, no. 11, pp. 1232-1238, Nov. 1969; Stewart, T. P. and Magnano, S. *Burns or Pressure Ulcers in the Surgical Patient.* Decubitus, vol. 1, pp. 36-40, 1988.

3 Llorens, Alfred S. *Reaction to povidone-iodine surgical scrub, scrub associated with radical pelvic operation*. Am. J. Obstet. Gynecol., pp. 834-835, Nov. 14, 1974; Hodgkinson, Darryl J., Irons, George B. and Williams, Tiffany J., *Chemical Burns and Skin Preparation Solutions*. Surgery, Gynecology & Obstetrics, vol. 17 pp. 534-536, Oct. 1978.

2.0 MACHINE PRECAUTIONS

⚠ DANGER

Disconnect power before servicing unit. **Risk of electric shock.**

⚠ WARNING

- Repairs should be performed only by qualified personnel such as certified biomedical electronics technicians or certified clinical engineers familiar with repair practices for servicing medical devices, and in accordance with the *Medi-Therm III Service Manual.* **Improper repair may result in death or serious injury, equipment damage, or malfunction.**
- Always perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3, p. 20) after making repairs and before returning the Medi-Therm III machine to patient use. **Improper repair may result in death or serious injury, equipment damage, or malfunction.**
- Some manufacturer's patient probes may contain compensation resistors in series with YSI 400 series thermistors. Do not use these probes with the Medi-Therm III machine. **Inaccurate patient temperature readouts will result and inappropriate therapy may be delivered.**

  NOTE: Use only Gaymar probes or equivalent YSI 400 series probes approved for use with medical devices.
  (Refer to the list of recommended probes in section 5.0, p. 7 *PROBE INFORMATION.*)

- All wire-lead, patient-connected transducer assemblies are subject to reading error, local heating, and possible damage from high-intensity sources of RF energy. Inadequately grounded electrosurgical equipment represents one such source, since capacitively-coupled currents may seek alternate paths to ground through probe cables and associated instruments. **Patient burns may result.**

  If possible, remove the probe from patient contact before activating the surgical unit or other RF source. If probes must be used simultaneously with electrosurgical apparatus, hazards can be reduced by selecting a temperature monitoring point which is remote from the expected RF current path to the ground return pad.
- Do not tip machine over without first draining the water out and unplugging the power cord. **Electrical shock or damage to the machine can result.**

⚠ CAUTION

Add distilled water only. **Failure to use distilled water may result in poor machine performance.**

- Do not use alcohol, since it is flammable. Alcohol may also accelerate blanket/body wrap deterioration.
- Do not operate the machine without water, since damage to internal components may result.
- Do not overfill. Overfilling may result in overflow because the water in the blanket/body wrap drains back into the machine when the machine is turned off. Overfilling may also result in splashing from the overflow tube during transport.

3.0 REPAIR POLICY

The Medi-Therm III Hyper/Hypothermia machine is warranted free of defects in material and workmanship for a period of two (2) years, under the terms and conditions of the Gaymar warranty in place at the time of purchase. The compressor portion of the machine carries a five (5) year prorated warranty. The full warranty is available from Gaymar upon request. Medi-Therm III Hyper/Hypothermia machines can be repaired at the factory or in the field. Upon customer request, a shipping carton will be provided to safely return the machine to Gaymar or a qualified Service Center.

For customers who repair Gaymar Medi-Therm III machines at their location, this manual contains information to allow a qualified biomedical technician, familiar with practices for servicing medical devices, to make necessary repairs. Service training for the Hyper/Hypothermia machine is recommended and is available from Gaymar. For specific details, contact your Gaymar representative or the Technical Service Department at Gaymar. (See back cover of this manual for Gaymar telephone numbers.)

3.1 IN-WARRANTY REPAIRS

All in-warranty field repairs must be authorized by Gaymar's Technical Service Department before proceeding.

3.2 OUT-OF-WARRANTY REPAIRS

The following repair options are available when local machine servicing is elected:

1. **Defective Component**
   Replacement parts can be ordered. Specify the Gaymar part number; refer to the Parts Lists in section 11, pp. 76–88 of this manual.

2. **Machine Repairs**
   If the Medi-Therm III machine becomes defective and the cause of the problem cannot be determined, the complete machine can be returned to the factory for servicing at the purchaser's expense. This normally represents the most expensive repair option.

   Please contact Gaymar to obtain an RG (returned goods) number prior to returning the machine.

4.0 SPECIFICATIONS

4.1 PHYSICAL SPECIFICATIONS

	MTA7900
Dimensions	37 in. high x 18-3/4 in. deep x 14 in. wide (94.0 cm high x 47.6 cm deep x 35.6 cm wide)
Weight	141 lb (full); 121 lb (empty); shipping wt, 136 lb 64.0 kg (full); 54.9 kg (empty); shipping wt, 61.7 kg
Normal Reservoir Operating Volume	Approximately 10 quarts (9-1/2 liters) distilled water
Operating Ambient Temperature Range	15.6ºC to 32.2ºC (60ºF to 90ºF)
Dead Head Pressure	9.0 psi max (62 kPa max)
Flow	16 gph (gallons per hour) 60.6 liters/hour) *

* Minimum flow rate through a full size Gaymar Hyper/Hypothermia Blanket

4.2 THERMAL SPECIFICATIONS

High Temperature Limits Fixed (S2) & (S3)	44ºC (111.2ºF) to 49ºC (120.2ºF)
	(Machine will go into REMOVE FROM USE NOW / MACHINE SHUTDOWN condition and audible alarm will be on)
Low Temperature Limits Fixed (S1)	-3ºC (26.6ºF) to +2.5ºC (36.5ºF)
	(Machine will go into REMOVE FROM USE NOW / MACHINE SHUTDOWN condition and audible alarm will be on)
Add Water Alert Actuation	Less than 8 quarts (7.6 liters) of water in the cold reservoir
Check Water Flow Alert Actuation	6 GPH
Check Probe Activation Temperature (whenever probe is used)	29ºC (84.2ºF) or above 45ºC (113ºF)
Patient Temperature Control Range for Automatic Mode	30ºC (86.0ºF) to 41ºC (105.8ºF)
Water Temperature Control Range for Manual Mode	4ºC (39.2ºF) to 42ºC (107.6ºF)

4.2 THERMAL SPECIFICATIONS (cont'd)

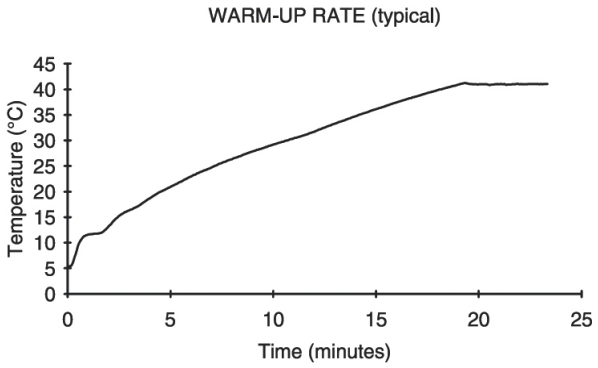

Figure 1—Typical water warm-up rate (with full size blanket)

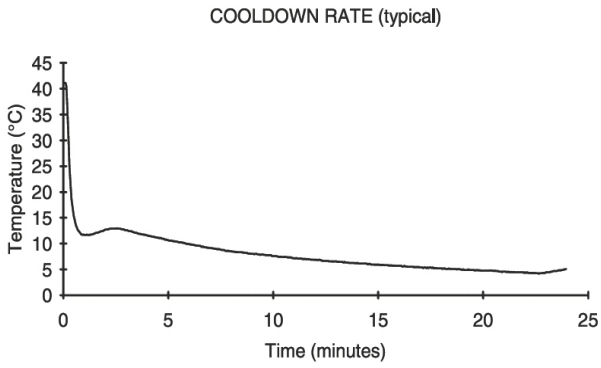

Figure 2—Typical water cooldown rate (with full size blanket)

4.3 ELECTRICAL SPECIFICATIONS

		MTA7900
Patient Temperature Measurement Accuracy		±0.5ºC, ±0.9ºF (using Gaymar 400 series probe)
Display Accuracy		±0.3ºC, ±0.5ºF
Display Resolution	Blanket Water Temperature	1ºC, 1ºF
	Patient Temperature	0.1ºC, 0.1ºF
Controller Accuracy	Blanket Water Temperature	±0.8ºC, ±1.4ºF NOTE: At set points of 4ºC to 6ºC, this accuracy may not be obtainable due to compressor control characteristics.
	Patient Temperature	±0.5ºC, ±0.9ºF
Current Leakage	Chassis	100 microamps maximum
	Patient Probe	50 microamps maximum
Input Voltage		120V ± 10V
Frequency		60 Hz
Input Current		11.5A
Regulatory		UL416 CSA C22.2 No. 125
Electromagnetic Compatibility		Meets EN60601-1-2:1993 (CISPR 11 Classified as Class A, Group 1 ISM Equipment)
Defibrillation Proof 		The Medi-Therm III MTA7900 along with its temperature probe is a “Defibrillator Proof, Type BF Applied Part” per IEC60601-1 standards.

5.0 PROBE INFORMATION

Disposable Probes

- DP400CE Disposable Rectal/Esophageal - Adult/Small Child (3' [0.9 meters] long, requires adaptor); YSI 400 series type

Probe Adaptor

- ADP10CE Reusable adaptor cable for DP400CE: connects Gaymar disposable probe to Gaymar or Cincinnati Sub-Zero control unit.

Reusable Probes

- PAT101 Patient probe—Rectal/Esophageal - Adult (10' [3.0 meters] long); YSI 400 series type
- PAT102 Patient probe—Rectal/Esophageal - Pediatric (10' [3.0 meters] long); YSI 400 series type
- PAT108 Patient probe—Skin surface (10' [3.0 meters] long); YSI 400 series type

⚠ WARNING

Some manufacturer's patient probes may contain compensation resistors in series with YSI 400 series thermistors. Do not use these probes with the Medi-Therm III machine.

Inaccurate patient temperature readouts will result and inappropriate therapy may be delivered.

NOTE: Use only Gaymar probes or equivalent YSI 400 series probes approved for use with medical devices. (Refer to the list of recommended probes above.)

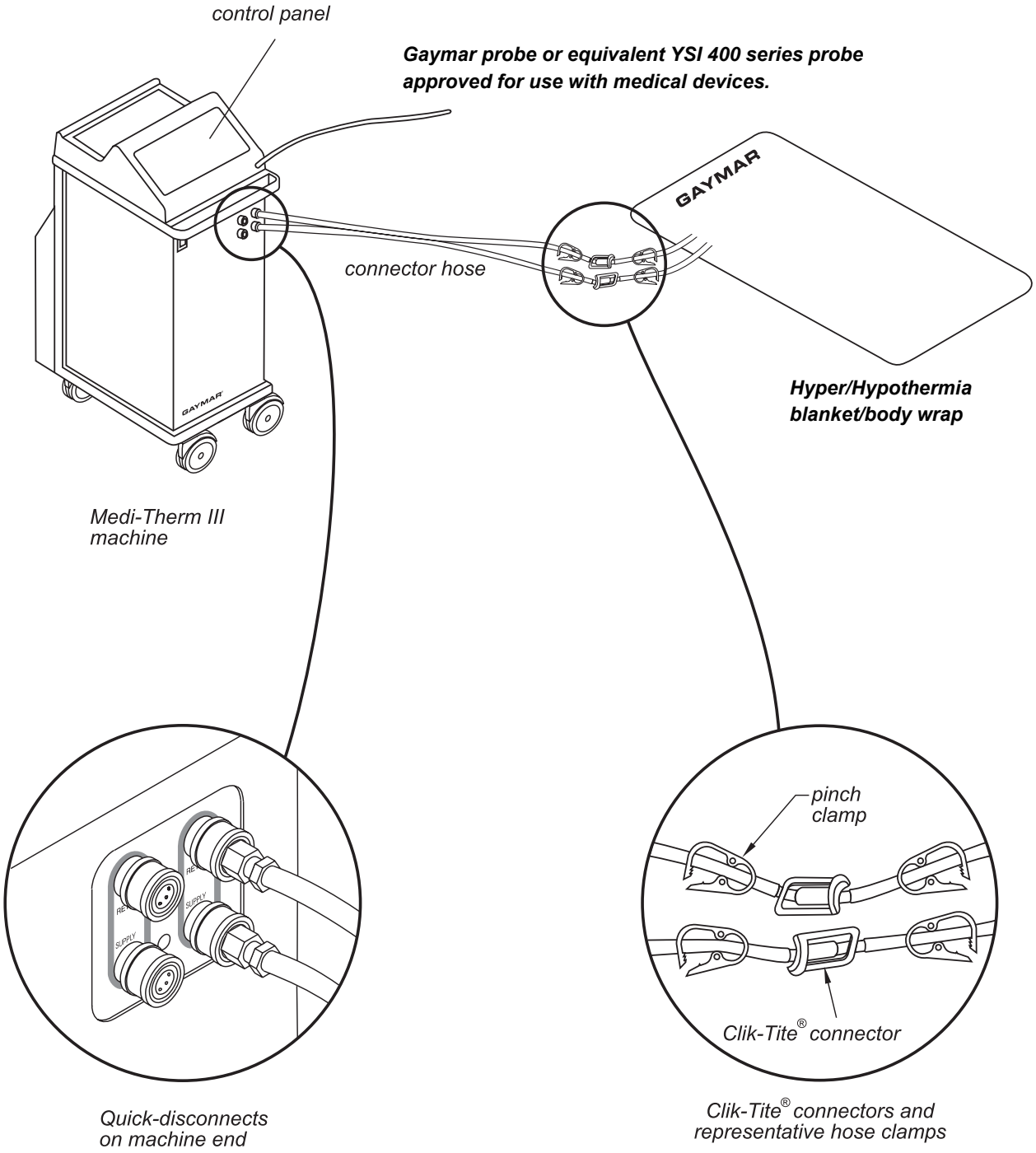

Figure 3 - Medi-Therm III System

6.0 THEORY OF OPERATION, SYSTEM

The Gaymar Medi-Therm III machine provides a means of regulating patient temperature by supplying temperature-controlled water through a connector hose to a Gaymar Hyper/Hypothermia blanket/body wrap. The blanket/body wrap provides an interface for heating or cooling the patient. A patient probe senses patient temperature, which is displayed on the control panel. (See figure 3, p. 8.)

The Medi-Therm III machine controls output water temperature by mixing hot and cold water using hot and cold solenoid valves under microcontroller control. A circulating pump, heater and refrigeration unit are also utilized.

Bimetallic thermostats and associated backup circuitry limit output water temperature independent of the microcontroller.

The feedback for control purposes depends upon the machine's operating mode. The Medi-Therm III machine may be operated in one of three operating modes:

- In *MANUAL* mode, the operator sets the desired water temperature. A temperature sensor within the machine monitors the water temperature and the machine heats or cools the water as required to bring the water temperature to the *SET POINT* temperature. The patient temperature may be monitored by use of a patient probe connected to the patient probe jack on the front of the unit.

- In *AUTO* mode, the Medi-Therm III machine automatically regulates the patient's temperature to the selected *SET POINT.* The machine constantly compares actual patient temperature with the *SET POINT* value, and automatically adjusts the water temperature so that the desired patient temperature is achieved.

- In *MONITOR* mode, the operator can monitor patient temperature through the patient probe, without providing therapy.

Two gray hose sets are provided to connect multiple blankets and/or body wraps in order to provide more body surface contact. Increased body surface contact facilitates more efficient warming/cooling.

NOTE: When connecting a second blanket/body wrap to the Medi-Therm III machine, check the water level **prior** to connecting the additional blanket/body wrap.

6.1 THEORY, MEDI-THERM III MACHINE

Whenever the machine is on, 10 quarts of water are maintained cold in the cold water reservoir. A cold water reservoir probe provides temperature feedback to the microcontroller which cycles the refrigeration unit on at 5.8°C (42.5°F) and off at 3.3°C (38.0°F).

When the water requires cooling, water is pumped from the cold water reservoir. When the water requires heating, a cartridge heater is used to quickly heat the water.

6.1 THEORY OF OPERATION, MEDI-THERM III MACHINE (continued)

WATER TEMPERATURE CONTROL

Hot and cold solenoid valves regulate the flow path by directing water returning from the blanket/body wrap to either the hot or cold water reservoir. Regulating the flow path controls the temperature of water pumped to the blanket/body wrap. The microcontroller controls solenoid valve operation. Only one valve may open at a time:

When the *WARMING* status light is lit, the hot solenoid valve is open. Water returning from the blanket/body wrap circulates through the hot water reservoir and is heated before being pumped back to the blanket/body wrap. The heater, pump, and hot solenoid valve are energized. (See fig. 10, p. 72.)

When the *COOLING* status light is lit, the cold solenoid valve is open. Water returns from the blanket/body wrap to the cold water reservoir and is replenished by chilled water from the cold water reservoir before being pumped back to the blanket/body wrap. The pump and cold solenoid valve are energized. (See fig. 11, p. 72.) The refrigeration unit maintains the cold water reservoir temperature and operates independently of the solenoid status.

When both the *WARMING* and *COOLING* lights are off, either the **water** temperature is within 1°C (1.8°F) of the setpoint (in *MANUAL* mode) or the **patient** temperature is within 0.5°C (0.9°F) of the setpoint (in *AUTO* mode). Water temperature is controlled by alternating between heating and cooling (see figures 10–11) with the heater cycled on and off as needed.

REFRIGERATION UNIT

The refrigeration circuit (see figure 12, p. 73) consists of two heat exchangers operating at two pressures and two devices used to change these pressures. The first of these devices is the compressor which changes the gas pressure from low to high. The other device is the capillary tube which reduces the refrigerant pressure from high to low.

Beginning the cycle at the capillary tube, high pressure liquid refrigerant flows in the capillary tube and is discharged into the evaporator coil. The evaporator coil, which is a heat exchanger, receives the refrigerant as a mixture of liquid and vapor at a pressure low enough so that it boils and absorbs heat from the water surrounding it.

The heated refrigerant vapor then leaves the evaporator coils, enters the suction side of the compressor and is compressed, causing its pressure and temperature to increase. The vapor, much warmer than the ambient air, travels to the condenser.

The condenser is the other heat exchanger. The condenser fan draws the colder ambient air over the condenser coils and removes the heat being carried by the refrigerant and causes it to condense back into liquid refrigerant. This completes the cycle and the high pressure liquid refrigerant is returned to the capillary tube to be used over again. The temperature of the water surrounding the evaporator coil (in the cold water reservoir) is controlled by the microcontroller. The microcontroller senses the temperature with a cold water reservoir probe and cycles the compressor relay on and off.

6.1 THEORY OF OPERATION, MEDI-THERM III MACHINE (continued)

BACKUP SYSTEMS

Backup systems within the Medi-Therm III machine limit the temperature of water exiting the machine to specified ranges in the event of a failure of the control system including the microcontroller:

Maximum water temperature is limited by two bimetallic thermostats. If either of these two thermostats is actuated, a *REMOVE FROM USE NOW / MACHINE SHUTDOWN* circuit is triggered which:

- shuts down the pump and heater;
- lights the *ALERT* and the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* indicators; and,
- sounds the audible alarm.

In addition, if the microcontroller is operational, the compressor shuts down, the displays blank, and the *ALERT* indicator and audible alarm turn on and off.

Minimum water temperature is limited by a bimetallic thermostat. If this thermostat is actuated, a *REMOVE FROM USE NOW / MACHINE SHUTDOWN* circuit is triggered, which in turn:

- shuts down the pump and heater;
- lights the *ALERT* and the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* indicators; and,
- sounds the audible alarm.

In addition, if the microcontroller is operational, the compressor shuts down, the displays blank, and the *ALERT* indicator and audible alarm turn on and off.

6.2 SYSTEM COMPONENT INTERCONNECTIONS

See figure 8, p. 67 for base-to-head and control/display board-to-power supply board connections; figure 18, p. 81 for system wiring diagram; figures 19–21, pp. 82–84 for electrical schematics; figures 22–23, pp. 85–86 for component layouts and part designations; and figure 24, p. 87 for the system block diagram.

CONTROL/DISPLAY BOARD AND POWER SUPPLY BOARD

The Medi-Therm III machine uses two printed circuit boards (see figure 8, p. 67):

- The control/display board contains the microcontroller circuits, the display circuits, and all other low voltage control circuits.
- The power supply board contains the power supply, the low voltage to high voltage interface circuits, and the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* backup safety circuits.

The control/display board connects to the patient probe jack J1 via P2 at J2 and to the digital control assembly panel via P4 at J4. All other connections from the system's peripheral devices to the control/display board are made through the power supply board.

A 26-pin cable connects the control/display board via P1 at J1 to the power supply board via P3 at J4.

6.2 SYSTEM COMPONENT INTERCONNECTIONS (continued)

Four cables connect the components in the base of the machine to the PC boards in the head (see figure 8, p.67):

- A **9-pin connector** P6 ties the water temperature probe RT2, cold water reservoir probe RT1, flow switch S5, and level switch S4 to the power supply board at J2 and ultimately to the control/display board.
- A **12-pin connector** P7 ties the high voltage devices (pump, heater, hot solenoid valve SV2, cold solenoid valve SV1, and refrigeration compressor relay K1) to the interface circuits on the power supply board, as well as thermostats S1, S2, and S3 to the high voltage backup circuitry on the power supply board.
- A **6-pin connector** P5 connects transformer T1 housed in the base to the power supply circuitry at J3 on the power supply board.
- A **chassis ground harness** from the control/display board connects to the chassis.

6.3 POWER SUPPLY

See figure 18, p.81 for the system wiring diagram; figures 19–21, pp. 82–84 for the electrical schematics; figures 22–23, pp. 85–86 for component layouts and part designations; and figure 24, p. 87 for the system block diagram.

Power enters the Medi-Therm III machine through circuit breaker CB1 to feed the refrigeration unit through relay K1. It also then enters the power supply board at J1 to feed the hot solenoid valve, cold solenoid valve, heater and pump triacs, the high voltage backup water temperature limiting circuits and transformer T1.

Power to drive the low voltage circuits on the control/display board is derived from the machine's power supplies which reside entirely on the power supply board. The transformer T1 output is rectified and filtered to generate unregulated positive and negative voltages. Q5, D1, L1 and associated components are configured as a DC to DC switching regulator in a buck configuration yielding a nominal output of +5.3 volts DC. Q6 is a linear regulator with a nominal output of plus twelve (+12) volts DC, while Q7, also a linear regulator, delivers a nominal output of minus twelve (-12) volts DC.

6.4 MACHINE FUNCTIONS

See figure 18, p. 81 for system wiring diagram; figures 19–21, pp. 82–84 for the electrical schematics; figures 22–23, pp. 85–86 for component layouts and part designations; and figure 24, p. 87 for the system block diagram.

The U37 microcontroller is fully dependent on the code stored in the U31 EPROM. When the machine is on, the microcontroller continually cycles through its main program loop to perform the following:

- Thermistor output measurement (see section 6.4.1, p. 13)
- Digital control panel input (section 6.4.2, p. 13)
- Display update (section 6.4.3, p. 13)
- Peripheral input (section 6.4.4, p. 14)
- Water/Patient temperature control (section 6.4.5, p. 15)
- Cold water reservoir temperature control (section 6.4.6, p. 16)

Backup water temperature limiting is achieved independently of the microcontroller. (See section 6.4.7, p. 16.)

6.4.1 THERMISTOR OUTPUT MEASUREMENT

Temperature measurement is achieved using 400 series thermistor beads located in the water path (water temperature probe RT2), the cold water reservoir (cold water reservoir probe RT1), and in the patient via the patient probe jack J1.

Under microcontroller U37 control, each of the three beads is connected to the current source circuitry (U38 and associated components) by a demultiplexor U49. At the same time, the resulting output voltage created by the current through the thermistor is presented to an amplifier circuit (U39 and associated components) via multiplexor U50. The amplified voltage is then applied to a voltage-to-frequency converter U24. A frequency up to 100kHz is presented to port pin P3.5 of the microcontroller. The microcontroller converts the incoming frequency to a temperature value.

At regular intervals two compensation resistors R13 and R12 are also processed in the same manner. These compensation resistors are precision resistors with values at each end of the probe temperature range of 0°C (32°F) to 50°C (122°F). The values from the precision resistors are used to compensate for circuit drift.

6.4.2 DIGITAL CONTROL PANEL INPUT

User input is entered via a digital control panel. The input from the buttons is decoded by U45. The "data available" line of U45 is tied to the microcontroller port pin P3.3. When a button press is decoded and debounced by U45, the "data available" line goes high and the microcontroller responds by inputting the decoded value.

6.4.3 DISPLAY UPDATE

For display of measured and set point temperatures, 7 segment LED displays are utilized:

- The set point display is driven by driver chip U48. The microcontroller interfaces to it via the data bus at addresses 0FFF8H, 0FFF9H, 0FFFAH, 0FFFBH.
- The patient display is driven by driver chip U6. The microcontroller interfaces to it via the data bus at addresses 0FFF4H, 0FFF5H, 0FFF6H, 0FFF7H.
- The water temperature display is driven by driver chip U5. The microcontroller interfaces to it via the data bus at addresses 0FFECH, 0FFEDH, 0FFEEH, 0FFEFH.

6.4.3 DISPLAY UPDATE (continued)

All alarm and status indicators are lit by LED bars driven by inverter/driver IC's:

- The alarm latch U53 is the interface between the microcontroller and the *ALERT, ADD WATER, CHECK PROBE, CHECK FLOW, REMOVE FROM USE NOW / MACHINE SHUTDOWN, SELECT, °F* and *°C* drivers via the data bus at address 0FFBFH. A high signal written to the latch by the microcontroller activates the individual inverter/drivers to light the corresponding indicator.
- The mode display latch U54 is the interface between the microcontroller and the *COOLING, WARMING, FLOW-OK, AUTO, MANUAL,* and *MONITOR* drivers via the data bus at address 0FFDFH. A high signal written to the latch by the microcontroller activates the individual inverter/drivers.
- The control option display latch U64 is the interface between the microcontroller and the *GRADUAL, MODERATE,* and *RAPID* drivers via the databus at address FDFFH. A high signal written to the latch by the microcontroller activates the individual drivers.
- The control latch U51 is the interface between the microcontroller and the two leader light drivers via the data bus at address 0FF7FH. When this latch is selected, a low signal on the data line from the microcontroller causes a high signal on the latch output Therefore, these two LED bar displays are "active low" in the eyes of the microcontroller in contrast to all the other LED bar displays of the machine.

The audible alarm is driven either by a high signal from the control latch U51 (from the microcontroller via the data bus at address 0FF7FH) or a high RFU IN signal from Q10 on the power supply board. A low data line signal from the microcontroller to U51 causes a high signal on the latch output. Therefore, the alarm is "active low" in the eyes of the microcontroller. Transistor Q2 activates the alarm.

6.4.4 PERIPHERAL INPUT

The input buffer U55 is the interface between the microcontroller (via the data bus at a "read" address of 0FFFEH) and the input signals from the flow switch S5 and the level switch S4 (which travel from the base through the power supply board), the probe presence switch within the patient probe jack J1, and the service mode button S3 on the control/display board. The lines to the buffer from the peripheral devices are default high (via pull-up resistors).

The level switch S4 will pull its buffer input line low when it senses a sufficient water level.

The flow switch S5 will pull its buffer input line low when it senses sufficient flow.

The probe presence switch within J1 will pull its buffer input line low when it senses the presence of the patient probe.

Pressing the service mode switch S3 on the control/display board will pull its buffer input line low.

6.4.5 WATER / PATIENT TEMPERATURE CONTROL

If the machine is in *MANUAL* mode, the water temperature as sensed by the water temperature probe is used as the feedback signal for controlling the water temperature to the *MANUAL* mode set point temperature.

If the machine is in *AUTO* mode, the patient temperature as sensed by the patient probe connected to the patient probe jack is used as the feedback signal for controlling the patient temperature to the *AUTO* mode set point temperature. The machine accomplishes this by adjusting the water temperature. The water temperature the machine uses in *AUTO* mode is dependent on the *CONTROL OPTION* setting selected and if *COOLING* or *WARMING* is desired.

When **COOLING** the patient:

RAPID - the coldest water is used for cooling - as low as 4°C (39°F). This may not be the most comfortable setting for the patient.

MODERATE - Water temperature is limited to 15°C (27°F) below the patient's temperature. This will provide an improved comfort setting to the patient.

GRADUAL - Water temperature is limited to 10°C (18°F) below the patient's temperature. This will provide the optimal comfort setting to the patient.

When **WARMING** the patient:

RAPID - the highest allowable water temperature is used for warming - as high as 42°C (107.6°F). This is the fastest warming mode the machine can provide.

MODERATE - The patient temperature will increase at a rate of 1°C (1.8°F) in a period of 3 hours (0.33°C/Hr [0.6°F/Hr]).

GRADUAL - The patient temperature will increase at a rate of 1°C (1.8°F) in a period of 6 hours (0.17°C/Hr [0.3°F/Hr]).

When using AUTO MODERATE and AUTO GRADUAL for patient warming, **NO MANUAL INTERVENTION** is required once the patient set point temperature has been selected for warming.

When **WARMING** a patient in MODERATE or GRADUAL modes, water temperature is limited to a maximum of 42.0°C (107.6°F) and a minimum which is determined by the current control option selected 15.0°C [27°F] below the patient temperature in MODERATE mode and 10.0°C [18°F] below the patient temperature in GRADUAL mode).

If the patient temperature deviates from the warming rate specified by the *CONTROL OPTION* selected (Moderate and Gradual only) by 1.0°C (1.8°F) the following will occur:

- the *PATIENT* temperature will flash;
- the *ALERT* led will flash; and;
- the audible alarm will toggle

Once the patient temperature returns to within 1.0°C (1.8°F) of the warming rate specified by the *CONTROL OPTION* selected, the *PATIENT* temperature and *ALERT* light will stop flashing and the audible will silence.

NOTE: If the control *MODE* or *SET POINT* is changed while this alarm is occuring, the alarm will be reset.

NOTE: If the control *MODE* or *SET POINT* is changed while in Auto-Gradual or Auto-Moderate control mode, this may impact the overall time period of the therapy depending on when in the hourly cycle the mode is inter rupted. The therapy time duration is also dependent on the patient's temperature at the time the Auto-Moderate or Auto-Gradual control modes are re-selected.

For water temperature control, the microcontroller outputs a pulse train to each solenoid valve and the heater. The pulse train duty cycle depends on the magnitude and sense of the control signal calculated by the microcontroller.

That is, while the solenoids and heater are either on or off, the ratio of on time to off time is proportional to the calculated control signal amplitude. For large differences between set point and probe temperatures, the output to the cold solenoid will be on and the output to the hot solenoid/heater combination will be off, or vice-versa. For differences approaching zero, the output pulse train will be applied to the hot solenoid and cold solenoid in a complementary fashion, with the on times and off times automatically adjusted to maintain a probe temperature equal to the set point, or the output pulse train will be applied to the heater (with the hot solenoid remaining open), with the on times and off times of the heater automatically adjusted to maintain a probe temperature equal to the set point.

The circulating pump is energized whenever the unit is in *AUTO* or *MANUAL* modes.

The control latch U51 on the control/display board is the interface between the microcontroller (via the data bus at address 0FF7FH) and the peripheral drivers on the power supply board.

Interface circuitry on the power supply board consists of U1, U2, U7, U8, Q3, Q4, Q8, Q9, and associated components. U1, U2, U7, and U8 are optically coupled triac drivers used to control their respective triacs (Q3, Q4, Q8, and Q9); these combinations provide electrical isolation between the low voltage microcontroller control circuits and the line voltage circuits.

The heater, pump, hot solenoid valve, and cold solenoid valve are individually controlled by the microcontroller through latch U51 on the control/display board. A high signal on the data line from the microcontroller causes a low signal on the appropriate output line of U51 which then sinks current from the power supply board to activate the peripheral devices.

Pin 11 of U51 on the control/display board and U8 and Q9 of the power supply board control the cold solenoid valve while pin 9 of U51 on the control/display board and U7 and Q8 of the power supply board control the hot solenoid valve. Pin 8 of U51 on the control/display board and U2 and Q4 of the power supply board control the circulating pump. Pin 7 of U51 on the control/display board and U1 and Q3 of the power supply board control power to the heater.

6.4.6 COLD WATER RESERVOIR TEMPERATURE CONTROL

The control latch U51 on the control/display board is the interface between the microcontroller (via the data bus at address 0FF7FH) and the refrigeration compressor relay driver on the power supply board. A high signal on the appropriate data line causes a low signal at pin 6 of U51 on the control/display board, which then activates Q12 on the power supply board. Q12 on the power supply board is the interface between the control/display board and the coil of the power relay K1 located in the machine base. The microcontroller switches power through the relay to the refrigeration compressor at cut-out and cut-in temperatures of 3.3°C (38°F) and 5.8°C (42.5°F). These temperatures are sensed by the cold water reservoir probe RTI located in the water reservoir. (See figure 12, p. 73.) Control of the cold water reservoir temperature takes place whenever the machine is on.

6.4.7 BACK-UP WATER TEMPERATURE LIMITING

The power supply board includes the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* circuitry, which includes U3, U4, U5, U6, U9, U10, D2, D3, Q1, Q2, their interconnected components, and fixed, nonadjustable thermostats S2, S3, and S1 located in the base. Under normal circumstances, Q1 and Q2 are kept turned on by the action of R7, C10, and D4 and R5, C15, and D5 to complete the conduction path for the heater and pump. If the water temperature falls into the low temperature limit range, S1 will open. If the water temperature rises into the high temperature limits ranges, S2 and/or S3 will open. (See section 4.2 Thermal Specification table, page 5, for the correct high or low temperature limits

6.4.7 BACK-UP WATER TEMPERATURE LIMITING (continued)

with corresponding model number of your machine.) When any one of these thermostats opens, it directly interrupts the circuit and shuts off the pump and heater; at the same time, full line voltage will appear between J1-2 and J1-3. In this case, U5 and U10 will be turned on by the action of R4, D3, and associated parts while U3 and U9 will be turned on by the action of R6, D2, and associated parts. U5 prevents Q2 from turning on and U3 prevents Q1 from turning on even if the open thermostat(s) closes again. The output of either U9 or U10, through buffer Q10, signals the microcontroller that a thermostat has tripped and that a *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition has resulted. Thus, should any thermostat (S1, S2, or S3) trip, the heater and pump are shut off and the microcontroller is notified.

On the control/display board, a high signal from Q10 of the power supply board feeds Q2 to drive the audible alarm, feeds driver U62 to light the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* LED, and feeds driver U60 to light the *ALERT* LED. All this is done independent of the microcontroller. This same signal is sent to port pin P3.2 of the microcontroller Q3.

If the microcontroller is operational at the event of a high signal from Q10 of the power supply board, the signal at P3.2 causes the microcontroller to shut off the 7 segment displays, flash the *ALERT* LED and light the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* LED, toggle the audible alarm, store the appropriate RFU* code indicating the reason for the shutdown, turn off the heater and pump triacs Q3 and Q4, turn off the solenoid triacs Q8 and Q9, and turn off the compressor transistor Q12. Anytime the microcontroller goes into a shutdown condition it also sends an output signal from port pin P3.4, through U40 of the control/display board, to command, via Q11, U4, and U6 on the power supply board, a *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition. The process of turning off the heater and pump triacs Q3 and Q4 by the microcontroller removes power from the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* circuitry on the power supply board which then allows the indicators on the control/display board to toggle under microcontroller control. This shutdown condition by the microcontroller program will remain until the machine is powered down. If, upon machine turn on, the fault condition still exists, attempting to resume therapy (which would turn on the pump and possibly heater) will replace power to the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* circuits on the power supply board and cause the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition to recur.

Also, if during normal operation, the microcontroller senses internal problems, it will attempt a shutdown as described above. (See table 2, section 8.1, p. 35.)

If the microcontroller is nonoperational at the event of a signal from Q10 of the power supply board, the user is notified of the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition by the fact that the above mentioned indicators are on continuously. In addition, there are separate, redundant circuits on the power supply board, each triggered by any of the thermostats, that insure that the pump and heater remain off even if the thermostat cools sufficiently to close again. The *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition remains latched and can be cleared only by an operator intervention in the form of turning the machine circuit breaker off. If, upon machine turn on, the fault condition still exists, attempting to resume therapy will cause the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* condition to recur.

* RFU = *REMOVE FROM USE NOW / MACHINE SHUTDOWN*

7.0 FUNCTIONAL CHECK, SAFETY INSPECTION, AND PREVENTIVE MAINTENANCE

7.1 RECEIVING INSPECTION PROCEDURES

Concealed Damage

After unpacking the Medi-Therm III machine, inspect the machine for concealed damage. Save all packing material and carefully describe or photograph the damage. Notify the carrier at once and ask for an inspection (in writing). Failure to do this within 15 days may result in loss of claim. Do not return the machine to GAYMAR — call Gaymar's Technical Service Department for advice.

Before placing the Medi-Therm III machine into service, perform a *FUNCTIONAL CHECK AND SAFETY INSPECTION* (pp. 20 to 33).

IMPORTANT

Before operating the Medi-Therm III machine, remove the compressor shipping braces. (See p. 88, figure B.)

7.2 CLEANING PROCEDURES

Fluid System

Use distilled water to retard algae growth and mineral buildup. Change the distilled water monthly or more often depending upon use.

The water circulation system, including reusable blankets, should be cleaned every month to retard algae growth.

To clean the fluid system, drain the machine and prepare an algaecidal solution according to manufacturer's instructions. Use Gaymar product catalog MTA33. Add the solution to the machine, attach blankets, set the machine in *MANUAL* mode to a setpoint temperature of 10°C (50°F) and circulate the solution for 12 hours. Drain the solution and refill the machine with distilled water.

⚠ CAUTION

- Do not use bleach (sodium hypochlorite).

  Bleach will damage the heating element in the machine, which could result in excessive leakage current.

Compressor

Dirt that has accumulated on the condenser coils and cooling fins within the machine will reduce the efficiency of the compressor and should be removed with a vacuum cleaner or compressed air hose. This will require removal of the rear baffle assembly. This should be checked monthly or more frequently depending upon use. (See figure 14, p. 75.)

7.2 CLEANING PROCEDURES (continued)

Pump
Pump motor should be oiled once a year with 3-4 drops of general purpose motor oil in the locations identified on the pump label.

Panel Exterior
Clean the control panel and panel exterior with a cloth dampened with isopropyl alcohol.

Reusable Blankets
Outside surfaces of standard reusable blankets may be cleaned with a damp cloth and mild detergent to prevent algae growth. To clean the insides, attach the blankets to the machine and follow instructions for section 7.2, p. 18, *CLEANING PROCEDURES,* Fluid System.

NOTE: Exposure to harsh chemicals will cause blankets to lose flexibility and resistance to cracking.

Probe Check Well
The Probe Check Well should be cleaned with a small tubular brush and detergent, and then wiped with a commercial disinfectant.

⚠ WARNING

When performing the PROBE CHECK, use a disposable protective sheath (Becton-Dickinson catalog 3700 oral sheath or equivalent) on the probe.

Failure to use sheath could result in cross-contamination.

Connector Hoses
Clean connector hose sets with a damp cloth and mild detergent. Always wipe dry.

Probes
Do not autoclave. Clean with a damp cloth and mild detergent. Wipe dry.

Probes are made of PVC. If probe must be sterilized, use any cold sterilization means except alcohol, which may accelerate probe deterioration. Always wipe dry.

If gas sterilization is necessary, probes should be handled like any other PVC product. Probes are made of PVC.

Reusable probes may be cleaned with a damp cloth and mild detergent. Always wipe dry. Exposure to harsh chemicals will cause probe to lose flexibility and resistance to cracking.

Disposable probes should be discarded after use.

NOTE: Exposure to harsh chemicals will cause probe to lose flexibility and resistance to cracking. Do not use damaged temperature probes. Discard probes having visible pinholes, cracks or abrasions.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION

To assure the optimum performance, dependability and safety, the following should be performed every twelve (12) months or as specified in the facility's preventive maintenance program.

An Inspection Form is provided at the end of this section to facilitate and document the inspection process. Lower case letters preceding the subheadings within section 7.3 correspond to the lines on the *INSPECTION FORM*.

⚠ WARNING

Always perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* after making repairs and before returning the Medi-Therm III machine to patient use.

Improper repair may result in death or serious injury, equipment damage, or malfunction.

Test Equipment Requirements

The following test equipment (or equivalent) is required to perform the preventive maintenance/functional check procedures:

- GAYMAR TPT9 Flowmeter/Temperature Tester
- GAYMAR TFC1 Thermometer (±1°C accuracy); -2°C to +52°C range
- GAYMAR DBK9 Blanket Connector Hose
- * GAYMAR MT590 Test Tool, or GAYMAR PRK2 Patient Temp Simulator Kit, or Precision Decade Box (0-10K ohms, 0.2% accuracy, 1 ohm increments)
- GAYMAR DHP901 or DHP813 Hyper/Hypothermia Blanket
- * GAYMAR MT590 Test Tool, or 6" (approximately 150 cm) Shorting Jumper
- Ground Resistance Checker
- Current Leakage Tester
- Static Control Wrist Strap

* The GAYMAR MT590 Test Tool is a dedicated test tool available from Gaymar Industries. This tool was designed to allow for more convenient and safer testing of the high temp backup thermostats by eliminating the need to remove the lower wraparound cover and avoiding the use of a shorting jumper that could be accidentally left inside the machine. In addition, the test tool can be used to monitor input/output signals between the head and base of the machine through the use of indicator lights. This feature can be of great value during any troubleshooting process. This test tool also provides a patient probe simulator which allows testing of the machine without a precision decade box.

For more information on the MT590 Test Tool, contact the Gaymar Technical Service Department.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

⚠ DANGER

Disconnect power before servicing unit. **Risk of electrical shock.**

Follow the following procedures carefully, paying particular attention to test setups. Any deviation from the setups, procedures, or test equipment may result in incorrect or misleading results.

Before making any repairs, be sure to recheck your test setup, procedure, and test equipment.

Test equipment should be calibrated in accordance with NIST (National Institute of Standards and Technology) guidelines to insure accurate readings.

a) Condition of Chassis

The following inspections should be performed:

1. The chassis should be clean and relatively free of rust and corrosion.
2. Exterior screws should be tight.
3. Legends, markings, and operator instructions should be legible.
4. Dirt that has accumulated in vents and cooling fins within the machine should be removed with a vacuum cleaner or compressed air hose. This will require removal of the rear baffle assembly.
5. Check that the casters are tight and functioning properly.
6. The quick-disconnect fittings on the machine may become stiff and difficult to engage. If so, apply a silicone-base lubricant to the inside of the machine fittings and the outside of the blanket connector.
7. Clean the Probe Check Well according to the procedure described in section 7.2, p. 19.
8. Inspect the fluid system for debris and any sign of algae growth. Clean according to *Cleaning Procedures, Fluid System* (section 7.2).

b) Attachment Plug

Examine the attachment plug on the line cord to be sure that it is in good condition.

c) Line Cord and Strain Reliefs

Examine the line cord along its entire length for physical damage, such as cuts or cracked insulation. A damaged line cord should be replaced rather than repaired. Check the quality of the strain reliefs at both ends of the line cord.

d) Circuit Breaker

A worn out circuit breaker can be responsible for intermittent shutoffs, with no other apparent indications of failure.

Examine the physical condition of the circuit breaker, paying particular attention to the push-on terminals at the rear of the breaker. Terminals should be snug. Replace breaker and/or terminals if there is discoloration or any indications of heating.

Cycle the switch on and off several times. The switch should have a positive engagement ("click") for the *OFF* and *ON* positions.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

e) Condition of Lights and Alarm

Plug in the Medi-Therm III machine and turn it on. Press and hold the *TEST LIGHTS* button. The right and left halves of the display panel should light and blank alternately (along with the audible alarm). The three status legends (*FLOW OK, WARMING*, and *COOLING),* the *ALERT* legend and its four (triangular) indicators, the three mode legends, *SELECT* heading should be lit, and the three *AUTO/CONTROL OPTION* legends should be lit. The three temperature displays should indicate "888", "888.8", and "888.8". The two temperature scale indicators ("°C" and "°F") and the two lines connecting *SET POINT* to both the *WATER* and *PATIENT DISPLAY* should be lit. The audible alarm should sound. Replace any LED's which do not light.

f) Flow

To measure the machine's flow rate and check the flow switch actuation, perform the following:

1. Fill machine with distilled water until green band on float stem is fully visible.
2. Connect the test setup shown in figure 13, p.74.
3. Turn machine on. Set machine in *MANUAL* mode.
4. Increase the temperature set point to light the *WARMING* status light. Note the flow rate. The *FLOW OK* indicator should be lit.
5. Decrease the temperature set point to light the *COOLING* status light. Note the flow rate. The *FLOW OK* indicator should be lit.
6. The flow rate in both modes should exceed 16 GPH (60.6 liters/hr).

   NOTE: If the unit has been completely drained, air can be trapped in the pump causing the flow to be decreased. To clear the air, turn the unit off, wait approximately one minute, and start again from step 3.
7. Kink the hose to stop the flow. The *CHECK WATER FLOW* indicator should light, the *FLOW OK* indicator should go out, the *ALERT* indicator should flash on and off, and the audible alarm will toggle.

g) Level Switch Actuation

To test the actuation of the level switch, perform the following:

1. Fill machine with distilled water until green band on float stem is fully visible. The *ADD WATER* indicator should be off.
2. Connect a DBK9 hose to a supply fitting on the machine and direct the other end to a drain or gallon (4 liter) container.
3. Turn machine on. Set machine in *MANUAL* mode. Adjust the temperature set point to 4°C (39.2°F) (*COOLING* status light on).
4. Allow water to drain until bobber has bottomed out on the drain screen (about 3 quarts or 3 liters). The *ADD WATER* indicator should be lit.
5. Refill machine until the green band is fully visible and verify that the *ADD WATER* indicator goes out.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

h) Cold Water Reservoir Controller

To check the cold water reservoir controller, perform the following:

1. Fill machine with distilled water until green band on float stem is fully visible.
2. Connect the test setup shown in figure 13, p. 74.

   NOTE: To minimize the test time for this test only, do not connect a blanket as shown in figure 13. Connect the return line of connector hose to the TPT9 tester.
3. Turn machine on and push the *MANUAL* mode button.
4. Set the Temperature Setpoint to 4°C (39.2°F).
5. Verify that the machine can supply water anywhere within the 3°C (37.4°F) to 6°C (42.8°F) range as measured by the thermometer and that the compressor turns off one time. (This will take 15-30 minutes, depending upon room temperature and other conditions. The use of a blanket for this test can extend this time up to 60 minutes.)

i) Water Temperature Controller and Display Test

To check the temperature controller, perform the following:

1. Fill machine with distilled water until green band on float stem is fully visible.
2. Connect the test setup shown in figure 13, p. 74.
3. Turn machine on. Set in *MANUAL* mode.
4. Set the Temperature Setpoint to the various settings specified on the *INSPECTION FORM* (section 7.4, p. 33), wait until both the *COOLING* and *WARMING* indicators turn off and the water temperature stabilizes, then record the temperature of the thermometer and that shown on the display. Verify that the recorded values are within limits outlined on *INSPECTION FORM*, item i.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

j) High Temperature Backup Thermostat Trip Temperatures

The following procedure describes two different approaches for measuring the trip points (actuation temperatures) of the machine's high temperature backup thermostats. Steps 1-15, pp. 24-26, should be followed when a Gaymar MT590 Test Tool is available. For those facilities not having access to an MT590, follow steps 1A-20A, pp. 27-28.

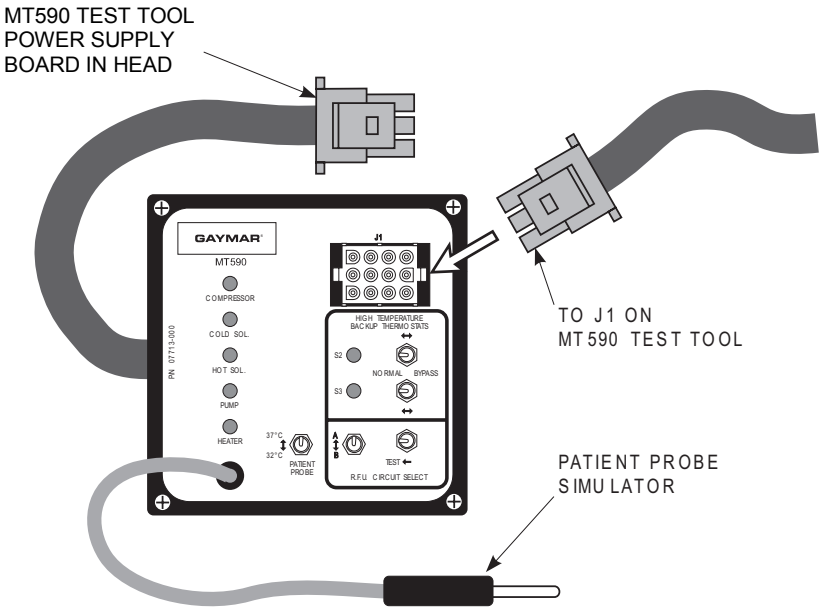

Figure 4—MT590 Test Tool

j) High Temperature Backup Thermostat Trip Temperatures [MT590 Test Tool Procedure]

⚠ WARNING

- Changes to the wiring of the high temperature backup thermostats can defeat their operation. To verify thermostat operation, perform the *Thermostat Verification Test* described in section 7.3, item *k,* p. 29 after performing the following test procedure.
- After performing the following test procedure, verify that the MT590 Test Tool or any installed shorting jumpers have been removed before returning the machine to patient use.

Failure to do the above may result in death or serious injury.

To measure trip points of the high temperature backup thermostats with an MT590 Test Tool, perform the following steps 1-15:

1. Fill machine with distilled water until green band on float stem is fully visible.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

2. **Unplug the power cord.**
3. Connect the test setup as shown in figure 13, p. 74.
4. Connect MT590 Test Tool as shown in figure 4. Connect P7 (base) to J1 (MT590). Connect 12 pin cable (MT590) to J1 (head, power supply board). Plug machine in. Insure the S2 and S3 toggle switches are in the *NORMAL* position.
5. Place the machine in service mode 3. Refer to section 8.1, *SERVICE MODES (*pp. 34-35) for instructions on how to access service modes.
6. To insure the correct measurement of thermostat trip points, run machine for 5 minutes in service mode 3 (see Table 3, service mode 3, p. 37) after the blanket water temperature has reached 42°C (107.6°F). This allows the inside of the machine to achieve normal operating temperature. (Bottom wraparound cover must be on machine during this test.)
7. Enter service mode 4 (see section 8.1, p. 34) from service mode 3. Mode 4 will cause the machine to heat up until one of the safety thermostats trip.
8. Monitor the water temperature. When the *ALERT* and *REMOVE FROM USE NOW / MACHINE SHUTDOWN* LED's light and the audible alarm sounds, the temperature on the thermometer should be within the high temperature limits range. (See Table 1 below for high temperature limits.) When the thermostat trips, record the thermometer temperature on the *INSPECTION FORM* (p. 33).

   (If this is the second thermostat tested, proceed to step 12. Otherwise, proceed with step 9.)

High Temperature Limits Fixed (S2) & (S3)	44°C (111.2°F) to 49°C (120.2°F)

Table 1—High Temperature Limits

9. An LED should be lit on the face of the MT590 Test Tool to indicate an open S2 or S3 thermostat. If both LED's are lit, proceed to step 12. (Both thermostats have tripped at the same temperature. This is allowable so long as the water at the TPT9 was within the high temperature limits range. See Table 1 for high temperature limits. Otherwise, toggle the corresponding switch S2 or S3 to the bypass position for whichever LED was lit.
10. Turn machine off.
11. Place machine in service mode 3. If machine still indicates *REMOVE FROM USE NOW / MACHINE SHUTDOWN,* then the other thermostat has tripped at the same temperature. This is allowable so long as the water temperature at the TPT9 was within the high temperature limits range. See Table 1 for high temperature limits. Verify the non-bypassed LED is lit. Record the temperature. Proceed to step 12.

    If the unit enters service mode 3 with no *REMOVE FROM USE NOW / MACHINE SHUTDOWN* alarm, then repeat steps 6 through 8 to check the other thermostat

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

j) High Temperature Backup Thermostat Trip Temperatures [MT590 Test Tool Procedure, cont'd.]

12. Place both switches S2 and S3 in the bypass position. Turn the machine off, then turn the machine on and select *MANUAL* mode. Allow machine to run for approximately 1 minute. This will circulate cold water from the reservoir past the thermostats, causing them to reset.
13. Return switches S2 and S3 to the normal position. If unit continues to be in alarm condition, repeat step 12.
14. While the machine is running in *MANUAL* mode, place the RFU CIRCUIT SELECT A-B switch in the "A" position and toggle the *TEST* switch. The machine should shut down, blank the displays, light the *REMOVE FROM USE NOW / MACHINE SHUTDOWN* LED, flash the *ALERT* LED and toggle the audible alarm. Turn the machine off, then restart the machine in the *MANUAL* mode.

    Repeat the above procedure with the RFU CIRCUIT SELECT switch in the "B" position.

    This step will verify that both (redundant) RFU circuits are functioning.
15. **Turn machine off and unplug the power cord.** Disconnect MT590 Test Tool from wire harness and reassemble machine.

⚠ WARNING

Verify that the MT590 Test Tool or any installed shorting jumpers have been removed before returning the machine to patient use.

Failure to do so may result in death or serious injury.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

j) High Temperature Backup Thermostat Trip Temperatures [Alternate Shorting Jumper Procedure]

To measure trip points of the high temperature backup thermostats if you do not have access to an MT590 Test Tool, perform the following steps 1A-20A. (If you have access to an MT590, follow steps 1-15 on the preceding pages.)

⚠ WARNING

- Changes to the wiring of the high temperature backup thermostats can defeat their operation. To verify thermostat operation, perform the *Thermostat Verification Test* described in section 7.3, item k, p. 29 after performing the following test procedure.
- After performing the following test procedure, verify that the MT590 Test Tool or any installed shorting jumpers have been removed before returning the machine to patient use.

Failure to do the above may result in death or serious injury.

1A. Fill machine with distilled water until green band on float stem is fully visible.

2A. **Unplug the power cord.**

3A. Remove wraparound (see figure 14, p. 75).

4A. Remove plastic cover from wiring terminal block TB1. (See figure 14 for TB1 location.)

5A. Replace wraparound cover. Do not reinstall screws at this time.

6A. Connect test setup as shown in figure 13, p. 74.

7A. Plug the machine in.

8A. Place the machine in service mode 3. Refer to section 8.1, *SERVICE MODES* (pp. 34-35) for instructions on how to access service modes.

9A. To insure the correct measurement of thermostat trip point (because the wraparound was removed), run machine for 15 minutes after the water temperature has reached 42°C (107.6°F). This allows the inside of the machine to achieve normal operating temperature.

10A. Enter service mode 4 (see section 8.1, p. 34) from service mode 3. Mode 4 will cause the machine to heat up until one of the safety thermostats trip.

11A. Monitor the water temperature. When the *ALERT* and *REMOVE FROM USE NOW / MACHINE SHUTDOWN* LED's light and the audible alarm sounds, the temperature on the thermometer should be within the high temperature limits range. (See Table 1, p. 25, for high temperature limits.) This indicates that one of the safety thermostats has tripped. Record the thermometer temperature at which the thermostat tripped on the *INSPECTION FORM*.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

j) High Temperature Backup Thermostat Trip Temperatures [Alternate Shorting Jumper Procedure, cont'd.]

NOTE: If this is the second time the thermostat has tripped (i.e., if you have previously completed steps 12A to 18A), proceed to step 19A. Otherwise, proceed to step 12A.

12A. **Turn the machine off and unplug the power cord.** Disconnect hoses.

13A. Remove wraparound cover from machine.

14A. Place a shorting jumper across terminals 7 and 9 of TB1. Reconnect the machine to the wall outlet, turn it on, and press the *MANUAL* mode button. If the unit indicates *REMOVE FROM USE NOW / MACHINE SHUTDOWN* proceed to step 15A. If the unit enters *MANUAL* mode with no *REMOVE FROM USE NOW / MACHINE SHUTDOWN* alarm, then proceed to step 17A.

15A. **Turn the machine off and unplug the power cord.** Remove shorting jumper from terminals 7 and 9 of TB1 and reconnect across terminals 7 and 10.

16A. Plug machine in and turn it on. Press the *MANUAL* mode button. If the machine still indicates a *REMOVE FROM USE NOW / MACHINE SHUTDOWN* alarm, then both thermostats have tripped at the same temperature. This is allowable so long as the water temperature at the TPT9 was within the high temperature limits range. (See Table 1, p. 25 for high temperature limits.) If both thermostats have tripped, proceed to step 19A. If the unit enters *MANUAL* mode with no *REMOVE FROM USE NOW / MACHINE SHUTDOWN* alarm, then proceed to step 17A.

17A. **Turn the machine off and unplug the power cord.** Replace wraparound cover. Reconnect hoses from test setup to machine (see figure 13, p. 74).

18A. Repeat steps 7A through 11A.

19A. **Turn the machine off and unplug the power cord.** Disconnect supply hose from TPT9 and allow water to gravity drain into a container for approximately one minute. This will circulate cold water from the reservoir past the thermostats, causing them to reset. Do not install a second shorting jumper. Reconnect supply hose to TPT9 and return drained water to machine reservoir.

20A. Remove wraparound cover from machine. Remove shorting jumper. Replace plastic terminal block cover. Replace wraparound cover and reinstall screws.

⚠ WARNING

Verify that the MT590 Test Tool or any installed shorting jumpers have been removed before returning the machine to patient use.

Failure to do so may result in death or serious injury.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

k) Thermostat Verification Test

⚠ WARNING

Verify that the high temperature backup thermostats independently shut down the machine.

Incorrect operation of these thermostats may result in death or serious injury.

1. Fill machine with distilled water until green band on float stem is fully visible.
2. **Unplug the power cord.**
3. Remove wraparound (see figure 14, p. 75).
4. Carefully disconnect the yellow wire from the top thermostat (S3) by pulling the connector off the terminal along the same angle as the terminal (see figure 17, p. 79).
5. Plug in the machine and turn it on.
6. Select *MANUAL* mode.
7. Observe that the machine indicates *REMOVE FROM USE NOW / MACHINE SHUTDOWN.*
8. **Turn the machine off and unplug the power cord.**
9. Reconnect the yellow wire to S3.
10. Carefully disconnect the yellow wire from the lower thermostat (S2) by pulling the connector off the terminal along the same angle as the terminal.
11. Plug the machine in and turn it on.
12. Select *MANUAL* mode.
13. Observe that the machine indicates *REMOVE FROM USE NOW / MACHINE SHUTDOWN.*
14. **Turn the machine off and unplug the power cord.**
15. Reconnect the yellow wire to S2.
16. Replace wraparound and reinstall screws.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

l) Patient Temperature Display Test

To check the patient temperature display, perform the following:

1. Fill machine with distilled water until green band on float stem is fully visible.
2. Connect a resistance of 1355 ohms to the patient probe jack, to simulate a 37°C (98.6°F) patient temperature.
3. Turn machine on and set it in the *MANUAL* mode.
4. *PATIENT* Temperature Display should indicate 37°C (98.6°F) ± 0.3°C (0.5°F). Record appropriate value on *INSPECTION FORM*.
5. Connect a resistance of 1667 ohms to the patient probe jack to simulate an 32°C (89.6°F) patient temperature.
6. *PATIENT* temperature display should indicate 32°C (89.6°F) ± 0.3°C (0.5°F). Record appropriate value on *INSPECTION FORM*.

NOTE: The *CHECK PATIENT PROBE* alarm may flash on during step 6 if the display indicates less than 32.0°C (89.6°F). This condition is considered normal and allowable.

m) Grounding Resistance

Use an ohmmeter to measure the resistance between the grounding pin on the line cord attachment plug and an exposed metal point on the chassis. The value should be less than 0.5 ohms.

n) Current Leakage, CHASSIS

Measure the maximum current leakage between the chassis and the ground in all operating configurations (heating, cooling, compressor *ON*, compressor *OFF*, normal and reverse polarity with the machine grounded and ungrounded). The current leakage should not exceed the following:

Condition	Current Leakage
Machine grounded	10 microamps
Machine ungrounded	100 microamps

Current Leakage, PATIENT PROBE

It is first necessary to prepare a patient probe by wrapping it tightly along its entire length with metal foil. Then measure current leakage at the foil for all combinations: grounded, ungrounded, normal polarity, and reversed polarity. The current leakage should not exceed 50 microamps.

NOTE: If additional information is required, refer to *AAMI American National Standard, Safe Current Limits for Electromedical Apparatus* or contact Gaymar's Technical Service Department.

7.3 FUNCTIONAL CHECK AND SAFETY INSPECTION (continued)

o) Reset the RFU Code

The Medi-Therm III machine will retain the previously stored code. Before returning a machine to service, reset the RFU code to zero so that a previous code is not held in memory.

To reset the RFU code to zero:

1. Place the machine in service mode 1 (see section 8.1, p. 34).
2. Press the *TEST LIGHTS* button on the control panel.

The RFU code is reset when the number on the blanket display shows "0".

This completes the recommended functional test and preventive maintenance procedures for the Gaymar Medi-Therm III.

If a machine passes all the requirements of paragraphs "a" through "o", the machine should be considered operational and suitable for return to service.

⚠ WARNING

Verify that the MT590 Test Tool or any installed shorting jumpers have been removed before returning the Medi-Therm III to service.

Failure to do so may result in death or serious injury.

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7.4 INSPECTION FORM

Medi-Therm III Hyper/Hypothermia
Functional Check / Inspection Form*

Location_____ **Serial number**_____

Item				OK? (Y/N)	Action Needed	Action Taken (Date / Initials)
a. Condition of chassis						
b. Condition of attachment plug						
c. Line cord and strain reliefs						
d. Circuit breaker						
e. Condition of lights and alarm						
f. Flow	1. Greater than... (WARMING)	16 GPH (60.6 l/hr)				
	2. Greater than... (COOLING)	16 GPH (60.6 l/hr)				
	3. Flow switch activation					
g. Level switch activation						
h. Cold water reservoir controller: 3ºC (37.4ºF) to 6ºC (42.8ºF)						
i. Water temperature controller and display test:						
	Temperature Control Setpoint	Display Reading	Thermometer Reading			
	10ºC (50ºF)					
	25ºC (77ºF)					
	41ºC (105.8ºF)					
	Display readings within 1ºC (1.8ºF) of temperature setpoint thermometer reading within 1ºC (1.8ºF) of temperature setpoint					
j.	S2: High temperature backup thermostat: 44ºC (111.2ºF) to 49ºC (120.2ºF)					
	S3: High temperature backup thermostat: 44ºC (111.2ºF) to 49ºC (120.2ºF)					
k. Thermostat verification test: S2/S3						
j. Patient temperature display test:						
	Probe Resistance (ohms)	Patient Temperature Display				
	1355	37ºC ± 0.3ºC (98.6ºF ± 0.5ºF)				
	1667	32ºC ± 0.3ºC (89.6ºF ± 0.5ºF)				
m. Ground resistance less than 0.5 ohms						
n. Current Leakage:						
	Chassis (grounded)..... 10 microamps max.					
	Chassis (ungrounded)..... 100 microamps max.					
	Patient Probe..... 50 microamps max.					
o. Reset of RFU code						

* *Complete entire Functional Check / Inspection Form prior to troubleshooting unit.*

8.0 TROUBLESHOOTING AND SERVICE MODES

Some troubleshooting and functional checks may be aided by using the Medi-Therm III machine's service modes of operation.

8.1 SERVICE MODES

All service modes are entered from service mode 1 by pressing the appropriate digital control panel button within 10 seconds of entry into service mode 1. If no button is pressed after service mode 1 is entered, the machine will reset itself to standby mode after 10 seconds. See table 3 for a description of each mode.

To initiate service mode 1:

1. Turn machine off.
2. Remove the 6 screws holding the head to the base.

⚠ CAUTION

Wear a static control device connected to the chassis ground to prevent electrostatic discharge. (See figure 5, p. 35.)

Electrostatic discharge can damage the control/display board.

3. Lift the head, press and hold service button S3 on the low voltage control/display board (figure 5), then turn the machine on.

   In service mode 1, the machine will display the last RFU* code (on the *WATER* temperature display) and the software version (on the *PATIENT* display). An RFU code may help to debug a machine which has shut down due to a *REMOVE FROM USE* condition (table 2).

   Pressing the *TEST LIGHTS* button while in service mode 1 will reset the RFU code to zero. Whenever returning a machine to service, reset the RFU code to zero to avoid basing future troubleshooting decisions on an old code.

   * RFU = *REMOVE FROM USE NOW / MACHINE SHUTDOWN*

8.1 SERVICE MODES (continued)

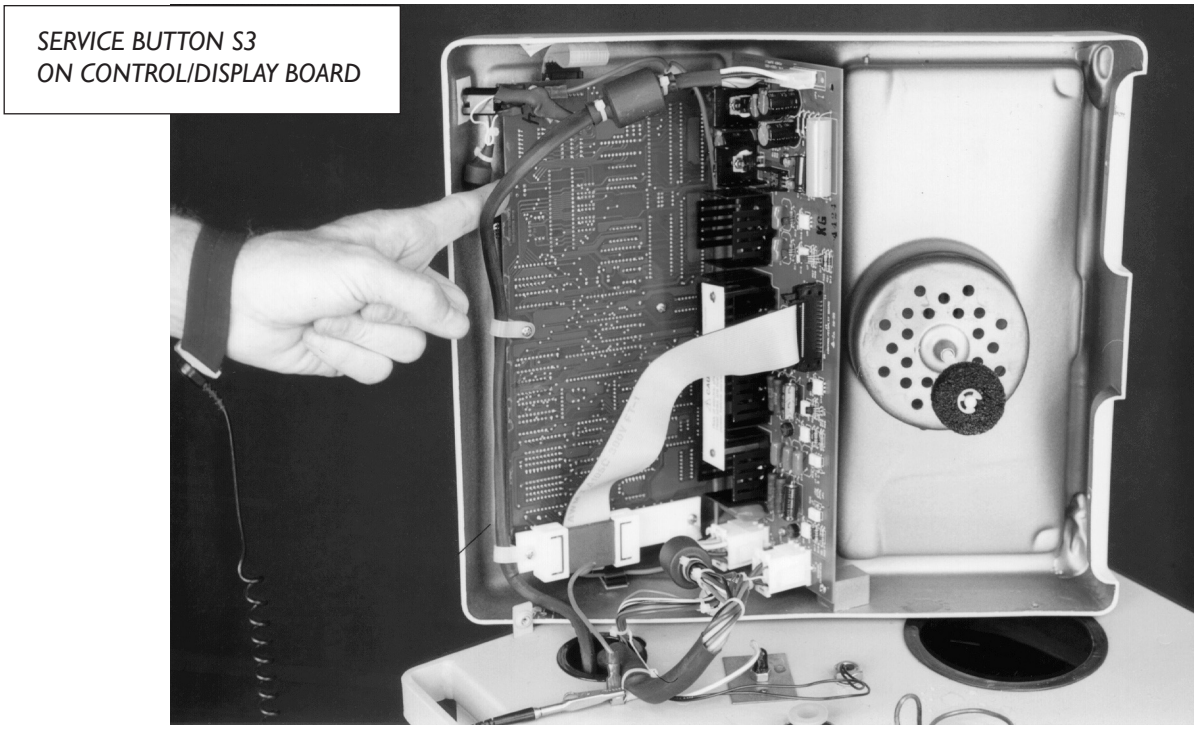

Figure 5—Initiating service mode 1

RFU Code	Description	Troubleshooting Chart
0	Reset code--Indicates no RFU† condition recorded.	None
1	Measured water or reservoir probe value is out of the range 32ºF to 122ºF (0ºC to 50ºC).	Figure 6B
2,3	Microcontroller system failure	Figure 6C
4	Compensation resistor 1 (R12) is out of spec-too high or open-circuited.	Figure 6D
5	Compensation resistor 1 (R12) is out of spec-too low or short-circuited.	Figure 6D
6	Compensation resistor 2 (R13) is out of spec-too high or open-circuited.	Figure 6E
7	Compensation resistor 2 (R13) is out of spec-too low or short-circuited.	Figure 6E
8	Water temperature probe measurement is out of spec-possibly open or short-circuited.	Figure 6F
9	Reservoir probe measurement is out of spec-possibly open or short-circuited.	Figure 6G
--	Microcontroller system failure-CHECKSUM.	Figure 6C
E	Microcontroller system failure-RAMTEST	Figure 6C
H	Microcontroller received RFU† signal from the power supply board.	Figure 6H
L	Microcontroller system failure	Figure 6C

† RFU = REMOVE FROM USE NOW / MACHINE SHUTDOWN

Table 2 - RFU† Error Codes

Table 3 - Service Modes

Service Mode 1:

To access	Press and hold S3 (see figure 5, p. 35) on the control/display board, then turn machine on.
Uses	• Verification of software version level. • Last RFU code indication and RFU code reset. • Verification of proper watchdog functioning (U34). • Entrance to other modes.
Description	• Required for entrance to other modes. • Patient display shows software version level. • Water temperature display shows RFU code. • Pressing the *TEST LIGHTS* button will reset RFU code to zero. • *ALERT* LED flashes. • Leader lights flash. • Setpoint display flashes "1". • 10 second duration. Machine resets to standby mode after 10 seconds if no buttons are pressed.
To exit	Pressing the *MANUAL, AUTO,* or *MONITOR* buttons will cause entrance into other modes. If no further action is taken by the user, the machine will reset itself to standby mode after approximately 10 seconds.

Service Mode 2:

To access	Press *MANUAL* button while in service mode 1.
Uses	To assist in testing trip point of S1 thermostat.
Description	• Patient and water temperature displays are blank. • *ALERT* LED flashes. • Leader lights flash. • Setpoint display flashes "2". • Pump and compressor are turned on, and cold solenoid valve is opened. • No temperature measurement is performed by the machine.
To exit	Pressing any button except the *MANUAL* button will reset the machine to standby mode. (Pressing the *MANUAL* button again will do nothing.)

(continued on next page)

RFU = *REMOVE FROM USE NOW / MACHINE SHUTDOWN*

Table 3 - Service Modes (continued)

Service Mode 3:

To access	Press *AUTO* button while in service mode 1.
Uses	To prewarm the machine for testing of high temperature thermostat S2 and S3 trip points.
Description	• Patient display is blank. • *ALERT* LED flashes. • Leader lights flash. • Setpoint display flashes "3". • The water temperature display shows the water temperature in degrees Celsius or Fahrenheit depending on choice made in last normal operating mode. • The output water temperature is controlled to 42°C (107.6°F).
To exit	Pressing any button except the *AUTO* button or the *°C/°F* button will reset machine to standby mode. (Pressing *AUTO* button again will do nothing.) Pressing the *°C/°F* button will put the machine into mode 4 from mode 3.

Service Mode 4:

To access	Press *°C/°F* button while in service mode 3.
Uses	To test the trip points of the high temperature thermostats S2 and S3.
Description	• Patient display is blank. • *ALERT* LED flashes. • Leader lights flash. • Setpoint display flashes "4". • The water temperature display shows the water temperature in degrees Celsius or Fahrenheit, depending on choice made in last normal operating mode. • The output water temperature is controlled to 49°C (120.2°F) .
To exit	Pressing any button except the *°C/°F* button will reset the machine to standby mode. (Pressing the *°C/°F* button again will do nothing.)

Service Mode 5:

To access	Press *MONITOR* button while in service mode 1.
Uses	• To verify reservoir probe reading. • To assist troubleshooting cooling problems.
Description	• Patient display shows the cold water reservoir temperature in degrees Celsius or Fahrenheit, depending on what was selected during the last normal operating mode. • *ALERT* LED flashes. • Leader lights flash. • Setpoint display flashes "5". • The water temperature display is blank. • The pump is on and cold solenoid valve is opened. • The compressor is controlled using normal control algorithms.
To exit	Pressing any button except the *MONITOR* button will reset the machine to standby mode. (Pressing the *MONITOR* button again will do nothing.)

8.2 TROUBLESHOOTING CHARTS

IMPORTANT

Whenever possible, perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (see section 7.3) prior to troubleshooting machine.

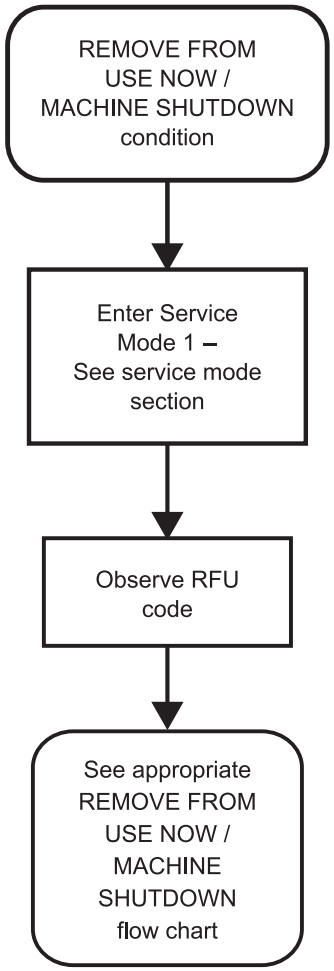

Figure 6A—Accessing RFU codes

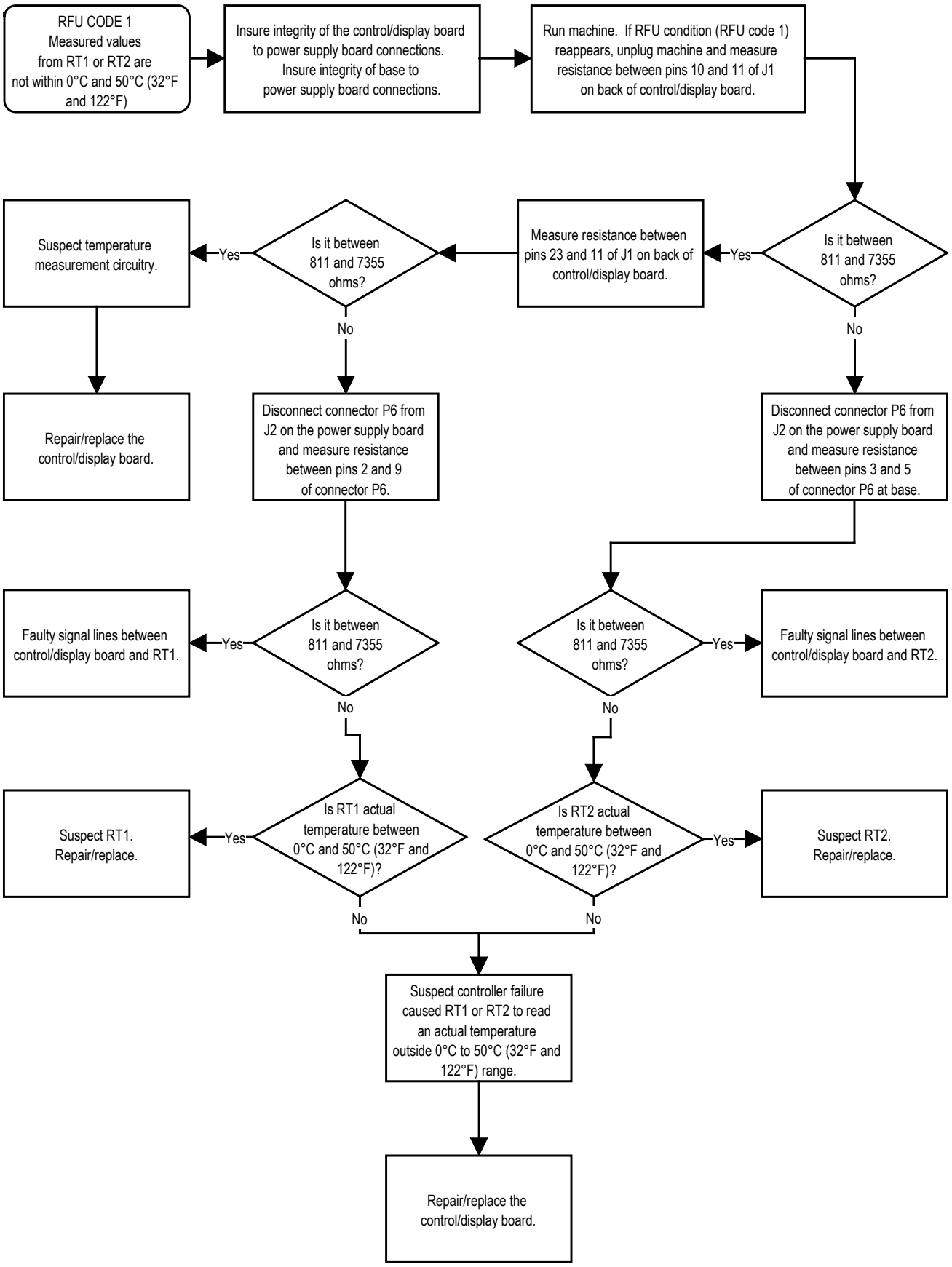

Figure 6B—RFU Code 1

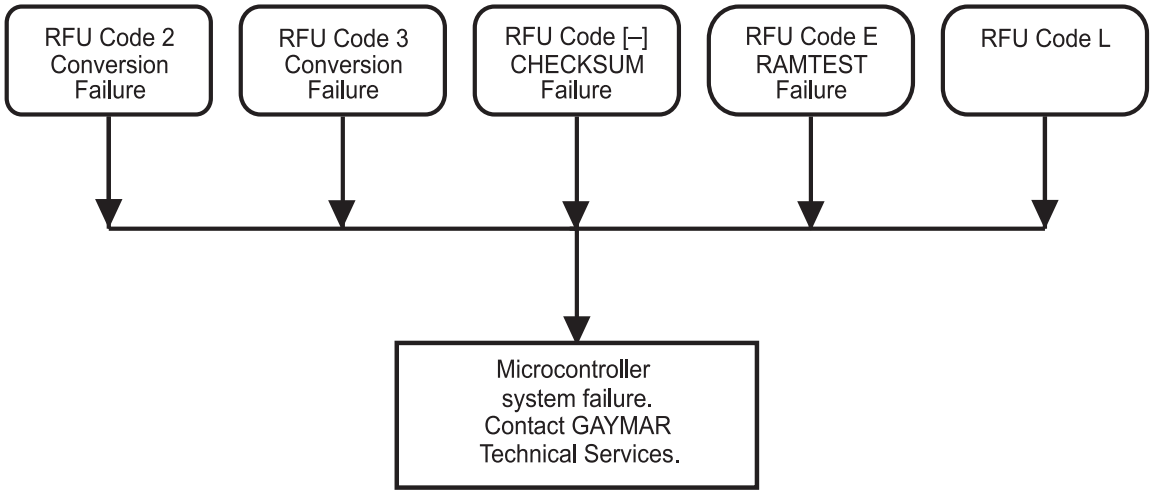

Figure 6C—RFU Codes 2, 3, – , E, and L

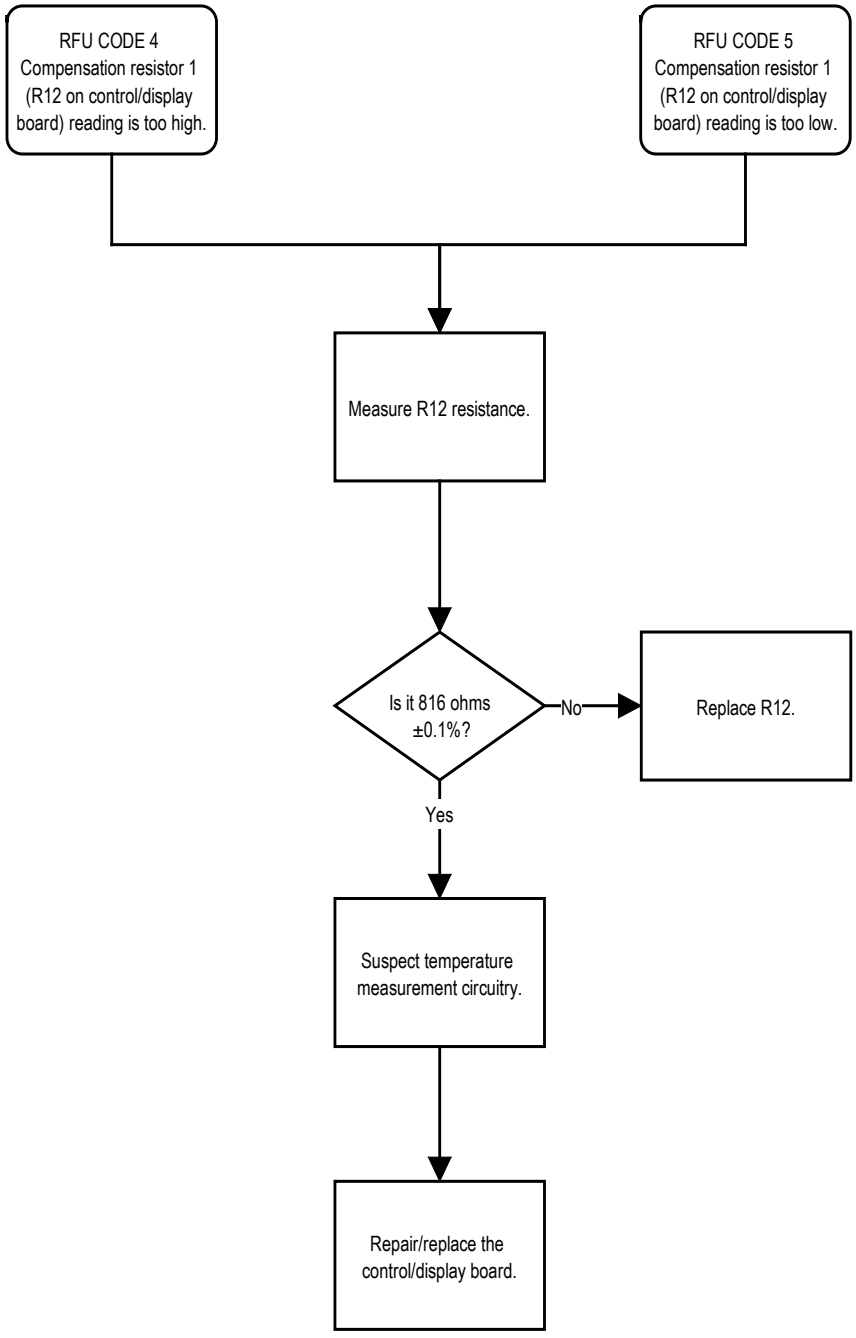

Figure 6D—RFU Codes 4, 5

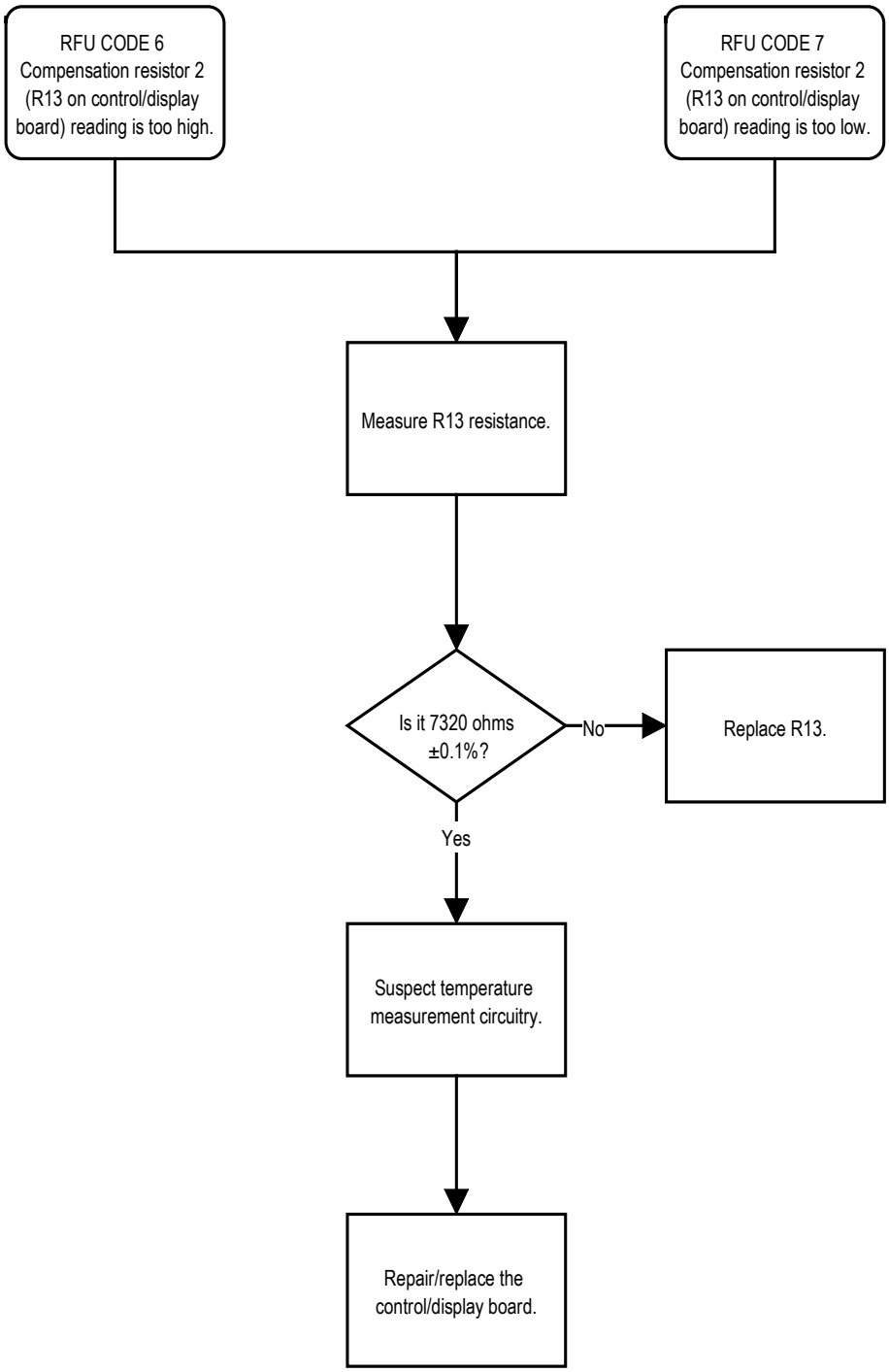

Figure 6E—RFU Codes 6, 7

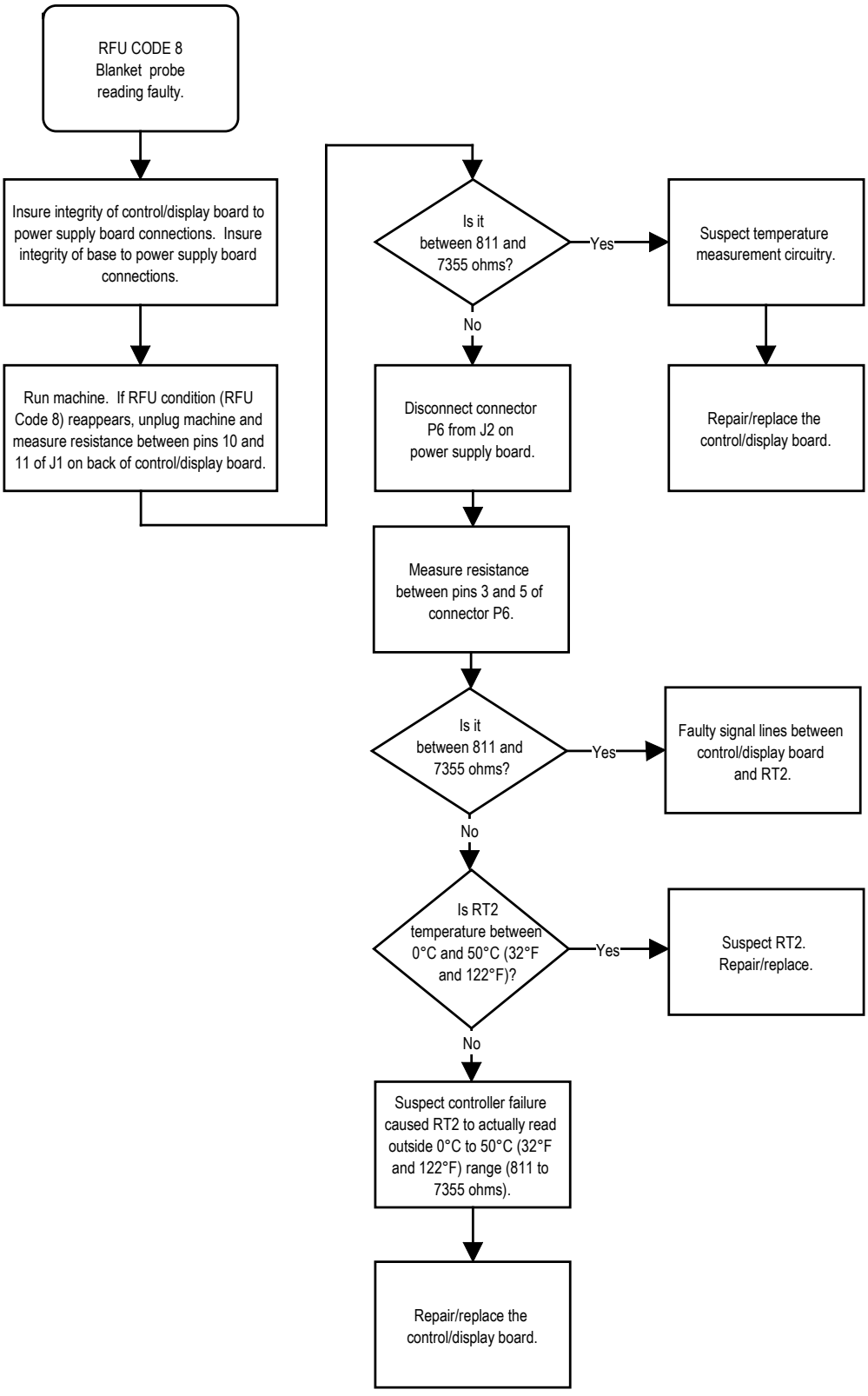

Figure 6F—RFU Code 8

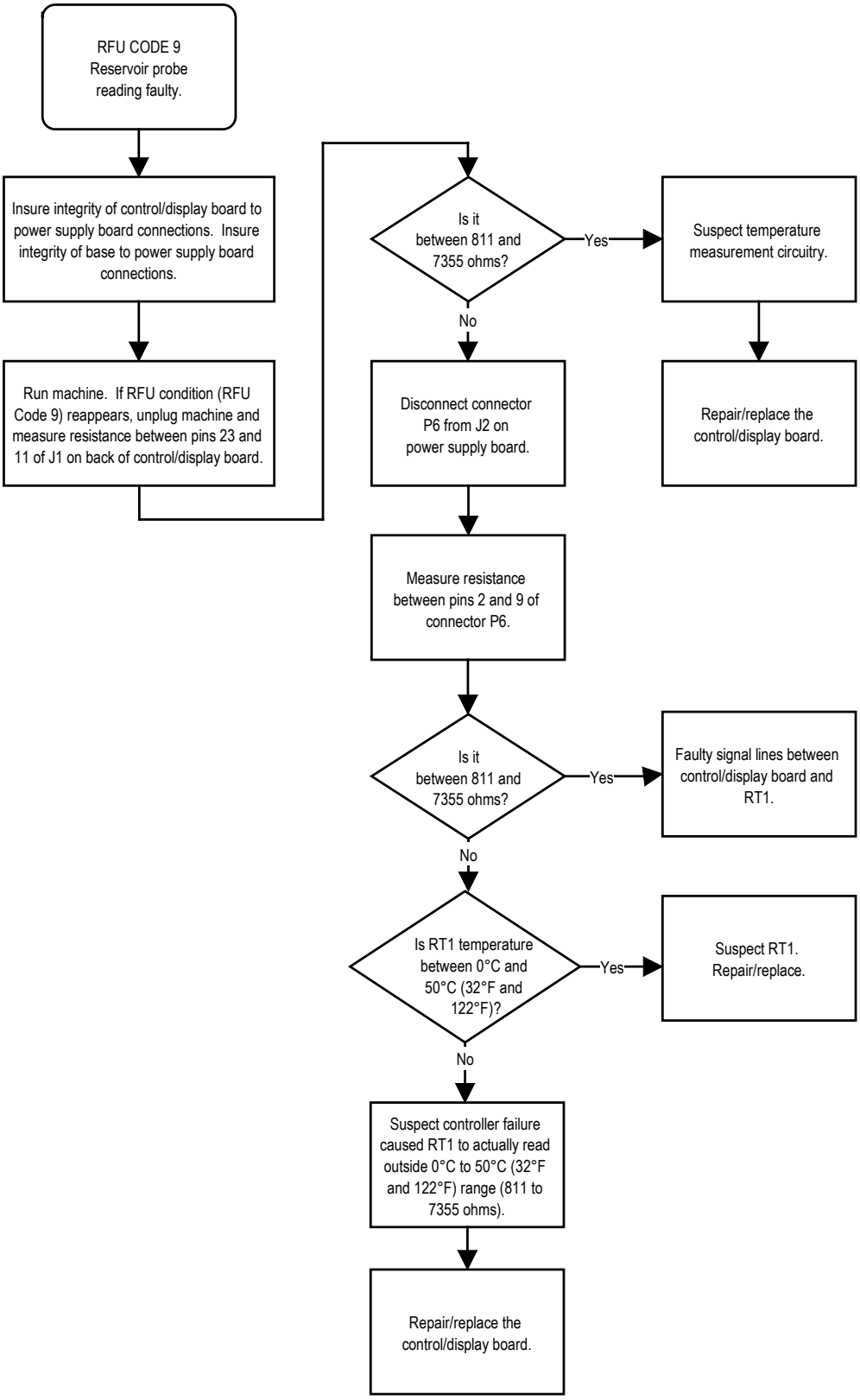

Figure 6G—RFU Code 9

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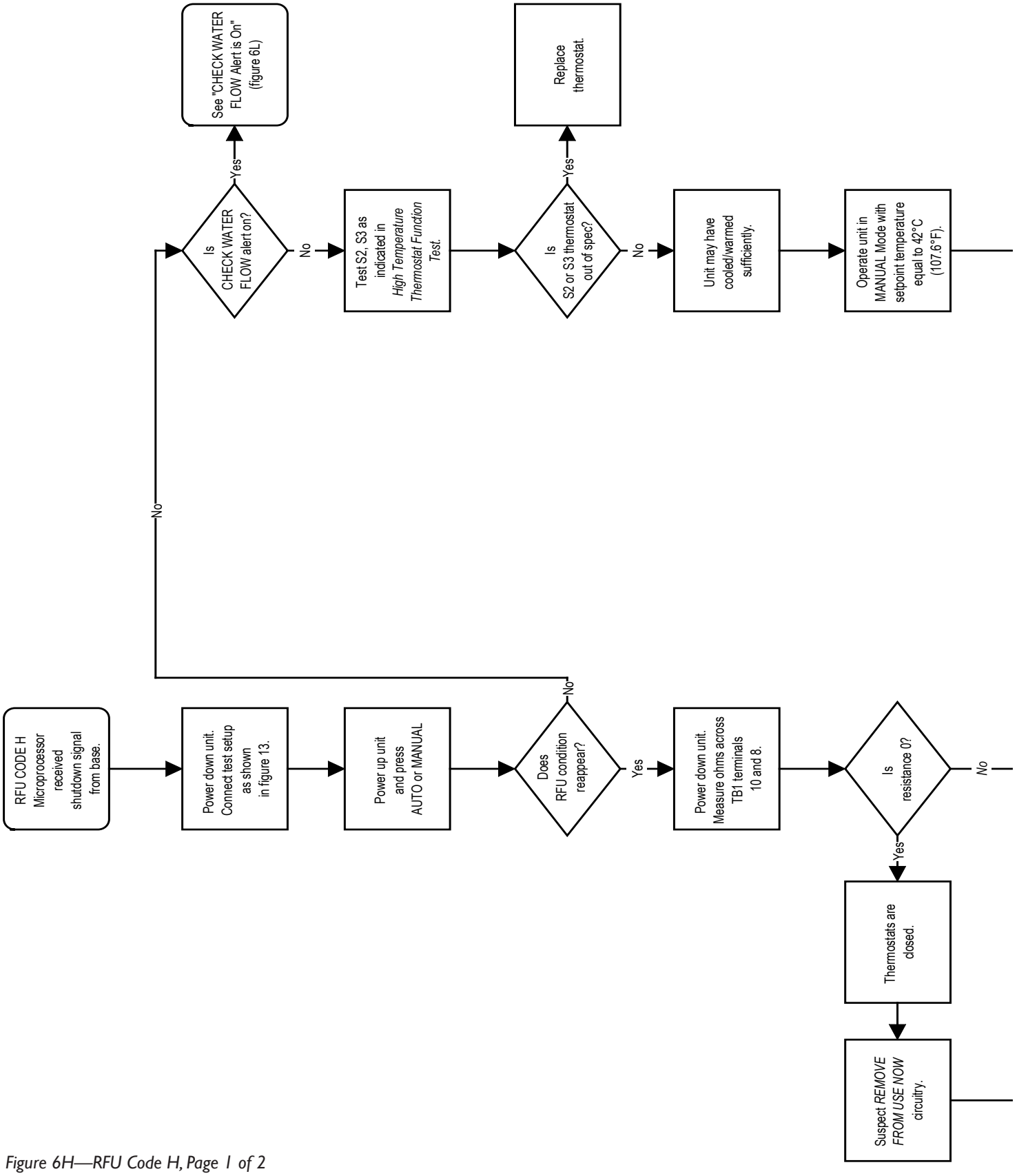


Figure 6H—RFU Code H, Page 1 of 2

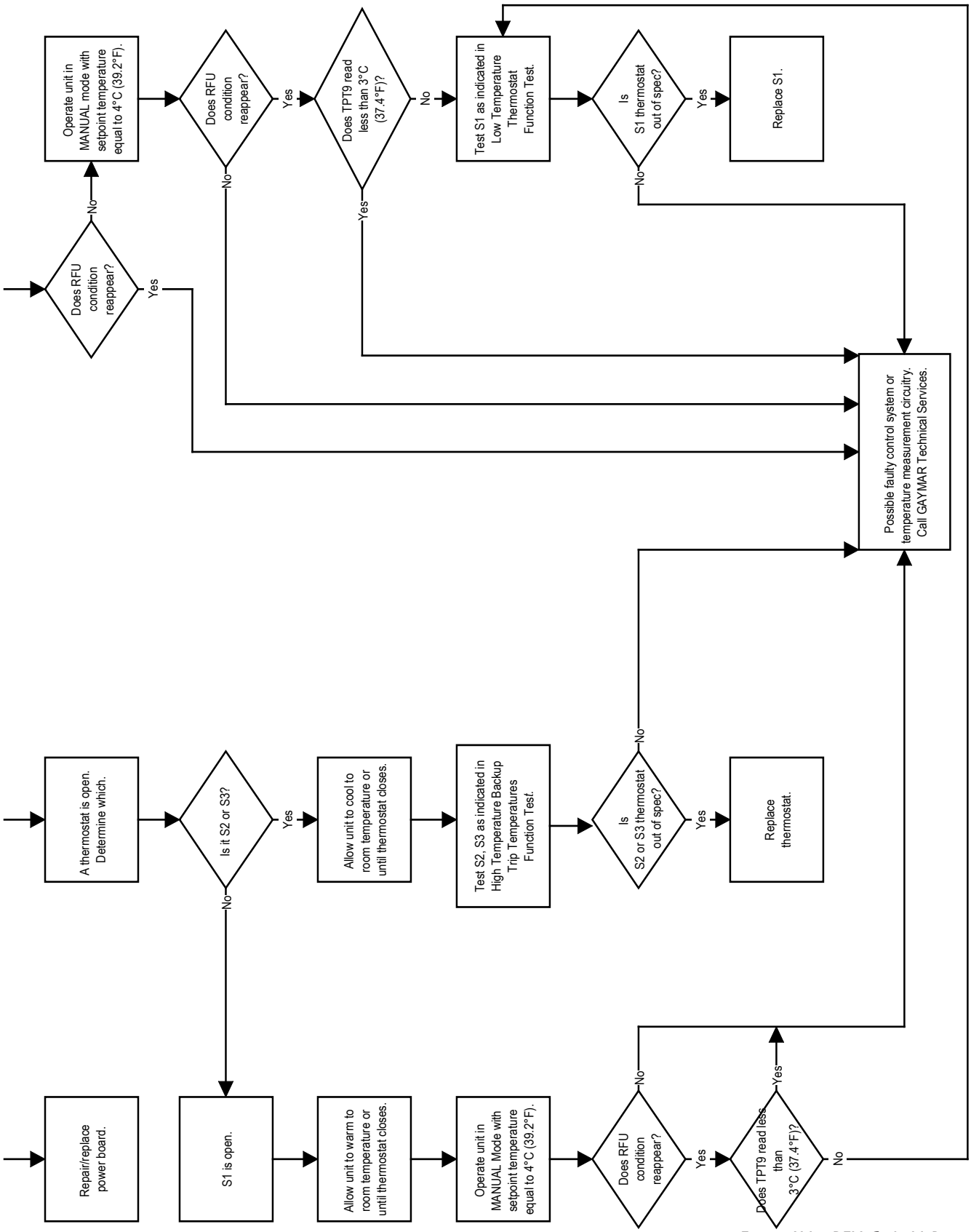


Figure 6H—RFU Code H, Page 2 of 2

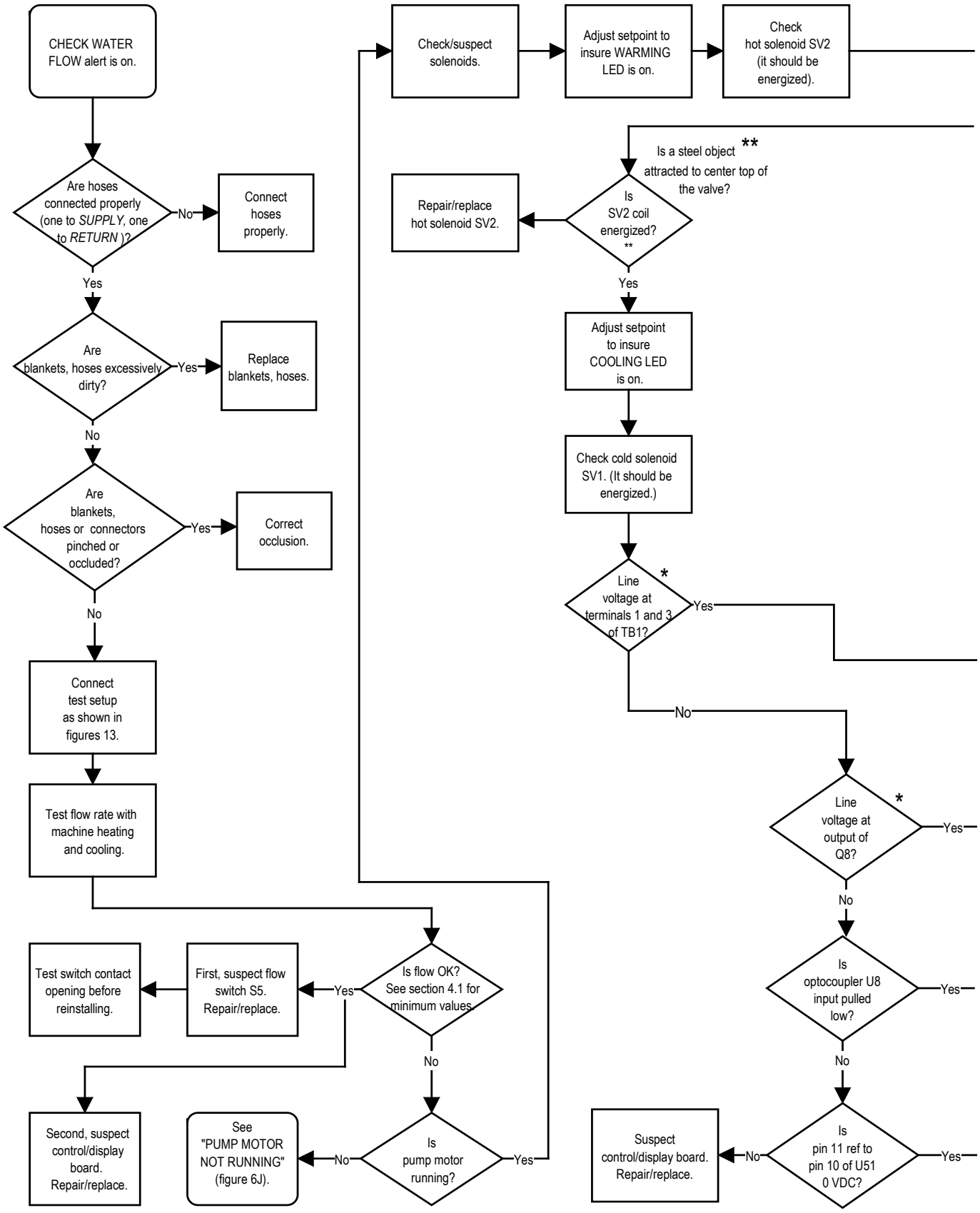
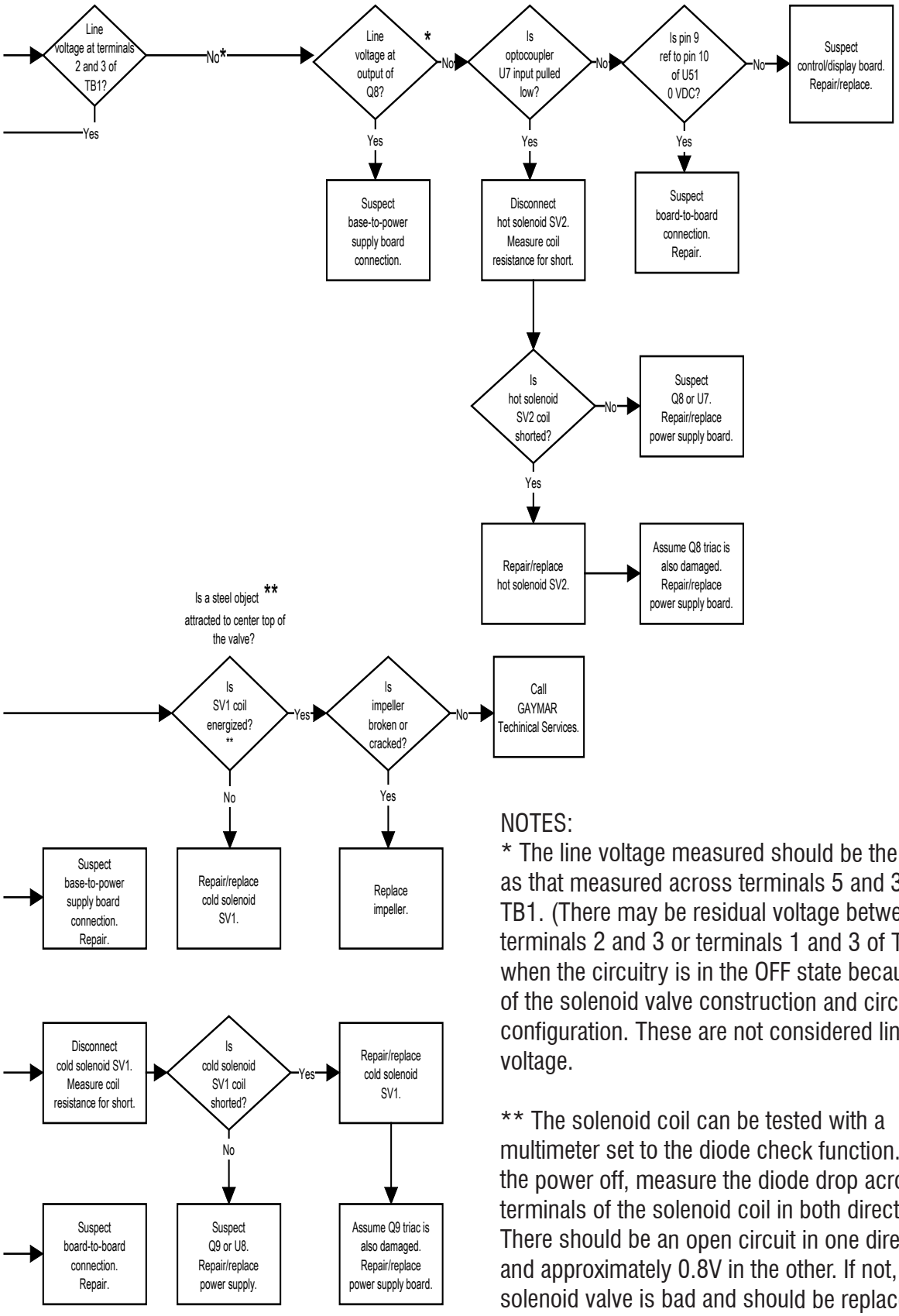


Figure 6I—Check Water Flow Alert is On, Page 1 of 2



NOTES:

* The line voltage measured should be the same as that measured across terminals 5 and 3 of TB1. (There may be residual voltage between terminals 2 and 3 or terminals 1 and 3 of TB1 when the circuitry is in the OFF state because of the solenoid valve construction and circuit configuration. These are not considered line voltage.

** The solenoid coil can be tested with a multimeter set to the diode check function. With the power off, measure the diode drop across the terminals of the solenoid coil in both directions. There should be an open circuit in one direction and approximately 0.8V in the other. If not, the solenoid valve is bad and should be replaced.

Figure 6I—Check Water Flow Alert is On, Page 2 of 2

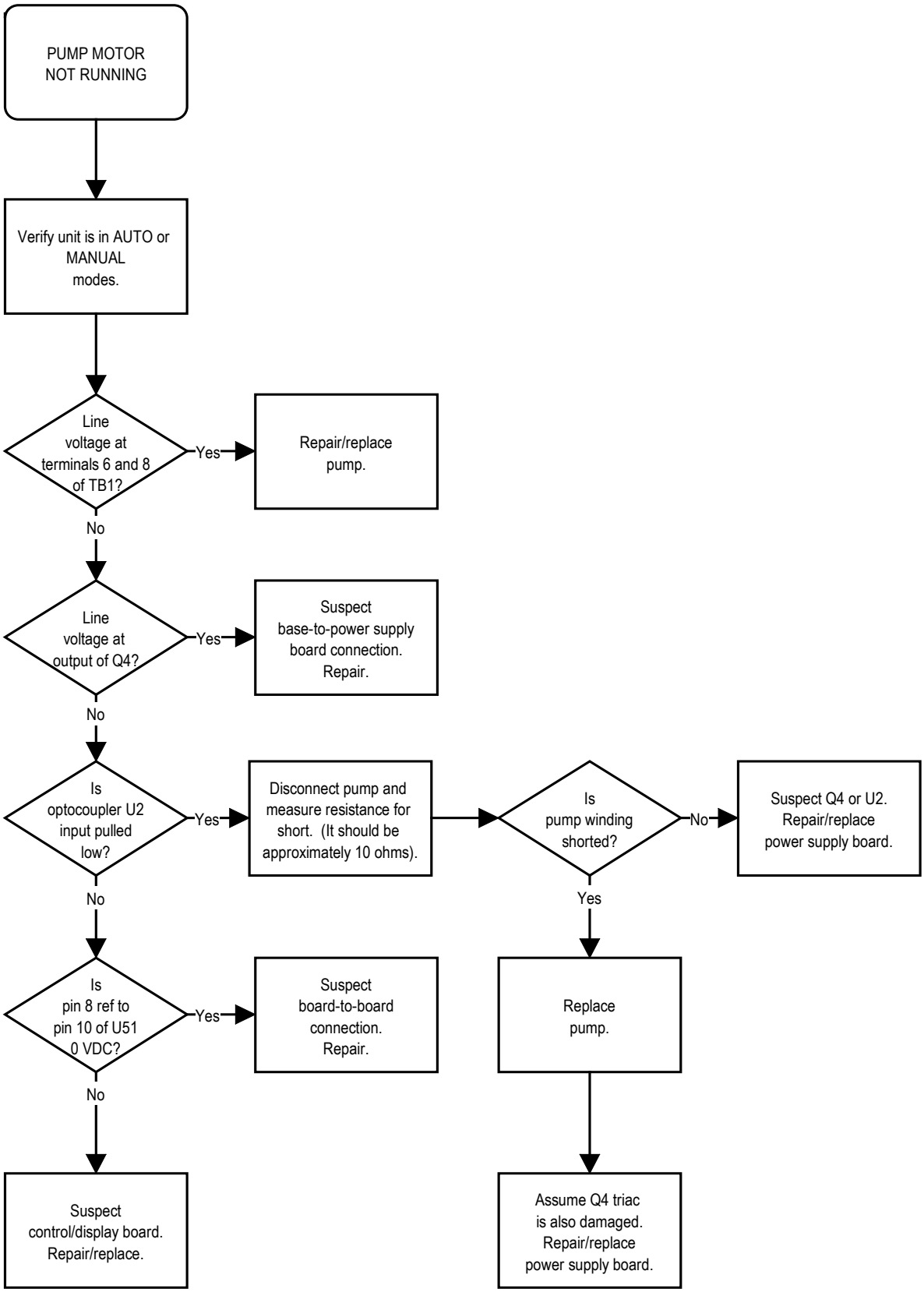


Figure 6J—Pump Motor Not Running

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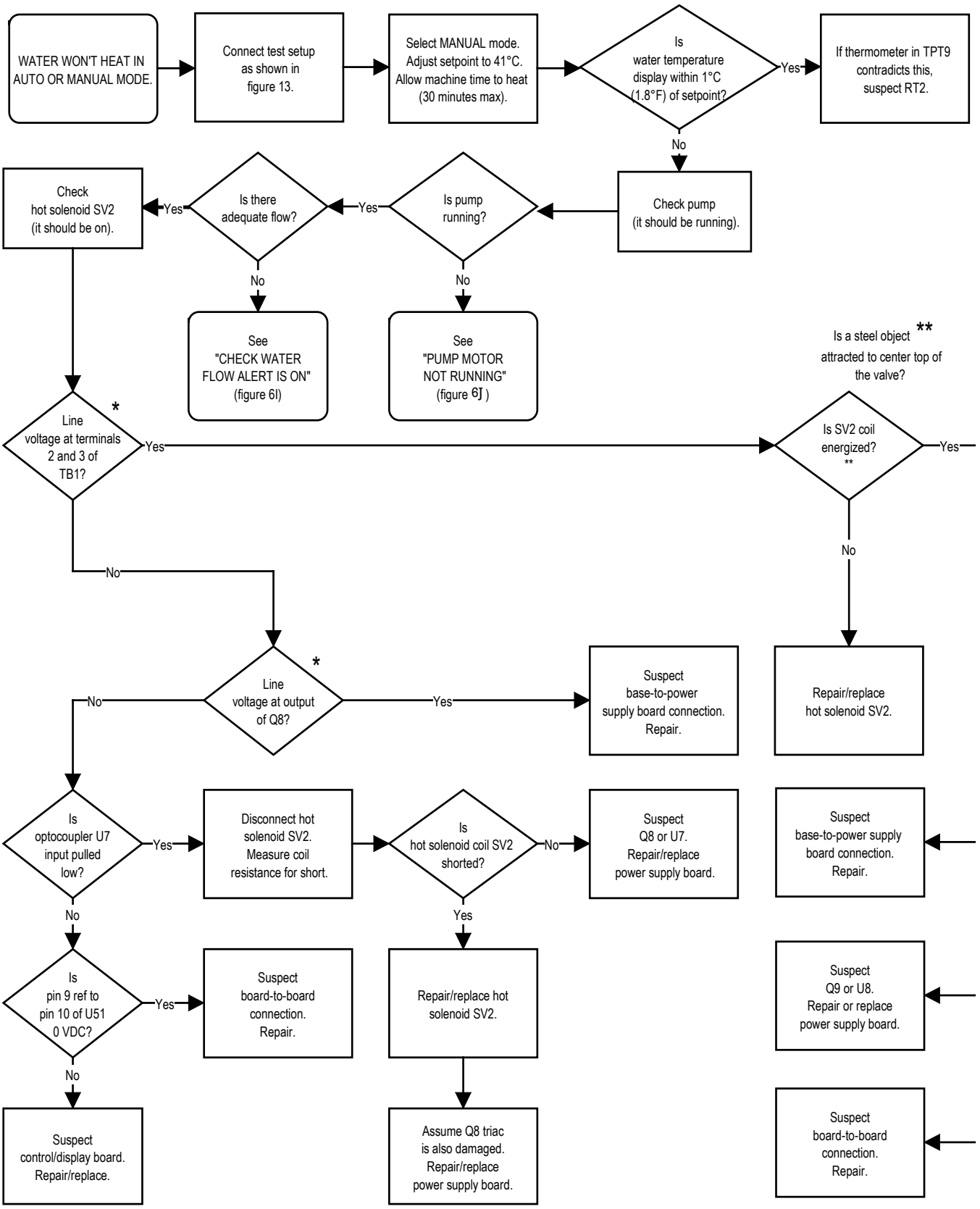


Figure 6K - Water Won't Heat in Auto or Manual Mode, Page 1 of 2

NOTES:
* The line voltage measured should be the same as that measured across terminals 5 and 3 of TB1. (There may be residual voltage between terminals 2 and 3 or terminals 1 and 3 of TB1 when the circuitry is in the OFF state because of the solenoid valve construction and circuit configuration. These are not considered line voltage.

** The solenoid coil can be tested with a multimeter set to the diode check function. With the power off, measure the diode drop across the terminals of the solenoid coil in both directions. There should be an open circuit in one direction and approximately 0.8V in the other. If not, the solenoid valve is bad and should be replaced.

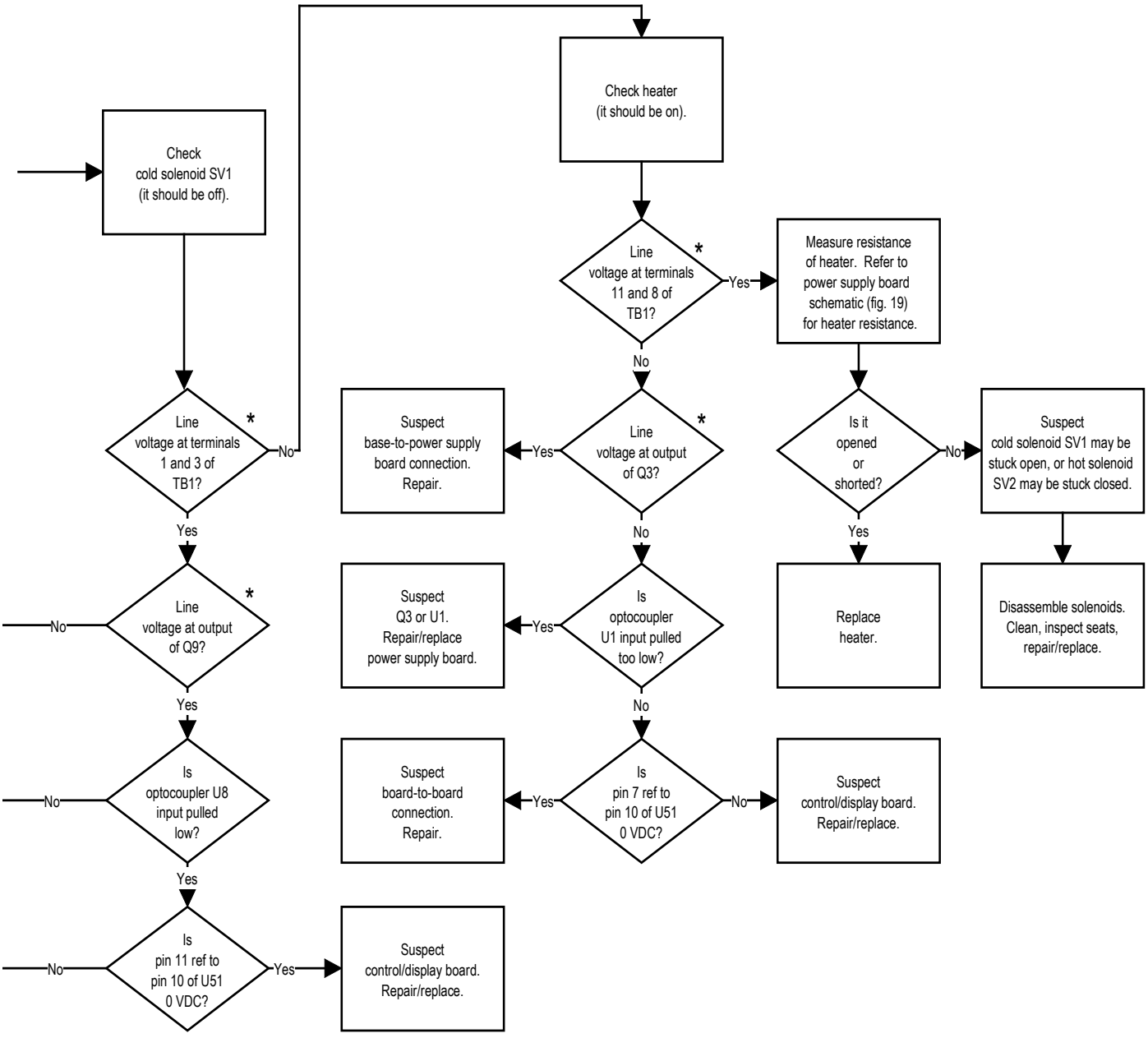


Figure 6K - Water Won't Heat in Auto or Manual Mode, Page 2 of 2

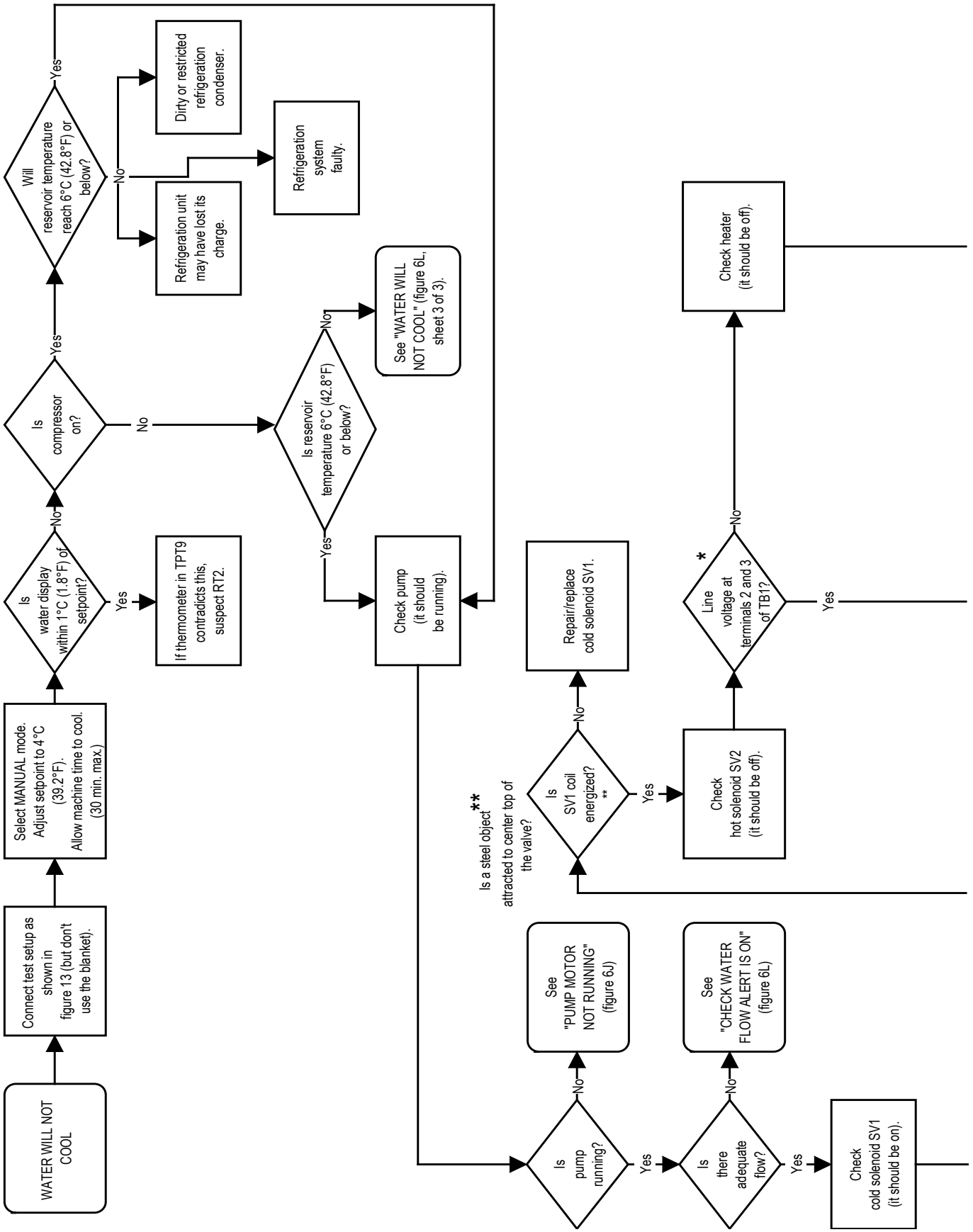
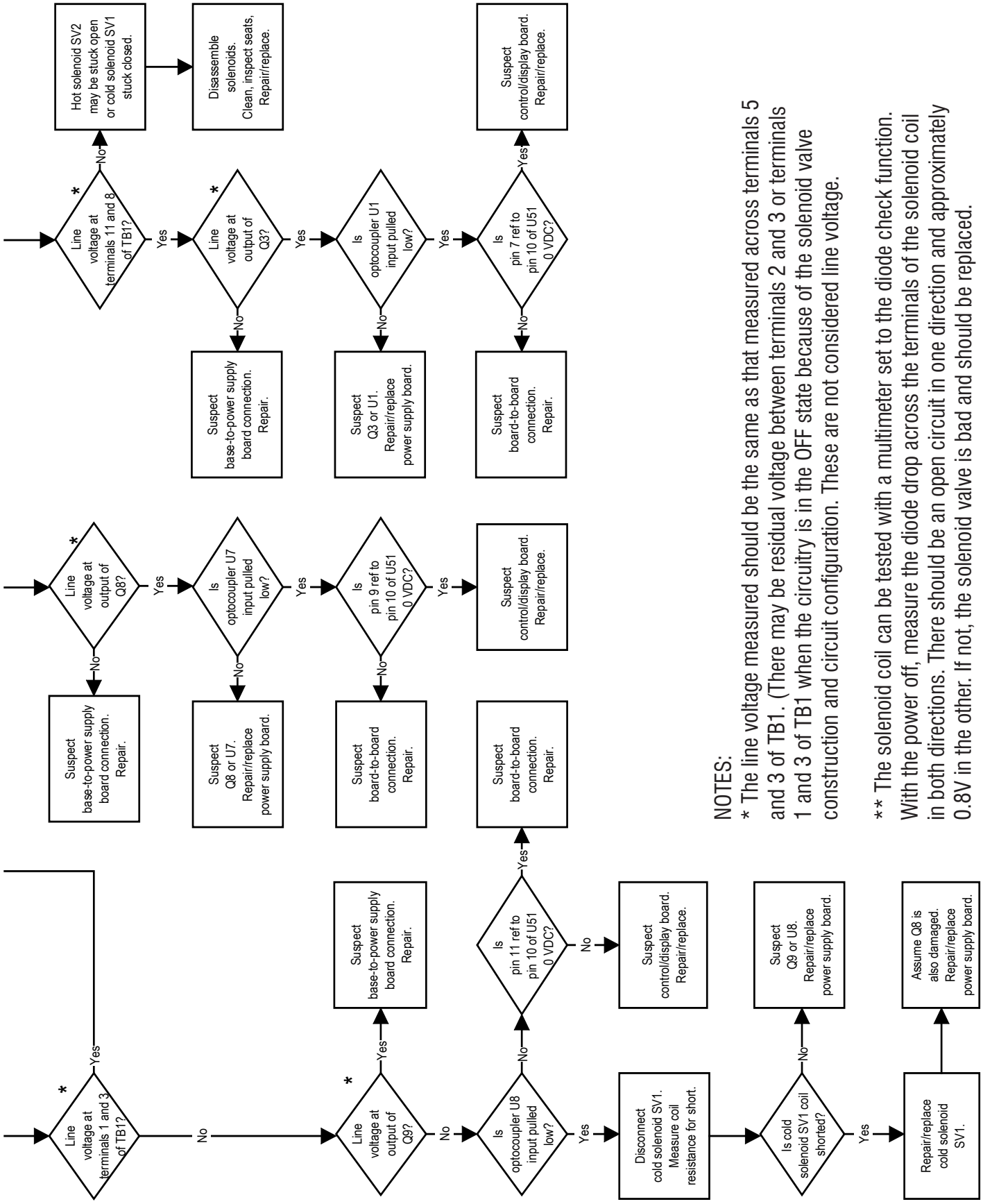


Figure 6L - Water Will Not Cool, Page 1 of 3



NOTES:

* The line voltage measured should be the same as that measured across terminals 5 and 3 of TB1. (There may be residual voltage between terminals 2 and 3 or terminals 1 and 3 of TB1 when the circuitry is in the OFF state because of the solenoid valve construction and circuit configuration. These are not considered line voltage.

** The solenoid coil can be tested with a multimeter set to the diode check function. With the power off, measure the diode drop across the terminals of the solenoid coil in both directions. There should be an open circuit in one direction and approximately 0.8V in the other. If not, the solenoid valve is bad and should be replaced.

Figure 6L - Water Will Not Cool, Page 2 of 3

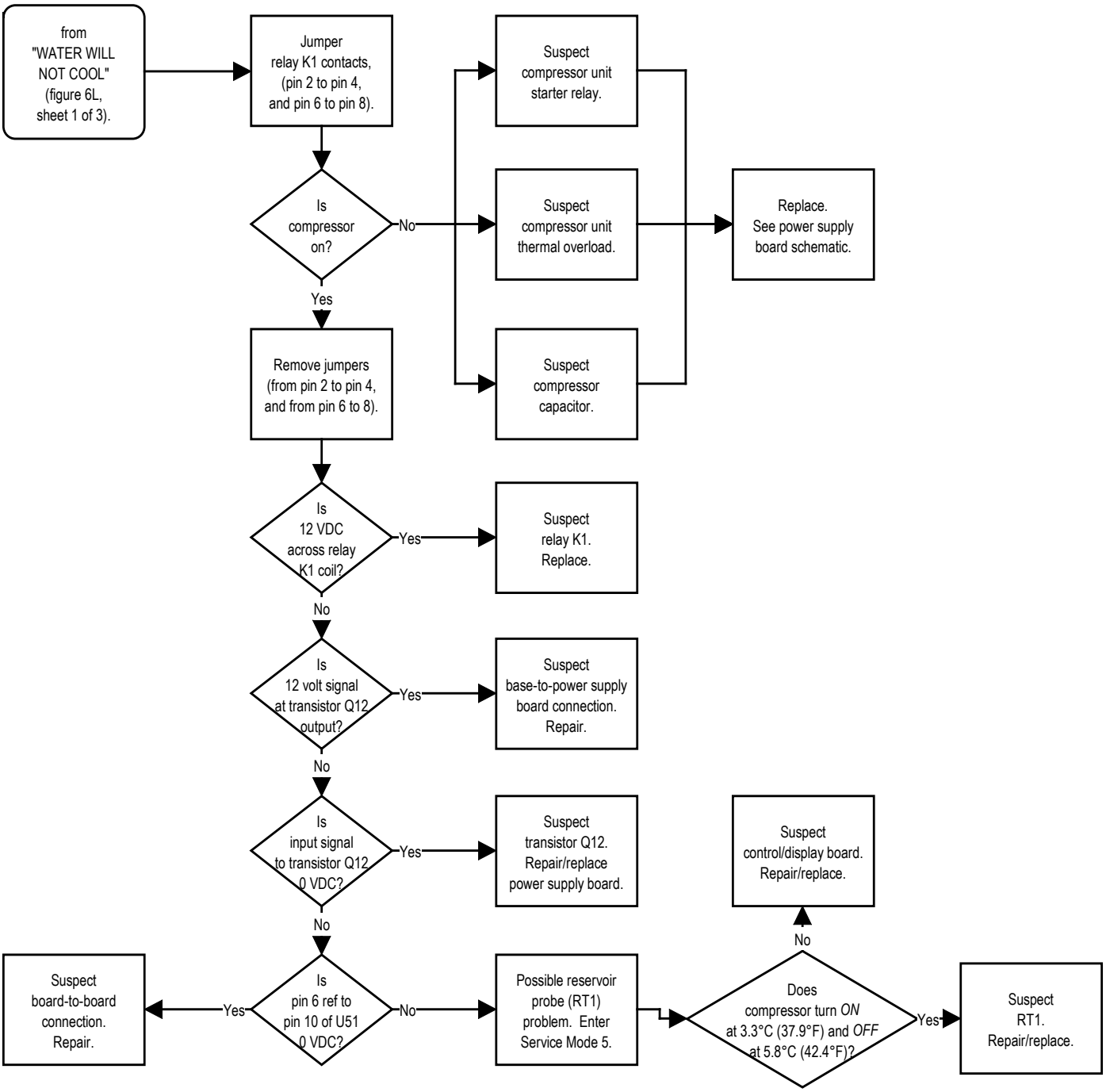


Figure 6L - Water Will Not Cool, Page 3 of 3

9.0 REPAIR PROCEDURES

⚠ WARNING

Always perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3) after making repairs and before returning the Medi-Therm III machine to patient use.

Improper repair may result in death or serious injury, equipment damage, or malfunction.

In addition to the following repair procedures, refer to the troubleshooting charts in section 8.0, page 34, *TROUBLESHOOTING AND SERVICE MODES.*

9.1 REFRIGERATION SYSTEM

⚠ WARNING

- Equipment contains refrigerant under high pressure. Refer servicing to a certified refrigeration service technician.

  Improper repair procedures can result in serious injury or damage the compressor unit.

- The refrigeration system contains rotating fan blades. Do not operate with fan shroud removed.

  Injury could result.

NOTE: Servicing and/or repair of the refrigeration system should be performed in compliance with applicable federal, state, and local regulations.

9.1.1 R-134a SYSTEMS

Do not attempt servicing the R-134a refrigeration system unless you are certified in R-134a refrigeration maintenance, repair, and reclaiming procedures. Supply the following information to the refrigeration service technician:

⚠ CAUTION

- Use only R-134a refrigerant and polyol ester oil when charging a Medi-Therm III R-134a system.

  Using other refrigerants or oils will damage the compressor.

- The Medi-Therm III R-134a system uses a polyol ester oil for lubrication because conventional mineral oils do not provide sufficient lubricity and miscibility. R-134a refrigerant and polyol ester oil are highly susceptible to moisture absorption (more so than mineral oil).

  It is important that proper system evacuation, charging, and leak detection procedures be employed. Do not leave the refrigeration system open to ambient air when servicing. Moisture absorption will result in reduced compressor life.

9.1.1 R-134a SYSTEMS (continued)

- The smaller molecular size of R-134a refrigerant allows it to leak from smaller openings.

- Prior to charging the system, Gaymar recommends evacuating the system to below 500 microns. Then, perform a vacuum decay test to assure there is not a large differential between the system and the vacuum pump. After 5 minutes, the system should still be at 500 microns or below.

- **For optimum performance, charge the R-134a system with 8.5 ounces of R-134a refrigerant.** Make sure that the entire 8.5 ounce charge is pulled from the gauge manifold and hoses into the system before disconnecting.

- If it is necessary to check a unit's charge, purge the refrigerant gauge manifold and hoses with R-134a refrigerant from an external source before opening the service valves to prevent affecting the unit's charge.

  In a properly charged unit, the low side refrigerant gauge pressure should be approximately 14 to 23 psi; the high side pressure should be approximately 123 to 137 psi, under the following conditions:

  1. the unit's wraparound is removed;
  2. the ambient temperature is 22.2°C (72°F);
  3. the unit is connected to a blanket/body wrap, and the Medi-Therm III has been set to 4°C (39.2°F) in manual mode;
  4. the reservoir water temperature is 4.4°C (40°F); and,
  5. the pressure check is performed with a gauge manifold connected to the system with flexible hoses.

  Upon completion of the pressure check, turn the unit off and allow refrigerant in the manifold and hoses (especially the high side) to migrate back into the unit before closing the service valves and disconnecting the hoses. Warming the hose near the service valve with your hands for 2-3 minutes will ensure this.

- If recharging is required, most likely there is a leak in the system. Locate and repair any leaks before recharging the unit.

- Replace the two service valve caps and two gage port caps after servicing the refrigeration system.

After servicing the refrigeration unit, make sure to perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (see section 7.3).

9.2 REPLACING THE POWER SUPPLY BOARD

⚠ CAUTION

Wear a static control device connected to the chassis ground to prevent electrostatic discharge. (See figure 5, p. 35.)

Electrostatic discharge can damage circuitry on PC boards.

The following procedures describe replacement of the power supply board. A digital voltmeter is required.

POWER SUPPLY BOARD REMOVAL (refer to figure 8, p. 67):

1. **Unplug the power cord.**
2. Disconnect the 26-conductor cable harness assembly from the power supply board at J4.
3. Disconnect the three cable harness connectors P5, P6, and P7.
4. Remove the seven (7) board mounting screws.
5. Lift board out of head.

POWER SUPPLY BOARD INSTALLATION (refer to figure 8, p. 67):

1. **Unplug the power cord.**
2. Place the new power supply board in head.
3. Install seven (7) board mounting screws.
4. Connect the three cable harness connectors P5, P6, and P7 to J3, J2, and J1 on the power supply board.
5. Perform a voltage check of the power supply board. Do not use the board or connect it to the control/display board if the voltages are incorrect.

   NOTE: To prevent an accidental short circuit, connect voltmeter leads while the machine is off.

   With the 26-conductor cable harness assembly disconnected from the power supply board and the machine on, measure for the following voltages at the following board locations (see figure 23, p. 86):

	DVM Common to Pin	DVM + Lead to Pin	Voltage Reading
Q7	1	3	-12 ± 0.5V
Q6	2	3	+12 ± 0.5V
C16	–	+	+5.3 ± 0.3V

6. Turn machine off.
7. Connect the 26-conductor cable assembly.
8. Perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3)

9.3 REPLACING THE CONTROL/DISPLAY BOARD

⚠ CAUTION

Wear a static control device connected to the chassis ground to prevent electrostatic discharge. (See figure 5, p. 35.)

Electrostatic discharge can damage circuitry on PC boards.

Control/Display Board Removal (refer to figure 8, p. 67):

1. **Unplug the power cord.**
2. Disconnect the 26 conductor cable harness assembly from the control/display board at J1.
3. Unfasten the patient probe assembly J1 from the head by removing the hex nut and pull the assembly from its mounting hole.
4. Remove the six (6) board mounting screws and three (3) lockwashers. Push aside the 26-conductor cable harness and EMI filter assembly. Remove the three standoffs from the PC board.
5. Push aside the ground harness and transformer cable and lift board enough to gain access to the PC board.
6. Disconnect the digital control panel from the board at J4 and the patient probe assembly from the board at J2.

   NOTE: These connectors have locking tabs that must be pressed in order to disengage them from the board.

⚠ CAUTION

Use care when disconnecting the digital control panel ribbon from the control board.

Folding the ribbon cable may cause failure of the control panel.

7. Lift board out of cover.

Control/Display Board Installation (refer to figure 8, p. 67):

1. **Unplug the power cord.**
2. Place the new control/display board in the head.
3. Install the six (6) board mounting screws and three (3) standoffs as follows:
   a. Insert one standoff through the middle mounting hole along the board's longer edge (toward front of machine). This will be used to hold the transformer cable off the board.
   b. Install the other two standoffs in the two mounting holes closest to the J1 connector for the 26-conductor cable harness. Theses will be used to hold the 26-conductor cable harness and EMI assembly off the board.

c. Move the 26-conductor cable harness and EMI filter assembly over the standoffs.

d. Insert two board screws through the transformer cable retaining clips on the transformer cable and mount one through the corner EMI filter assembly hole and into the standoff. Mount the other to the standoff along the board's longer edge.

e. Install three board screws and three lockwashers through the ground harness:

(1.) Install the corner board screw through the ground wire of the patient probe assembly, then into the board.

(2.) Install the second screw and washer through the ground harness into the board.

(3.) Install the third screw and washer through the EMI filter assembly and into the installed standoff.

f. Install the remaining board screw.

4. Insert patient probe assembly into mounting hole and fasten with hex nut. Insure patient probe assembly is oriented so that the bevelled corner of the probe assembly is positioned as shown in figure 16, p. 78.
5. Connect the digital control panel plug P4 to the board at J4.
6. Connect the patient probe assembly plug P2 to the board at J2.
7. Perform a voltage check of the power supply board (see section 9.2, p. 59).
8. Connect the 26 conductor cable assembly from the power supply board.
9. Perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3).

9.4 REPLACING THE TOP COVER

To install a complete new cover:

1. **Unplug the power cord.**
2. Remove old top cover from machine by removing 6 screws underneath top cover and disconnecting cables. See figure 14, p. 75.
3. Install new top cover.
4. Perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3).

9.5 REPLACING THERMOSTATS

To replace thermostat (see figures 15, 17, and 18; pp. 76-77, 79, 81):

1. **Unplug the power cord.**
2. Remove wraparound from chassis.
3. Disconnect spade lugs from thermostat terminals.
4. Carefully peel back insulating material.
5. Remove the two screws holding the thermostat. Remove the thermostat.
6. Apply thermal grease to the underside of the replacement thermostat to ensure proper operating temperature ranges.

   * Recommended thermal greases:

   - Silicone Heat Sink Compound
     (Dow Corning; Midland, Michigan)
   - Thermal Joint Compound Type 120-5
     (Wakefield Engineering; Wakefield, Massachusetts)

> **⚠ CAUTION**
>
> Always use thermal grease on thermostats for Medi-Therm III units.
>
> **Failure to use thermal grease could raise trip points above the acceptable range.**

7. Reconnect spade lugs to terminals. Refer to figures 17, p. 79 to ensure thermostat is connected correctly.

> **⚠ CAUTION**
>
> Do not bend or alter terminals.
>
> **Terminals may break. Also, bending may alter the trip point range.**

8. Mount thermostat, using existing screws.
9. Reapply insulating material.
10. Perform the *FUNCTIONAL CHECK AND SAFETY INSPECTION* (section 7.3).

9.6 CLEANING THE FLOW SWITCH

To clean the flow switch (see figure 7 below and figure 15, pp. 76-77):

1. Remove nuts (item A) and remove assembly.
2. Loosen hose clamps (items B and C) and remove hoses.
3. Remove barbed adapters (item D). Remove piston.
4. Clean all parts with alcohol and remove any foreign matter.
5. To reassemble, reverse steps 1 through 3 above. Ensure that the piston is replaced into the flow switch housing with its round "disk" side oriented down.

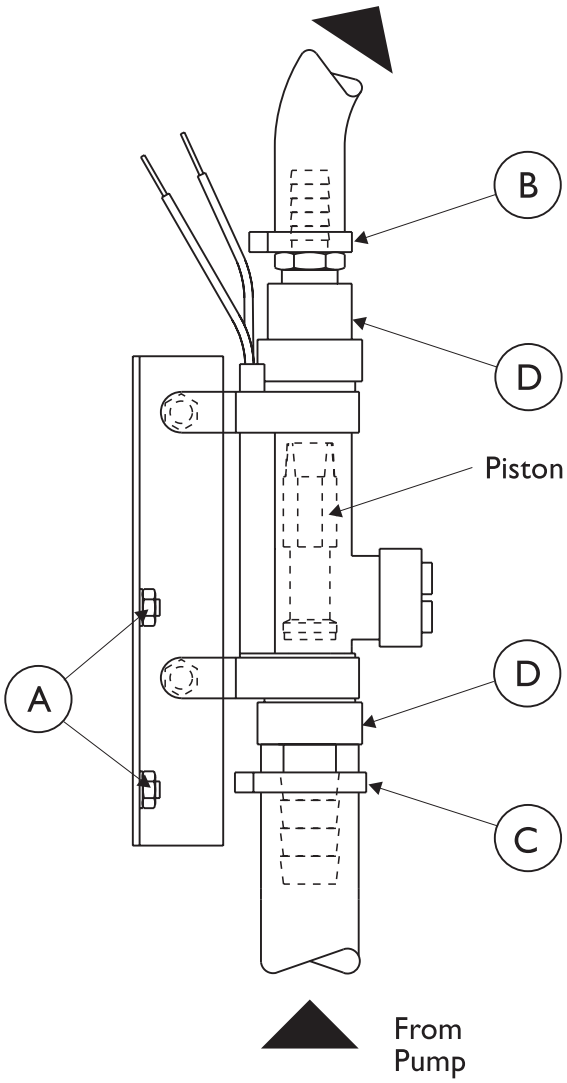


Figure 7 - Flow Switch

9.7 REPLACEMENT PARTS

For base replacement parts information, refer to figure 15, table 7, pp. 76-77.
For head replacement parts information, refer to figure 16, table 8, p. 78.

Repairs should only be performed by qualified personnel familiar with repair practices for servicing medical devices.

9.8 SHIPPING / REPACKAGING INSTRUCTIONS

⚠ CAUTION

Failure to install compressor shipping braces before shipment can result in extensive damage to the refrigeration section. (See p. 88, figure B.)

See figure 25, p. 88 for complete repackaging instructions to ship the Medi-Therm III machine back to Gaymar or to a qualified Service Center.
If you do not have the original packing materials, please contact Gaymar's Technical Service Department and a complete Customer Return Kit will be sent to you.

Be sure to obtain return authorization from our Technical Service Department before shipping the machine.

10.0 REFERENCE TABLES

10.1 CELSIUS-FAHRENHEIT CONVERSION

ºC	ºF
0.0	32.0
0.5	32.9
1.0	33.8
1.5	34.7
2.0	35.6
2.5	36.5
3.0	37.4
3.5	38.3
4.0	39.2
4.5	40.1
5.0	41.0
5.5	41.9
6.0	42.8
6.5	43.7
7.0	44.6
7.5	45.5
8.0	46.4
8.5	47.3
9.0	48.2
9.5	49.1
10.0	50.0
10.5	50.9
11.0	51.8

ºC	ºF
11.5	52.7
12.0	53.6
12.5	54.5
13.0	55.4
13.5	56.3
14.0	57.2
14.5	58.1
15.0	59.0
15.5	59.9
16.0	60.8
16.5	61.7
17.0	62.6
17.5	63.5
18.0	64.4
18.5	65.3
19.0	66.2
19.5	67.1
20.0	68.0
20.5	68.9
21.0	69.8
21.5	70.7
22.0	71.6
22.5	72.5

ºC	ºF
23.0	73.4
23.5	74.3
24.0	75.2
24.5	76.1
25.0	77.0
25.5	77.9
26.0	78.8
26.5	79.7
27.0	80.6
27.5	81.5
28.0	82.4
28.5	83.3
29.0	84.2
29.5	85.1
30.0	86.0
30.5	86.9
31.0	87.8
31.5	88.7
32.0	89.6
32.5	90.5
33.0	91.4
33.5	92.3
34.0	93.2

ºC	ºF
34.5	94.1
35.0	95.0
35.5	95.9
36.0	96.8
36.5	97.7
37.0	98.6
37.5	99.5
38.0	100.4
38.5	101.3
39.0	102.2
39.5	103.1
40.0	104.0
40.5	104.9
41.0	105.8
41.5	106.7
42.0	107.6
42.5	108.5
43.0	109.4
43.5	110.3
44.0	111.2
44.5	112.1
45.0	113.0

Table 4—Celsius-Fahrenheit Conversion

10.2 TEMPERATURE vs. RESISTANCE

PATIENT PROBE, BLANKET WATER PROBE (RT2), AND RESERVOIR PROBE (RT1) TEMPERATURE RESISTANCE

ºC	ºF	(OHMS)
0	32.0	7355
1	33.8	6989
2	35.6	6644
3	37.4	6319
4	39.2	6011
5	41.0	5719
6	42.8	5444
7	44.6	5183
8	46.4	4937
9	48.2	4703
10	50.0	4482
11	51.8	4273
12	53.6	4074
13	55.4	3886
14	57.2	3708
15	59.0	3539
16	60.8	3378
17	62.6	3226
18	64.4	3081
19	66.2	2944
20	68.0	2814
21	69.8	2690
22	71.6	2572
23	73.4	2460
24	75.2	2354
25	77.0	2252

ºC	ºF	(OHMS)
26	78.8	2156
27	80.6	2064
28	82.4	1977
29	84.2	1894
30	86.0	1815
31	87.8	1739
32	89.6	1667
33	91.4	1599
34	93.2	1533
35	95.0	1471
36	96.8	1412
37	98.6	1355
38	100.4	1301
39	102.2	1249
40	104.0	1200
41	105.8	1152
42	107.6	1107
43	109.4	1064
44	111.2	1023
45	113.0	983.8
46	114.8	946.2
47	116.6	910.2
48	118.4	875.8
49	120.2	842.8
50	122.0	811.3

Table 5—Temperature vs. Resistance

11.0 SERVICE INFORMATION

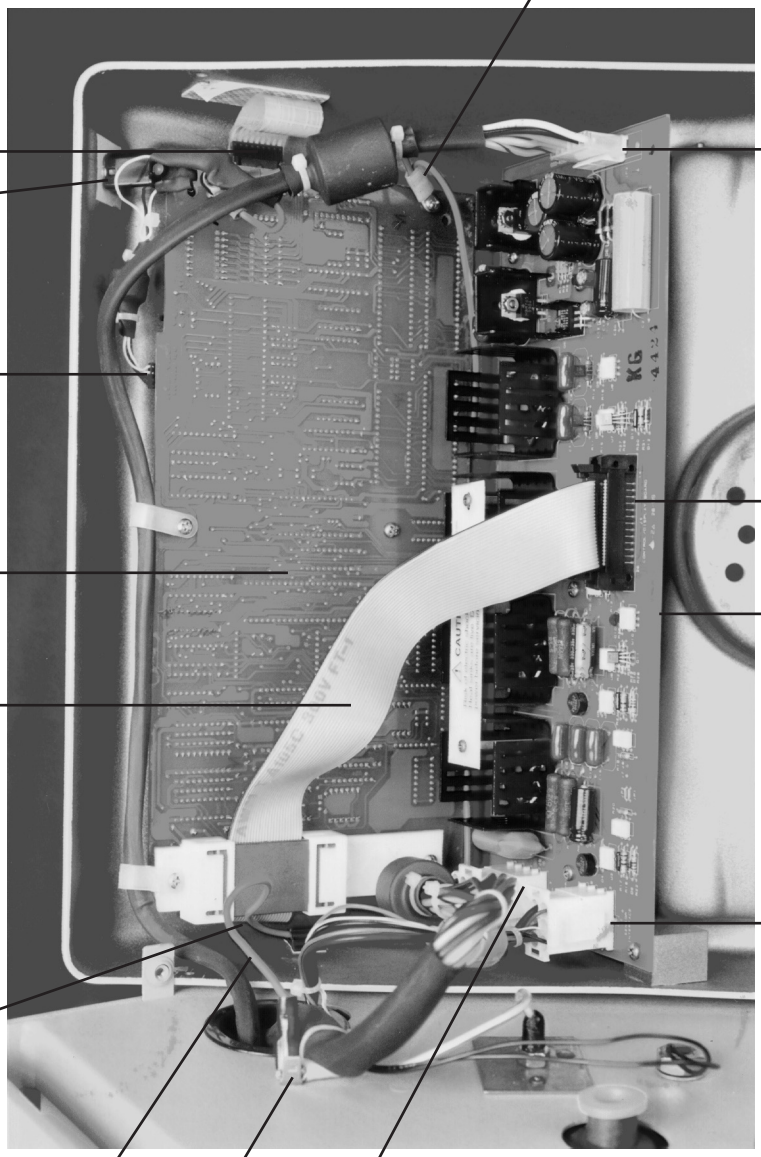


Figure 8—Circuit Boards and Connectors (Head)

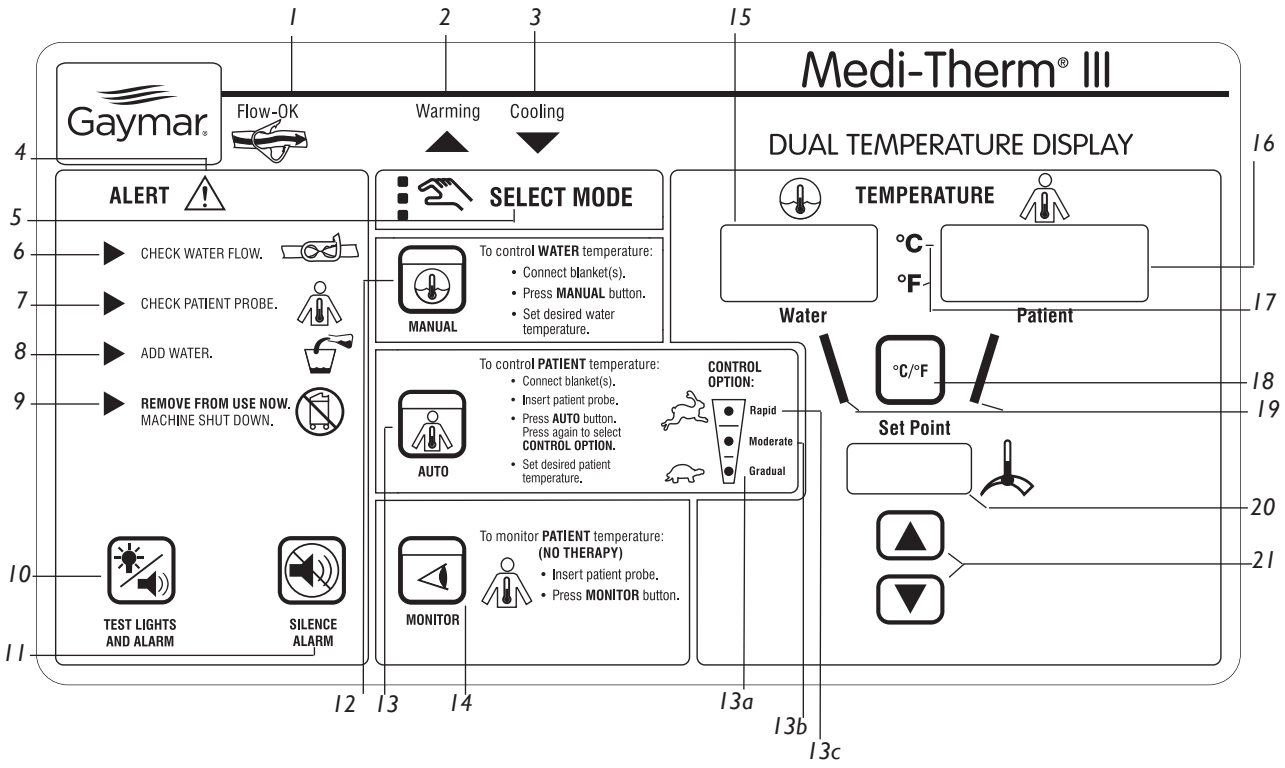


Figure 9A—Operator Controls/Indicators

Item	Name	Function
1	FLOW-OK	Indicates water is flowing adequately.
2	WARMING	Indicates water or patient is being heated. Refer to section 4.2 THERMAL SPECIFICATIONS, p.5.
3	COOLING	Indicates water or patient is being cooled. Refer to section 4.2 THERMAL SPECIFICATIONS, p.5.
4	ALERT	Indicates an alert condition exists.
5	SELECT	Indicates a mode must be selected. Flashes if set point buttons are pressed before selecting mode.
6	CHECK WATER FLOW	Indicates the flow of water to the blanket/body wrap has been restricted. An audible alarm accompanies this alert.
7	CHECK PATIENT PROBE	Indicates the patient probe is sensing an abnormal patient temperature (below 29C° [84.2°F] or above 45°C [113°F]). An audible alarm accompanies this alert.
8	ADD WATER	Indicates the water reservoir is below the recommended level.
9	REMOVE FROM USE NOW / MACHINE SHUT-DOWN	May indicate the Medi-Therm III has shut down due to water temperature exceeding either the high or low limit. It may also indicate an error in one of the circuit boards of the machine. Remove the Medi-Therm III machine from use immediately.
10	TEST LIGHTS	Enables the operator to confirm that all indicator lights and digital displays are working, and that the audible alarm is functioning. The displays flash and the audible alarm sounds as long as the TEST LIGHTS button is pressed.

11	SILENCE ALARMS	Temporarily silences the audible alarm. The alarm will reactivate in approximately 5 minutes if the condition persists. The SILENCE ALARM button will not function if the REMOVE FROM US NOW / MACHINE SHUTDOWN indicator is lit.
12	MANUAL	Selects the manual mode of operation. In MANUAL mode, the operator must observe the patient temperature and adjust the water set point temperature to obtain the desired results.
13	AUTO	Selects the automatic mode of operation. In AUTO mode, the operator sets the desired temperature and the patient temperature is automatically regulated to the operator-specified set point. The rate of cooling or warming is user adjustable through the use of the CONTROL OPTION.
13a	Rapid	COOLING: the coldest water is used for cooling, the temperature can be as low as 4°C (39°F). WARMING: the hottest water is used for warming, the temperature can be as high as 42°C (107.6°F).
13b	Moderate	COOLING: the cooling water temperature is limited to 15°C (27°F) below the PATIENT TEMPERATURE. WARMING: the PATIENT TEMPERATURE will increase at a rate of 1°C (1.8°F) in a period of 3 hours (0.33°C/Hr [0.6°F/Hr]).
13c	Gradual	COOLING: the cooling water temperature is limited to 10°C (18°F) below the PATIENT TEMPERATURE. WARMING: the PATIENT TEMPERATURE will increase at a rate of 1°C (1.8°F) in a period of 6 hours(0.17°C/Hr [0.3°F/Hr]).
14	MONITOR	Selects the monitor mode of operation. In MONITOR mode, the operator may monitor the patient temperature without providing therapy.
15	WATER	Indicates the temperature of the water being delivered to the blanket/body wrap. This display is only illuminated when the MODE is set to MANUAL or AUTO.
16	PATIENT	Indicates the actual patient temperature as sensed by the probe connected to the patient probe jack. This display is illuminated when MODE is set to MANUAL, AUTO, or MONITOR and a patient probe is plugged into the PATIENT PROBE jack.
17	°C/°F INDICATOR	Displays the temperature and set point in either degrees Celsius (°C) or Fahrenheit (°F). Pressing the °C/°F button will display the appropriate scale and light the corresponding indicator.
18	°C/°F BUTTON	
19	LEADER LIGHTS	Emphasizes whether water temperature or patient temperature is being set.
20	SET POINT	Indicates the desired SET POINT temperature. When operating in MANUAL mode, pressing the SET POINT button (up or down) sets the desired WATER temperature. When in AUTO mode, pressing the SET POINT button sets the desired patient temperature.
21	SET POINT BUTTONS	

Table 6A - Operator Controls/Indicators

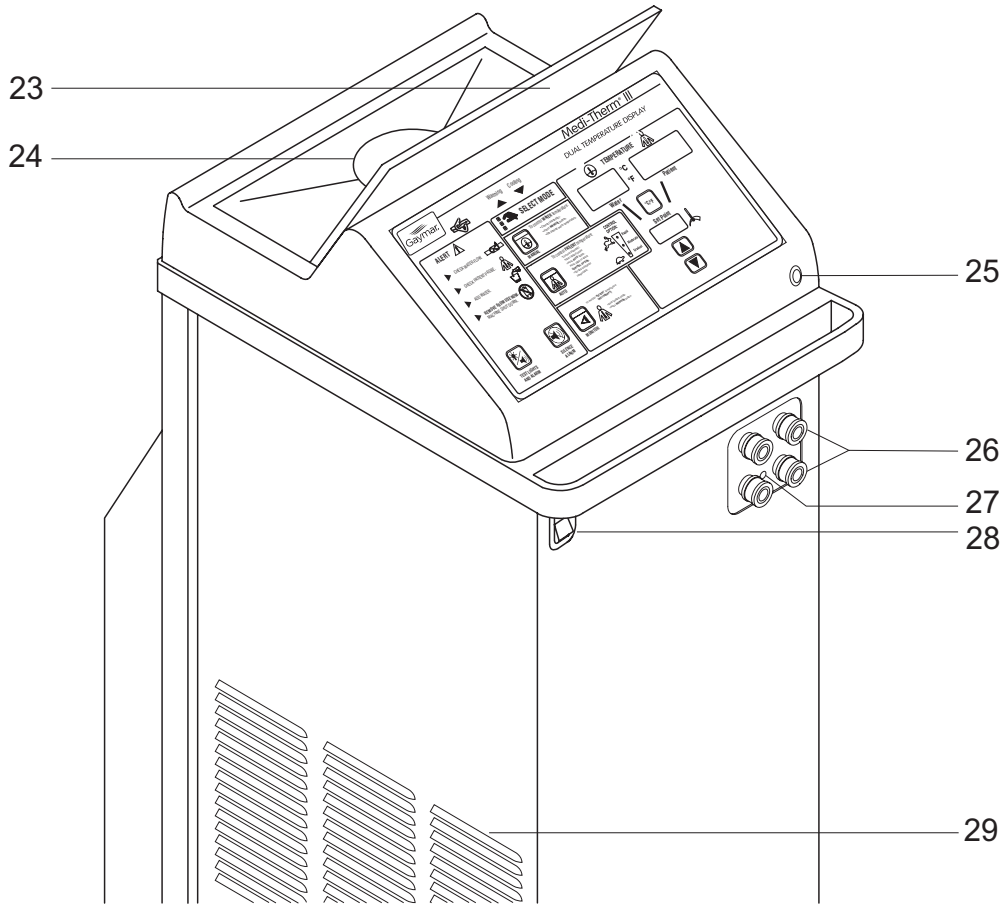
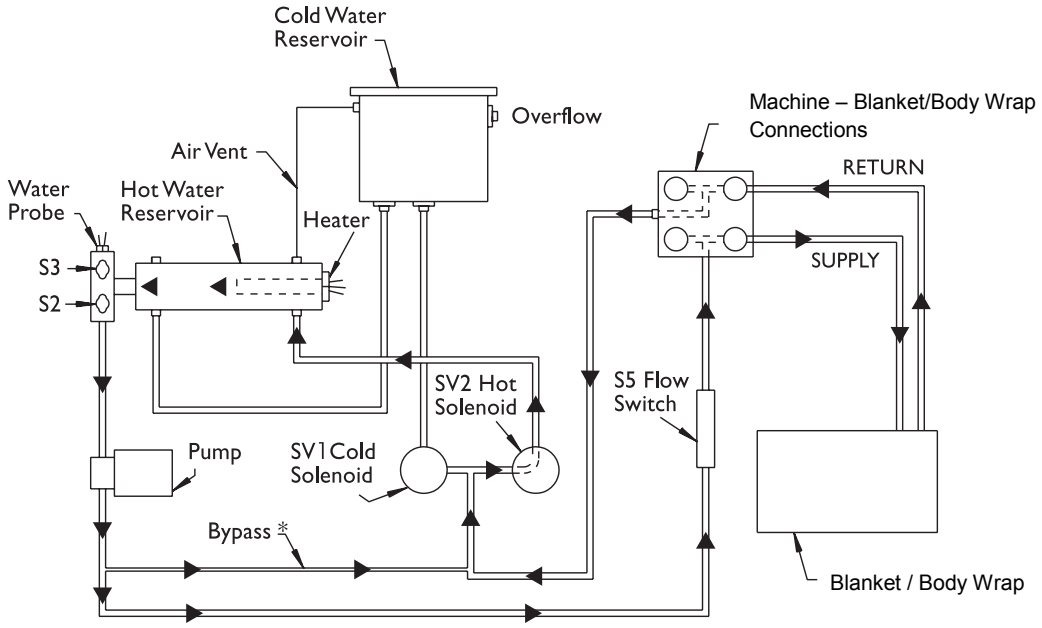


Figure 9B—Operator Controls/Indicators

Item	Name	Function
23	OPERATING INSTRUCTIONS	Condensed operating instructions are mounted on the machine head and on top of the water fill opening cover.
24	WATER FILL OPENING	Used to fill water reservoir to proper level. To fill, lift cover on the water fill opening and fill with distilled water until the green band on the float stem is fully visible.
		CAUTION: Add distilled water only. Failure to use distilled water may result in poor machine performance. Do not use alcohol. Do not operate without water. Do not overfill.
25	PATIENT PROBE JACK	Accepts patient probe plug connecting patient probe to machine.
		Use only Gaymar probes or equivalent YSI 400 series probes approved for use with medical devices.
26	BLANKET / BODY WRAP CONNECTIONS	Connects machine to quick-disconnects on the connector hose.
27	PROBE CHECK WELL	Used to perform probe check (refer to Operating Manual for procedure).
		WARNING: When performing the probe check, use a protective sheath (Becton-Dickinson catalog 3700 oral sheath or equivalent) on probe to prevent cross contamination.
28	ON / OFF SWITCH	(Circuit breaker) Controls power to the unit.
29	AIR VENTS	Permits adequate air circulation. Keep louvered openings clear on all three sides of the cabinet.

Table 6B—Operator Controls/Indicators

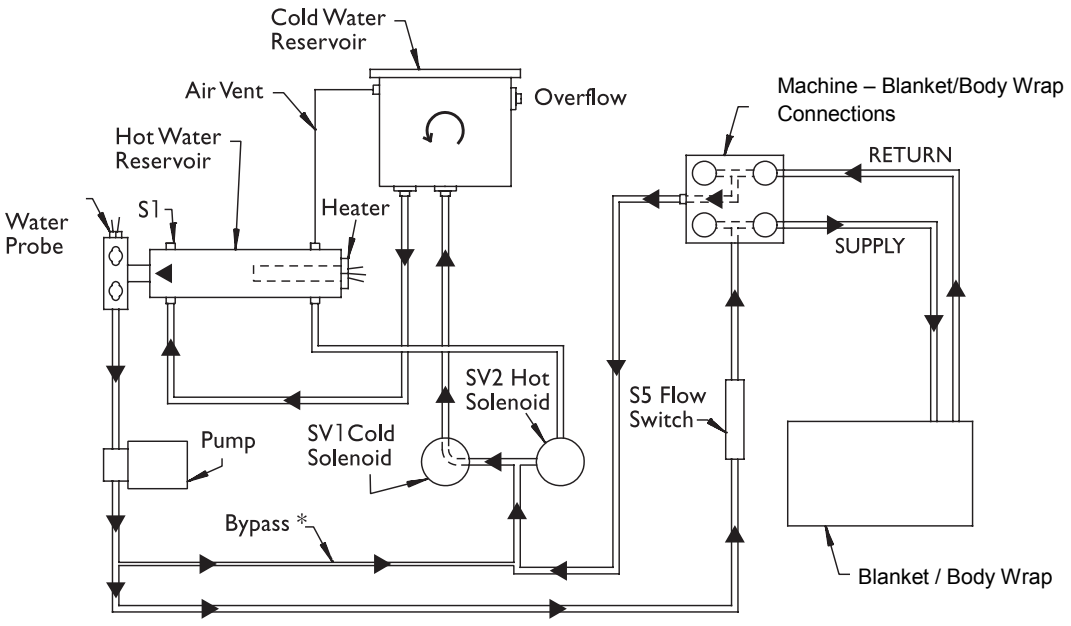
*When the Medi-Therm III machine is **heating,** water flows in the path shown below.*



* Water bypass prevents overheating when a blanket / body wrap is not connected to the Medi-Therm III.

Figure 10—Heating flow diagram

*When the Medi-Therm III machine is **cooling,** water flows in the path shown below.*



* Water bypass prevents overheating when a blanket / body wrap is not connected to the Medi-Therm III.

Figure 11—Cooling flow diagram

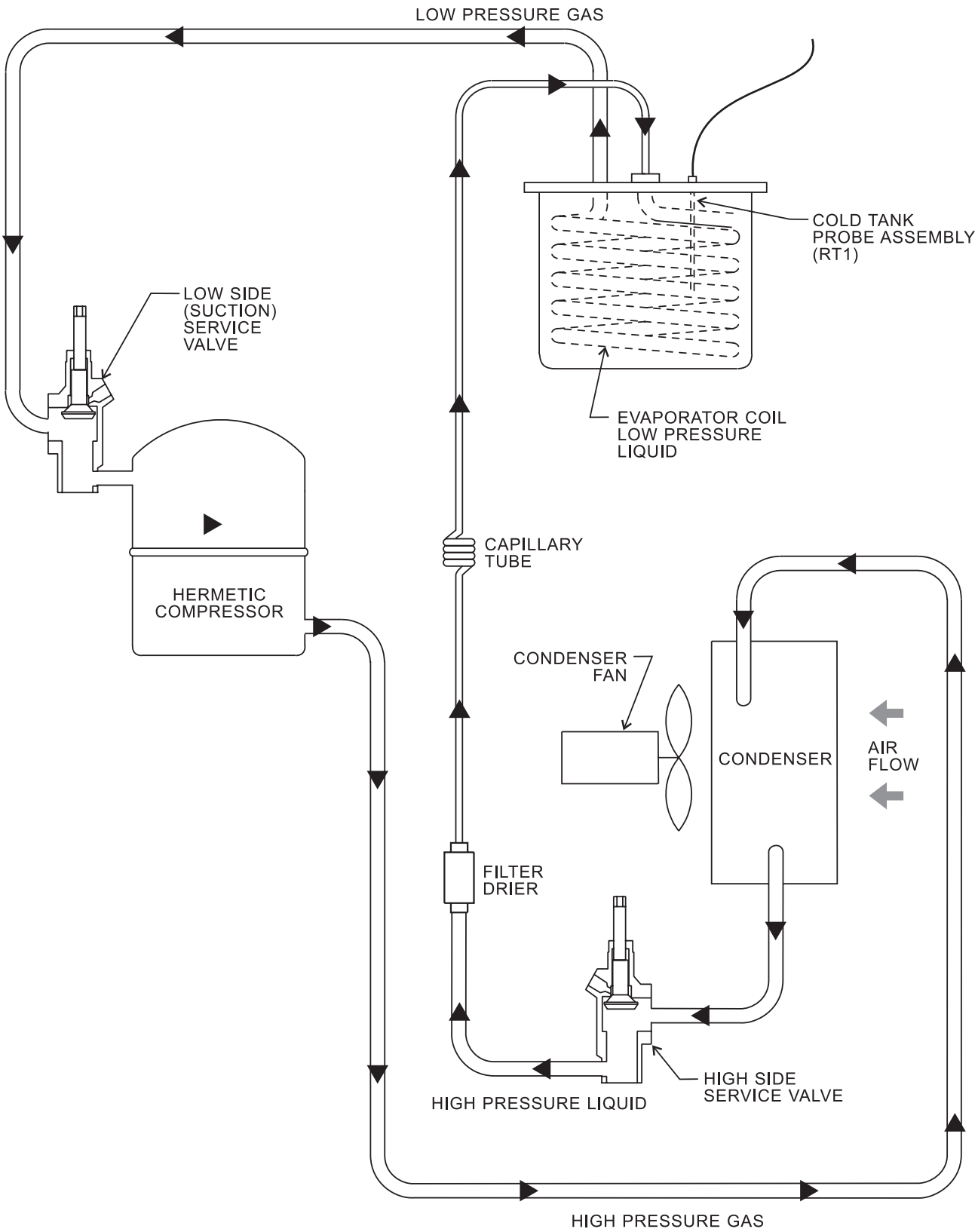


Figure 12—Refrigeration flow diagram

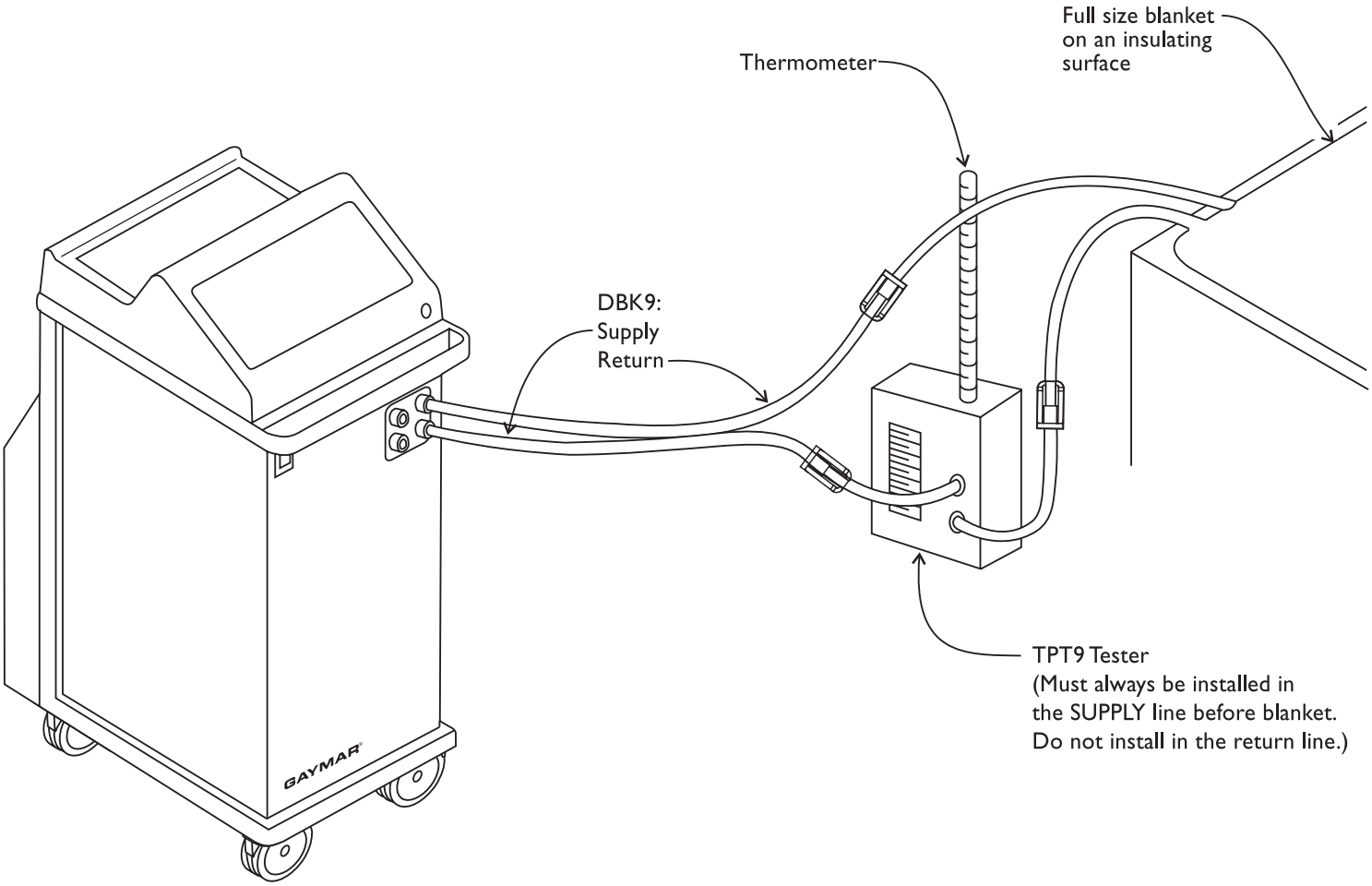


Figure 13—Test setup

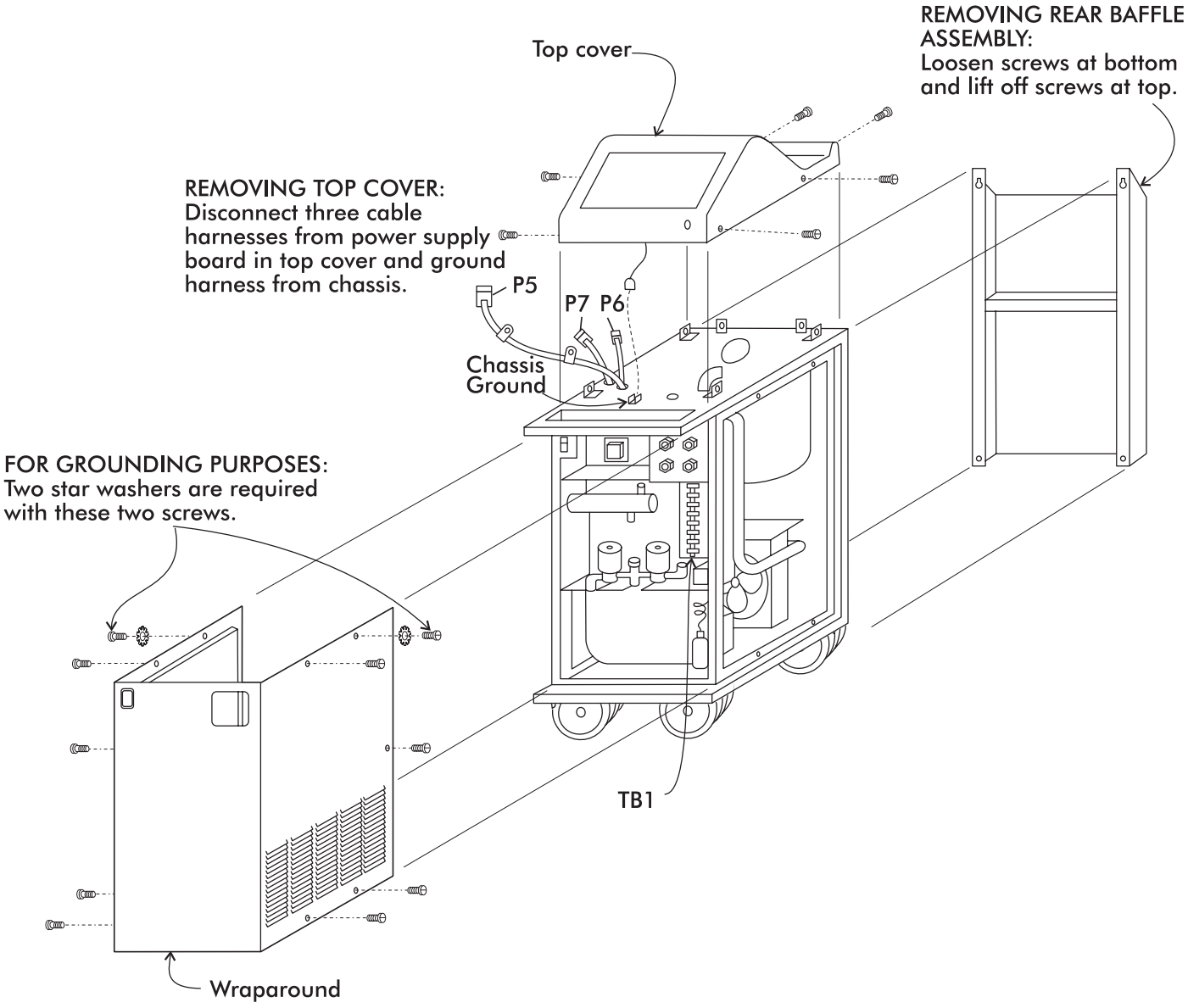


Figure 14—Machine disassembly

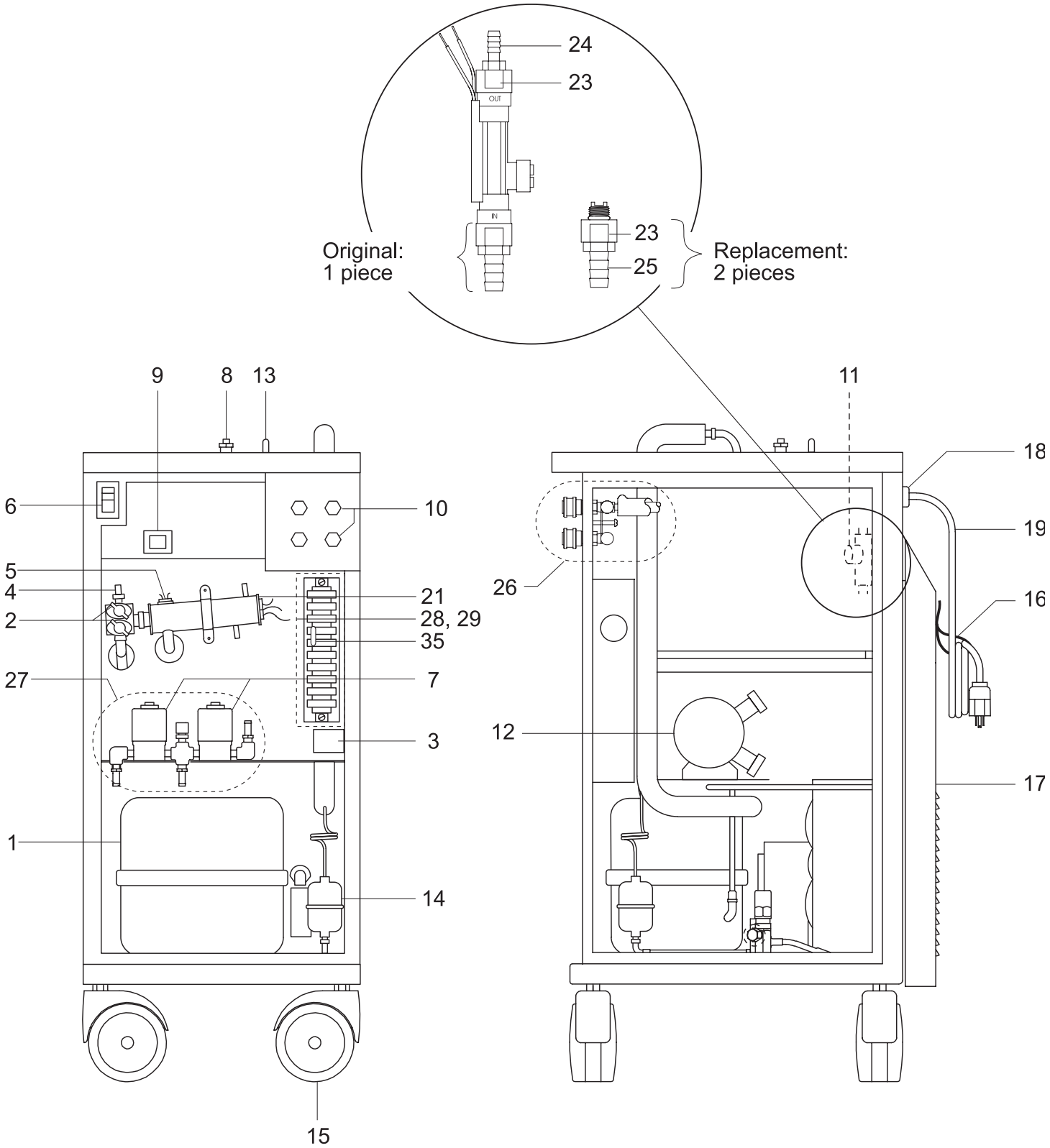


Figure 15—Parts Diagram (Base)

ITEM	DESCRIPTION	PART NUMBER
1	KIT, CONDENSING UNIT	78256-000
	A. START CAPACITOR	90701-142
	B. RELAY	78257-000
	C. THERMAL OVERLOAD	78258-000
	D. RC NETWORK	78429-000
2	THERMOSTAT, WHITE DOT (S2 & S3)	78263-000
3	COMPRESSOR RELAY	91234-001
4	TEMPERATURE PROBE ASSEMBLY (RT2) KIT	77737-000
5	THERMOSTAT, BLACK DOT (S1)	77372-000
6	CIRCUIT BREAKER (CB1)	77754-000
	CIRCUIT BREAKER COVER	77756-000
7	SOLENOID VALVE (SV1 OR SV2)	77824-000
8	WATER LEVEL SENSOR	77757-000
9	TRANSFORMER ASSEMBLY (T1)	10892-001
10	QUICK DISCONNECT (FEMALE)	01080-000
11	FLOW SWITCH ASSEMBLY	77797-000
12	PUMP	07368-001
13	COLD TANK PROBE ASSEMBLY (RT1)	77759-000
14	FILTER DRIER ASSEMBLY (INCLUDES SUCTION SERVICE LINE AND CAPILLARY TUBE)	10878-000
15	CASTER	91518-000
16	POWER CORD STRAP	03791-000
17	REAR BAFFLE ASSEMBLY	07464-001
18	STRAIN RELIEF	90634-001
19	POWER CORD	77879-000
20	WRAPAROUND (Not Shown)	07215-000
	A. WRAPAROUND SCREW (Not Shown)	90018-075
	B. WRAPAROUND LOCKWASHER (Not Shown)	90140-008
21	HEATER ASSEMBLY	07370-000
22	RC NETWORK (Not Shown); connected between terminals 4 and 8 of COMPRESSOR RELAY (ITEM 3	10615-000
23	ADAPTER	90726-001
24	HOSE BARB (5/16")	90275-018
25	HOSE BARB (1/2")	90275-054
26	MANIFOLD ASSEMBLY	07305-001
27	SOLENOID VALVE ASSEMBLY	07420-000
28	COVER PLATE (TB1)	04940-000
29	COVER PLATE LABEL	07835-000
30	TUBING, WATER PATH (5/16" ID)--order by the foot (Not Shown)	80366-000
31	INSULATION (1/2" ID; FOR 5/16" TUBING)--order by the foot (Not Shown)	80234-000
32	TUBING, WATER PATH (1/2" ID)--order by the foot (Not Shown)	80161-000
33	INSULATION (3/4" ID; FOR 1/2" TUBING)--order by the foot (Not Shown)	80162-000
34	FAN BLADE (Not Shown)	77543-001
35	QUICK REFERENCE GUIDE (Not Shown)	101274-000

Table 7—Parts List (Base)

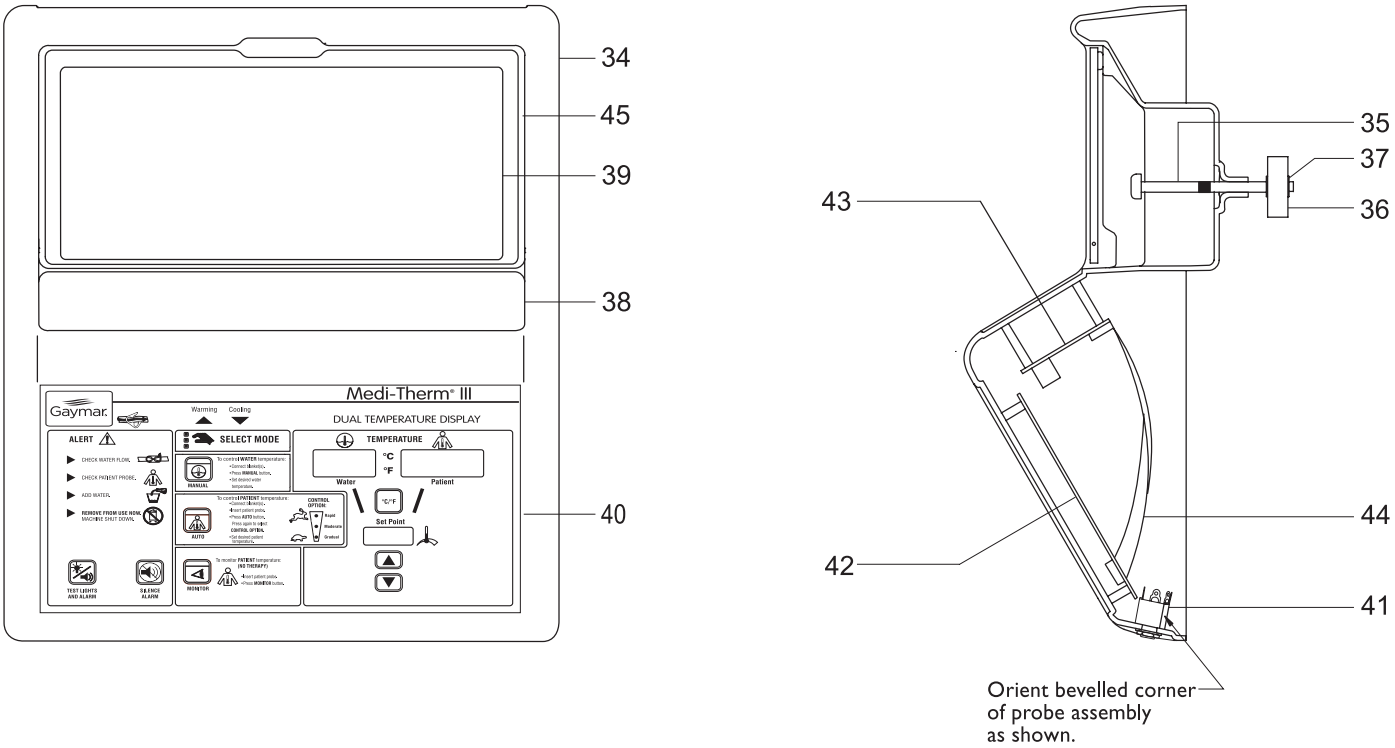


Figure 16—Parts Diagram (Head)

ITEM	DESCRIPTION	PART NUMBER
34	COVER, WITH LABELS, CONTROL PANEL, FLOAT ASSY	78259-002
35	STEM	77760-000 (ALL PARTS)
36	FOAM FLOAT	
37	RETAINING RING	
38	PRECAUTIONS AND ALERTS LABEL	100393-000
39	INSTRUCTION LABEL	101254-000
40	DIGITAL CONTROL PANEL ASSEMBLY KIT	101286-000
41	PATIENT PROBE JACK ASSEMBLY	07311-000
42	CONTROL/DISPLAY PCB ASSEMBLY KIT	101255-000
43	POWER SUPPLY PCB ASSEMBLY	10528-000
44	CABLE ASSEMBLY 26 CONDUCTOR	07481-000
45	COVER DOOR WITH LABELS AND HINGES	100386-000
46	COVER SCREW (Not shown)	90410-075

Table 8—Parts List (Head)

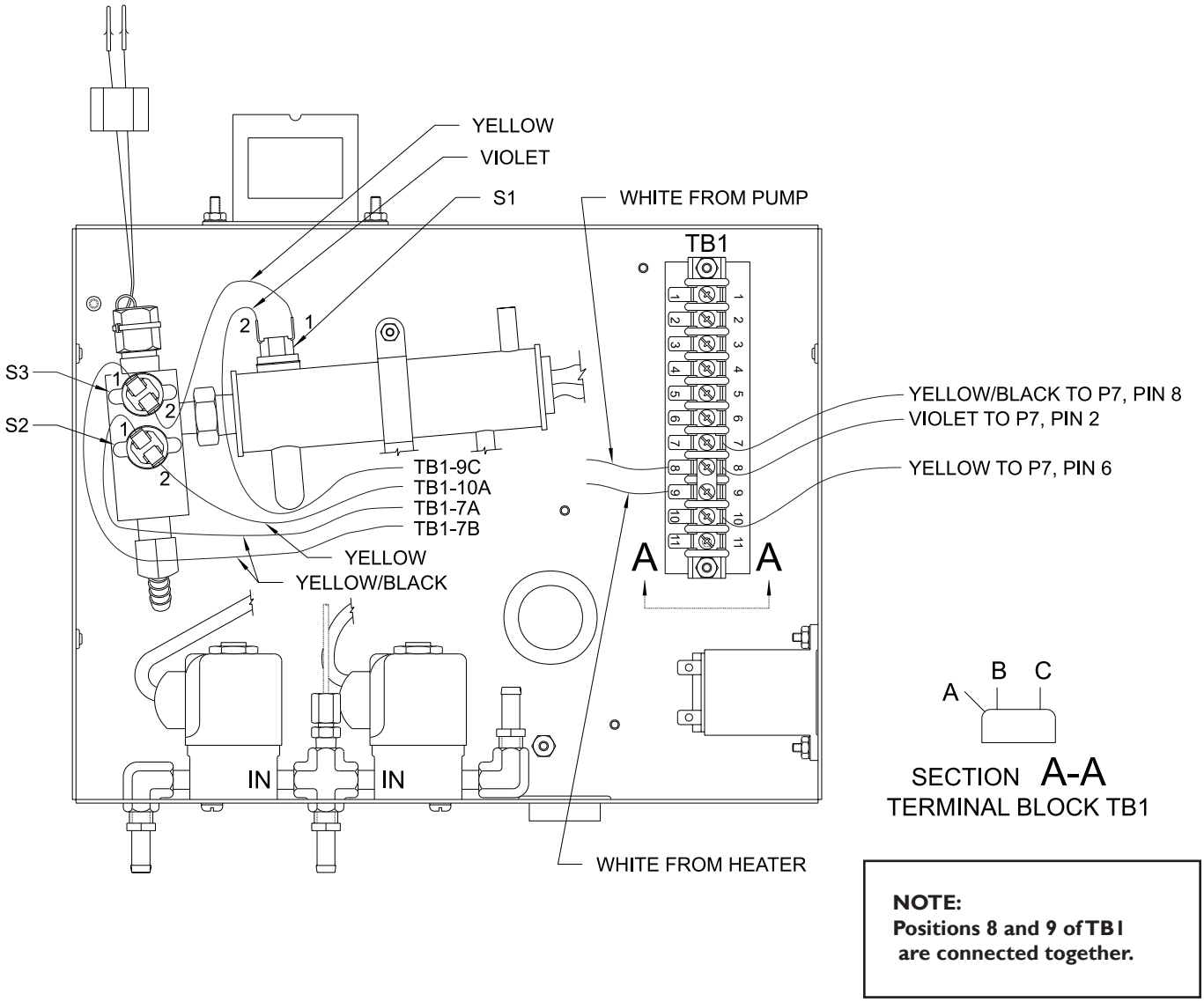


Figure 17—Thermostat Wiring Diagram

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