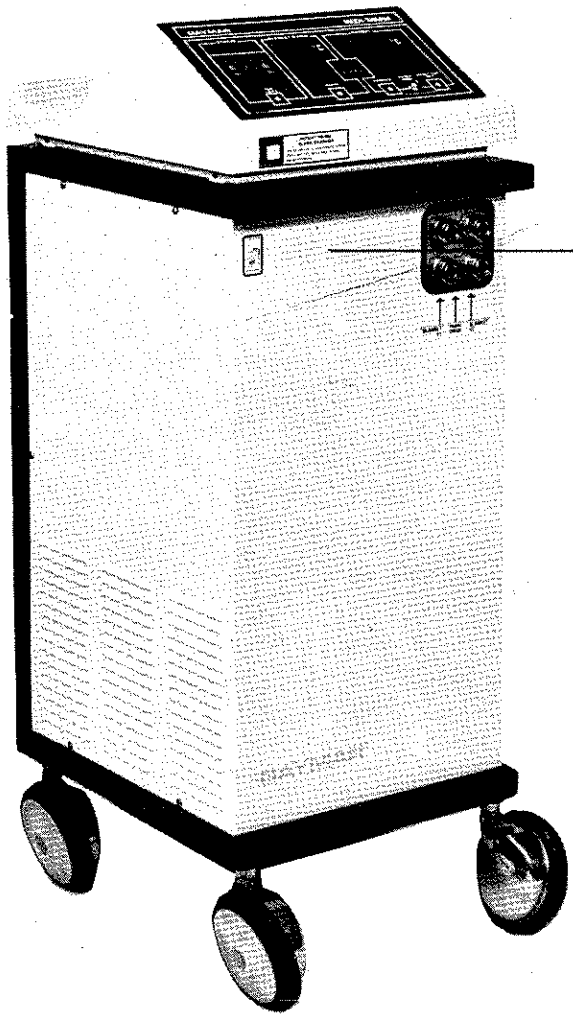
GAYMAR®

MEDI-THERM Hyper/Hypothermia

SERVICE MANUAL

AUTOMATIC/MANUAL CONTROL

MODEL MTA-4700/MTA-4701/MTA-4702



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CSA STANDARD (NORME) C22.2 NO. 125 RISK CLASS (CATEGORIE DE RISQUES) NO. 2G

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PLEASE NOTE

IMMEDIATELY UPON RECEIVING YOUR MEDI-THERM, BEFORE PROCEEDING IN READING THIS MANUAL, PLEASE REFER TO THE RECEIVING INSPECTION PROCEDURES IN SECTION 3.1 ON PAGE 3-1.

Objective

This publication is intended to provide the reader with significant data regarding the essential characteristics of equipment incorporated in the Gaymar Medi-therm. Although every attempt has been made to present information which is both complete and current, the large number of variations both in the equipment itself and in its application make it impossible to cover all of the contingencies which might arise in its installation, operation, or maintenance. In addition, incorporation of design changes to improve performance or reliability may occur at any time and are not necessarily reflected in the information provided. The right to revise or change this publication in whole or in part without prior notice is reserved. Should further information be desired or should problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to **Technical Service–Gaymar Industries, Inc.**

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1.0 GENERAL INFORMATION

1.1 PRECAUTIONS

1.1.1 PATIENT-RELATED PRECAUTIONS

1.1.1.1 PATIENT SAFETY

Maximum benefit to the patient at the greatest margin of safety requires a thorough knowledge and understanding of the correct operation and application of the unit. THE OPERATOR MUST UNDERSTAND THE OPERATING MANUAL AND ALL PRECAUTIONS PRIOR TO USE. PRECAUTIONS SHOULD BE CAREFULLY REVIEWED. CHECK THE PATIENT AND BLANKET WATER TEMPERATURE EVERY 20 MINUTES OR AS OFTEN AS DIRECTED BY THE PHYSICIAN.

CAUTION: POWER INTERRUPTION WILL CAUSE UNIT TO GO INTO STANDBY MODE (NO THERAPY) AND REQUIRE RESETTING BY THE USER BEFORE THERAPY CAN BE CONTINUED.

1.1.1.2 BLANKET TEMPERATURE EFFECTS

BLANKET TEMPERATURE SHOULD BE SET ONLY AS PRESCRIBED BY AND UNDER THE GUIDANCE OF A PHYSICIAN. CHECK PATIENT, INCLUDING PATIENT'S CORE TEMPERATURE, SKIN CONDITION IN AN AREA IN CONTACT WITH THE BLANKET, AND THE BLANKET WATER TEMPERATURE EVERY 20 MINUTES OR AS OFTEN AS DIRECTED BY THE PHYSICIAN. CHECK PEDIATRIC, TEMPERATURE SENSITIVE, AND OPERATING ROOM PATIENTS MORE FREQUENTLY.

a) 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.

b) 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. Patients unable to detect temperature (i.e. spinal chord injury) should always be closely monitored when a temperature blanket is in use.

c) Pediatrics - The core temperature in infants and children is more responsive to surface heating and cooling than in adults. The smaller the patient the more pronounced the effect because of their higher ratio of skin contact area to body volume.

d) Additional Heat Sources - Heat being applied by the blanket could result in a rise in skin temperature in the area of contact. Additional heat rise due, for example, to electrosurgical currents flowing to the dispersive electrode, could be sufficient to cause tissue injury. Each thermal effect by itself may be completely safe; however, the additive effect may be injurious.[1*] DO NOT PLACE ADDITIONAL HEAT SOURCES BETWEEN THE PATIENT AND THE BLANKET.

e) Localized Skin Injury - Localized skin injury corresponding to tissue compressed between boney prominences and fluid-filled channels has been associated with prolonged cardiovascular procedures and blanket temperatures well below the scientifically established epidermal burn injury threshold.[2,3,4,5,6]

Local ischemia can follow the application of pressures exceeding mean 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 hours.[7] PREVENT EXCESSIVE AND/OR PROLONGED TISSUE PRESSURE AND SHEARING FORCES--ESPECIALLY OVER BONEY PROMINENCES.

1.1.1.3 PATIENT CORE TEMPERATURE

If the patient's core temperature is not responding and/or does not reach the prescribed temperature in the prescribed time and/or deviates from the prescribed temperature range, the attending physician should be notified. MONITOR THE PATIENT'S CORE TEMPERATURE FREQUENTLY.

* Numbered superscripts refer to references in Section 1.1.1.6 of this manual.

1.1.1.4 BLANKET COVERING

A dry, cotton sheet placed between the patient and the blanket provides a sanitary barrier and absorbs perspiration. A sheet also promotes a more even distribution of heat and contributes to the reduction of localized tissue pressure. PLACE A DRY, COTTON SHEET BETWEEN THE PATIENT AND THE PLASTIC BLANKET SURFACE. GAYMAR'S MUL-T-BLANKET® ALSO PROVIDES A FABRIC SURFACE FOR WHICH AN INTERPOSED SHEET IS NOT REQUIRED.

1.1.1.5 DRYNESS BETWEEN THE PATIENT AND BLANKET

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 a water-circulating heating blanket during prolonged procedures.[8,9] KEEP THE AREA BETWEEN THE PATIENT AND THE BLANKET DRY.

1.1.1.6 LIST OF REFERENCES

1. Electrosurgery, AMM 310 (6/76), Ritter Co., Rochester, NY.

2. Scott, Stewart M. Thermal Blanket Injury in the Operating Room. Arch. Surg. Vol. 94, p. 181, Feb. 1967.

3. Crino, Marjanne H. Thermal Burns Caused by Warming Blankets in the Operating Room. Anesthesiology, Vol. 29, pp. 149-50, Jan-Feb 1980.

4. Gendron, Francis G. Journal of Clinical Engineering, Vol. 5, No. 1, pp.. 19-26, January-March 1980.

5. 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.

6. 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.

7. Kosiak, Michael. Etiology of Decubitus Ulcers, Archives of Physical Medicine and Rehabilitation, p. 19, Jan. 1961.

8. Llorens, Alfred S. Reaction to providone-iodine surgical scrub associated with radical pelvic operations. Am. J. Obstet. Gynecol., pp. 834-835, Nov. 14, 1972.

9. 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.

1.1.2 CONTROL UNIT-RELATED PRECAUTIONS

a) **IMPORTANT - ALWAYS PERFORM FUNCTIONAL CHECK-OUT AND SAFETY INSPECTION AFTER MAKING REPAIRS AND BEFORE RETURNING MEDITHERM FOR PATIENT USE. IMPROPER REPAIR COULD RESULT IN PATIENT INJURY.**

b) Do not run the machine without water, as damage to internal components may result. Use distilled water only. Alcohol should not be added to the water.

c) Gaymar Medi-Therm machines are provided with a means of checking rectal/esophageal temperature probes. When performing the probe check, use a disposable probe sheath (B-D catalog #3700 thermometer sheath or equivalent) to prevent cross contamination.

d) Use YSI 400 Series patient probes or equivalent.

1.2 REPAIR POLICY

The Medi-Therm Hyper/Hypothermia Unit is warrantied free of defects in material and workmanship for a period of one (1) year. The compressor portion of the unit has an additional four (4) year pro-rated warranty. The Medi-Therm Hyper/Hypothermia Units can be repaired at the factory or in the field. Upon customer request, a shipping carton will be provided to safely return the unit to Gaymar or a qualified Service Center.

For customers who elect to repair Gaymar Medi-Therm Units at their location, this manual contains information to allow a qualified bio-medical technician, familiar with practices for servicing medical devices, to make necessary repairs. Service training for the Hyper/Hypothermia Unit is recommended and is available from Gaymar. For specific details, contact your Gaymar representative.

1.2.1 IN-WARRANTY REPAIRS

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

a) Replacement lamps will be furnished at no charge during the warranty period. Since average lamp life is 14,000 hours, lamp failure is an uncommon occurrence.

b) Unit calibration is considered part of preventive maintenance procedures and is not covered by Gaymar's Warranty.

1.2.2 OUT-OF-WARRANTY REPAIRS

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

a) Defective Component - Replacement parts can be ordered. Specify the Gaymar part number; reference Parts List in Section 4 of this manual.

b) Defective Printed Circuit (PC) Board - Defective PC Boards can be exchanged for refurbished boards at a fixed cost directly from the factory.

c) Defective Top Module - The defective top module can be returned (without base) to the factory or qualified Service Center for repair.

d) Unit Repairs - If a Hyper/Hypothermia Unit becomes defective and the cause of the problem cannot be determined, the complete unit can be returned to the factory for servicing. This normally represents the most expensive repair option.

1.3 SPECIFICATIONS

1.3.1 PHYSICAL SPECIFICATIONS

a) Dimensions: 37 in. high x 17-1/8 in. deep x 14 in. wide
(93.98 cm high x 43.50 cm deep x 35.56 cm wide)

b) Weight - MTA-4700/4701:

145 lbs. (full); 124 lbs. (empty); Shipping Wt: 150 lbs.
65.77 kg (full); 56.25 kg (empty); Shipping Wt: 68.04 kg

Weight - MTA-4702:

155 lbs. (full); 134 lbs. (empty); Shipping Wt: 160 lbs.
70.31 kg (full); 60.78 kg (empty); Shipping Wt: 72.58 kg

c) Reservoir Capacity: 9 quarts (8.52 liters) distilled water

d) Pressure, Dead Head: 7.0 ± 1.0 psi (48.23 ± 6.89 kPa)

e) Flow: 16 GPH (60.57 liters/hour) minimum through a full size GAYMAR H/H Blanket

1.3.2 THERMAL SPECIFICATIONS

a) High Temperature Limits

1) Adjustable: 41°C ± 0.5°C (Average Water Temperature)

2) Fixed: 43°C to 46.5°C (Unit will go into MACHINE SHUT-DOWN REMOVE FROM SERVICE condition and Audible Alarm will be on.)

47°C to 50°C (Will turn heater off and on only.)

b) Low Temperature Limits

1) Adjustable: Cut in 5.2° - 6.5°C
Cut out 3.9° - 4.5°C
2) Fixed: 2.5°C to -3.0°C

c) Flow Switch Actuation Level

12 ± 2 GPH (45.42 ± 7.6 liters)

d) Check Probe Activation Temperature (whenever probe is used)

Below 32°C or above 45°C

e) Patient Temperature Control Range for Automatic Mode

32°C to 41°C

f) Blanket Water Temperature Control Range for Manual Mode

4°C to 41°C

g) Warm-up Rate Curve

See Figure 6.1, Page 6-1

h) Cool Down Rate Curve

See Figure 6.2, Page 6-1

1.3.3 ELECTRICAL SPECIFICATIONS

a) Display Accuracy: Water Temperature ±1°C, ±1.8°F
Patient Temperature ±0.5°C, ±.9°F

b) Controller Accuracy: Water Temperature ±.75°C, ±1.3°F
Patient Temperature ±0.5°C, ±.9°F

	MTA-4700	MTA-4701	MTA-4702
c) Current Leakage:			
Chassis Microamps Maximum	100	100	200
Patient Probe (Grounded) Microamps Maximum	50	50	100
d) Input Voltage (Volts)	120±10	100 (+10 / - 5)	220±20
e) Frequency (Hz)	60	50/60	50/60
f) Power Consumption (WATTS)	1325	1150	1188
g) Input Current (AMPS)			
--with compressor and heater ON	11.5	10.0	5.5
--with compressor ON	7.5	6.5	3.0
--with heater ON	4.0	3.5	2.5

1.3.4 PROBE SPECIFICATIONS

a) Disposable Probes

1. DP-400 - Disposable Rectal/Esophageal--Adult/Small Child - 3' length (requires adaptor).

2. ADP-10 - Reusable adaptor cable for DP-400 (connects to Gaymar or Cincinnati Sub-Zero equipment).

3. ADP-10A - Reusable adaptor cable for DP-400 (connects to American Medical Systems equipment). NOTE: THIS ADAPTOR CONTAINS TWO ADDITIONAL RESISTORS TO PROVIDE TEMPERATURE OFFSET FOR USE WITH AMERICAN MEDICAL SYSTEMS EQUIPMENT ONLY. SEE ADAPTOR CIRCUIT DIAGRAM, FIGURE 6.3, PAGE 6-1.

b) Reusable Probes

1. PAT-101 - Patient probe--Rectal/Esophageal - Adult (10' long).

2. PAT-102 - Patient probe--Rectal/Esophageal - Pediatric (10' long).

3. PAT-108 - Patient probe--Skin Surface (10' long).

2.0 PRINCIPLES OF OPERATION

The Gaymar Automatic Patient Control System is designed to regulate patient temperature by the application of hypothermia blankets through which temperature controlled water is circulated.

Gaymar's machine may be operated to provide patient therapy in two basic modes, AUTOMATIC and MANUAL. In Automatic mode (with Patient Probe), patient temperature is automatically regulated to an operator specified set point. While in MANUAL mode, the operator must observe the patient temperature and adjust the blanket water temperature to obtain the desired results.

MEDI-THERM also features a convenient means of monitoring patient temperature without providing therapy. This third operating mode, Patient Temperature Monitoring, is achieved by utilizing the Patient Probe and placing the unit in the PATIENT TEMP NO THERAPY mode.

2.1 OPERATOR CONTROLS/INDICATORS

For operator controls and indicators see Figure 6.4, Page 6-2.

(1) PATIENT TEMPERATURE - displays patient temperature to the nearest 0.1° C, .1°F (see Item #22).

(2) BLANKET WATER TEMPERATURE - displays blanket water temperature to the nearest 1° C, 1°F (see Item #22).

(3) COOL - when illuminated, indicates controller is calling for cool water -- minimum temperature, 4°C.

(4) IN TEMP ZONE - when illuminated, indicates the unit is controlling at the desired temperature setting.

(5) HEAT - when illuminated, indicates controller is calling for warm water -- maximum temperature 42°C.

(6) CHECK WATER FLOW - when illuminated, indicates the flow of water has been restricted.

(7) CHECK PATIENT TEMP SETTING - when illuminated, indicates that the requested patient temperature setting is not within the normal range (32°C - 45°C) for patient temperature control. At this time, therapy has been interrupted: blanket water is being circulated, but not heated or cooled. Recheck the setting.

(8) CHECK PATIENT PROBE - when illuminated, indicates the temperature of the Patient Probe is below 32°C or above 45°C (out of normal patient temperature range). This alert is accompanied by an audible tone that can be disabled (by pressing Item 21) for five minutes while the problem is being resolved. Check to determine if:

1) Probe is dislodged.
2) Probe is defective.
3) Incorrect probe is being used.

(9) MACHINE SHUT-DOWN REMOVE FROM SERVICE - when illuminated, indicates that all functions except the refrigeration compressor have shut down. This alert will also be accompanied by an audible alarm that cannot be silenced.

(10) TEST LIGHTS - press "TEST LIGHTS" switch. Temperature displays should indicate "188°E" and "188.8°E," all machine status legends, 3 mode legends and 2 thumbwheel legends should be lit. The audio alarm should sound.

(11) MANUAL BLANKET WATER TEMP - when illuminated, the unit will control the blanket water temperature to the temperature indicated on the thumbwheel switch.

(12) MANUAL CONTROL - when illuminated, the unit is operating in the MANUAL BLANKET Control mode.

(13) MANUAL CONTROL MODE SWITCH - when pressed, the unit will enter the MANUAL BLANKET Control mode.

(14) THUMBWHEEL SWITCH - used to set temperature in °C only for BLANKET WATER temperature or PATIENT temperature (depending on operating mode).

(15) AUTO CONTROL - when illuminated, the unit is operating in the AUTOMATIC PATIENT CONTROL mode.

(16) AUTO CONTROL MODE SWITCH - when pressed, the unit will enter the AUTOMATIC PATIENT CONTROL mode.

(17) PATIENT PROBE JACK - connector is designed to fit machine end of Patient Probe assembly. Use only YSI 400 Series probes or equivalent.

(18) PATIENT TEMP MONITOR MODE SWITCH - when pressed, the unit will only monitor patient's temperature. No therapy is being provided.

(19) PATIENT TEMP NO THERAPY - when illuminated the unit will only monitor patient's temperature. No therapy is being provided.

(20) AUTOMATIC PATIENT TEMP - when illuminated, the unit will control the patient's temperature to the temperature indicated on the thumbwheel switch.

(21) ALARM SILENCE SWITCH - if the CHECK PATIENT PROBE light is illuminated, the audible alarm will sound. Depressing this switch will silence the alarm for approximately five (5) minutes while the problem is being resolved. This switch will not silence the audible alarm in the MACHINE SHUT-DOWN REMOVE FROM SERVICE alarm condition.

(22) CELSIUS TO FAHRENHEIT CONVERSION SWITCH - press and hold switch to observe blanket water and patient temperatures in degrees Fahrenheit.

(23) ON/OFF SWITCH - a circuit breaker On/Off Switch that controls the power to the unit.

(24) PROBE CHECK WELL - Perform probe check by inserting probe into sterile sheath and then into probe check well on blanket manifold. Operate unit in MANUAL mode with a blanket connected. Set thumbwheel switch between 33°C & 37°C. Wait until unit stabilizes (IN TEMP ZONE). Digital temperature displays should read within 2°C of each other. If not, probe may be defective or incorrect probe is being used. If probe appears defective, try another probe. If new, and correct probe does not meet this test, unit may be out of calibration.

CAUTION: Use protective sheath (B-D catalog #3700 thermometer sheath or equivalent) on probe to prevent cross-contamination.

NOTE: THIS WELL IS NOT TO BE USED FOR CALIBRATION

(25) BLANKET MANIFOLD, BLANKET(S) WATER CONNECTIONS - machine connector fittings are marked SUPPLY and RETURN.

(26) AIR VENTS - louvers and screened ventilation openings are located on three sides of the cabinet. Keep clear to assure adequate air circulation.

(27) OPERATING INSTRUCTIONS

(28) WATER FILL OPENING - lift cover to fill unit with distilled water only. Proper level is attained when water just touches the screen.

CAUTION: DO NOT OVERFILL

2.2 THEORY OF OPERATION

Operation of the machine may be best explained by examining the Fluid, Electrical and Refrigeration Systems. Their description follows.

2.2.1 FLUID SYSTEM

The Medi-Therm Unit utilizes a two-reservoir system which consists of a cold water reservoir and a warm water reservoir. Physical locations of main system components are shown in Figure 6.20, page 6-13 and

Figure 6.21, page 6-14 of this manual.

In the MANUAL mode, the Blanket Water Probe (RT2/RT3) senses the temperature of the water going to the blanket. When the blanket water temperature is within 1°C of the desired setting, the Unit will enter the IN TEMP ZONE condition and will remain there so long as the temperature is within 1°C of the BLANKET WATER temperature setting.

The cold water reservoir system maintains approximately nine (9) quarts (8.52 liters) of water at 4°C. This reservoir temperature is maintained by the refrigeration controller (S4).

The warm water reservoir contains only a small reserve of water, and when heat is called for, water in the reservoir is quickly heated by means of the cartridge heater. The maximum attainable water temperature in the warm water reservoir is 41.5°C.

2.2.1.1 HEATING

See Figure 6.5, Page 6-3.

2.2.1.2 COOLING

See Figure 6.6, Page 6-3.

2.2.1.3 IN TEMP ZONE

When the Medi-Therm is in the IN TEMP ZONE, the water path alternates between heating (Fig. 6.5, pg. 6-3) and cooling (Fig. 6.6, pg. 6-3).

2.2.1.4 BACK-UP SYSTEMS

Several back-up systems are incorporated into the unit to assure maximum patient safety.

MAXIMUM WATER TEMPERATURE

To limit maximum water temperature, the following controls are utilized:

a) The primary high temperature back-up sensor (RT1) and associated circuitry limit the maximum average water temperature flowing through the warm water reservoir to 41° ± 0.5°C.

b) The second high temperature back-up sensor (43° to 46.5°C) is the bimetallic thermostat (S2). If this thermostat is activated, it, along with associated control circuitry, will activate the MACHINE-SHUT DOWN REMOVE FROM SERVICE circuit which automatically shuts down all functions except the refrigeration compressor.

c) Bimetallic thermostat (S3) is the third high temperature back-up sensor (47° to 50°C). If this thermostat is activated, it will turn the cartridge heater off and on again when it cools and resets.

MINIMUM WATER TEMPERATURE

Temperature of water in the cold reservoir is controlled by the refrigeration controller (S4) (3.9° to 6.5°C). The bimetallic thermostat (S1), is a low temperature back-up (-2.5° to +3.0°C) for (S4). If S1 activates, the MACHINE SHUT-DOWN REMOVE FROM SERVICE circuit is triggered, which in turn shuts down all functions except the refrigeration compressor.

2.2.2 ELECTRICAL SYSTEM

The unit's electronics package utilizes a closed-loop controller with provisions for operator input (temperature set point selection and operating mode selection), status and alert displays, and redundant back-up and safety systems. The controller controls blanket water temperature using an internal water temperature probe, or controls patient temperature using a patient connected probe.

The solid-state design assures reliability and accurate control at the set point while modular construction provides for easy and convenient serviceability.

The electrical system consists of the Power Supply, Interface Circuits, Back-Up and Safety Circuits, Control Circuits, Alert Circuits, Mode Selection Circuits, and Display Circuits.

Component layout and parts designation are shown on pages 6-15, 6-16, and 6-17. The electrical schematics are shown on pages 6-4, 6-5, 6-6, and 6-7.

2.2.2.1 POWER SUPPLY

With the exception of Transformer T-1, the unit's Power Supply is completely contained on the A3 Power Supply Printed Wiring Board. The output of T-1 is rectified, filtered, and by means of on-board regulators (A3) Q8 through (A3) Q11, is controlled at output levels of +5, +12, -12, and -5 volts D.C. A full wave rectified lamp supply (L.S.) is used to illuminate status, alert, and legend lamps.

2.2.2.2 INTERFACE CIRCUITRY

Interface Circuitry is also located on the A3 Power Supply Board and consists of (A3) U1 through (A3) U4, (A3) Q1 through (A3) Q4 and associated parts. (A3) U1 through (A3) U4 are optically coupled triac drivers used to control their respective triacs; these combinations provide electrical isolation between the low voltage control circuits and the line voltage power circuits. (A3) U4 and (A3) Q1 control the cold solenoid valve K1 while (A3) U2 and (A3) Q2 control the hot solenoid valve K2. (A3) U3 and (A3) Q3 control the circulating pump while (A3) U1 and (A3) Q4 control power to the heater circuit.

2.2.2.3 BACK-UP CIRCUITRY

The A3 Board also contains the Primary Back-Up Circuit. This is a solid state on/off controller consisting of (A3) U7, (A3) Q5, surrounding components, and RT1 located in the heater manifold in the machine base. Whenever the temperature of the output water exceeds 41° ± 0.5°C, (adjustable by A3R1), U7 disables Q5. This circuit operates independently from the main control circuits to turn the heater off to limit the average output water temperature to 41° ± 0.5°C.

Finally, the A3 Board includes the MACHINE SHUT-DOWN REMOVE FROM SERVICE circuitry, which includes (A3) Q6, (A3) U6, (A3) U5, (A3) Q7, (A3) CR9, their interconnected components, and fixed, non-adjustable thermostats S1 and S2 in the base. Under normal conditions (A3) Q6 is kept turned on by the action of (A3) R19, (A3) C11 and (A3) CR10 and completes the heater circuit. If the blanket water temperature falls into the range from -3°C to +2.5°C or rises into the range from 43°C

to 46.5°C, S1 or S2 respectively will open and full line voltage will appear between (A3) P1 pins 7 and 1. In this case, optical couplers (A3) U6 and (A3) U5 will be turned on. (A3) U6 prevents (A3) Q6 from turning on even after S1 (or S2) has closed again. The electrically isolated output of (A3) U5, buffered by (A3) Q7, results in a signal to the controller which returns the controller to standby status, turns on the MACHINE SHUT-DOWN REMOVE FROM SERVICE indicator and enables the audible alarm. This MACHINE SHUT-DOWN REMOVE FROM SERVICE condition remains latched up and can be cleared only by turning the machine off. If, upon machine turn on, the fault condition still exists, attempting to apply therapy will cause the MACHINE SHUT-DOWN REMOVE FROM SERVICE to recur.

The final protective device, bimetallic thermostat S3, is wired only in series with the heater and would regulate the heater for water temperatures in the range from 47°C to 50°C, but will not activate the MACHINE SHUT-DOWN REMOVE FROM SERVICE circuit.

2.2.2.4 CONTROL AND ALERT CIRCUITRY

The Control and Alert Circuits reside primarily on the A2 Main Control Board; exceptions are the Flow Switch and Blanket Water Probe Assembly located in the machine base, the ALARM SILENCER Switch, Temperature Set Switch, and Patient Probe. The following is a brief description of the Control and Alert Circuitry:

A) Reference Diode (A2) CR1, integrated circuits (A2) U1 and (A2) U2, transistors (A2) Q1 and (A2) Q2, and associated components generate temperature stable reference voltages (+Vref and -Vref) at nominal levels of +5 and -5 volts, respectively. Temperature stable resistors are used here and throughout the circuitry, where appropriate, to minimize the effect of ambient temperature changes on system operation.

B) Blanket water temperature sensing thermistors RT2 and RT3 are part of the feedback loop of (A2) U3. The combination of RT2, RT3, (A2) R11 and (A2) R12 is a linearly temperature dependent resistive network. A linear temperature sensitive voltage results

at the output of (A2) U3 with zero and span adjustments provided by (A2) R9 and (A2) R6. The voltage at (A2) TP4 is thus linearly dependent on the temperature of the Blanket Water Probe Assembly. This signal goes off the board (A2J2 pin 6) to the A1 Display Board.

C) A circuit (A2) (U4) similar to that described in "B" uses the Patient Probe in its feedback loop to generate a signal at (A2) TP5 that represents PATIENT temperature. (A2) R19 linearizes the probe response over the range from +30°C to +41°C so that patient temperature determinations of the required accuracy can be achieved. This signal goes off the board (A2J2 pin 3) to the A1 Display Board.

D) Transistors (A2) Q3 through (A2) Q7 form a single pole double throw switch; under command of the Mode Selection Circuits (by way of A2J2 pin 1) this switch selects either blanket water temperature or patient temperature as the input to the controller. The switch output is buffered by voltage follower (A2) U12; R117 allows offset correction of U12.

E) The controller set point is determined by a three digit thumbwheel switch. This setting is converted to a voltage by resistor ladder network (A2) R24 through (A2) R34 and (A2) U5. (A2) R35 and (A2) R38 provide span and zero adjustments, respectively.

F) The output from the controller set point circuit (E) and that from the selected probe circuit are compared by error amplifier (A2) U11. If the two levels are unequal, an output of appropriate polarity is developed at the output of (A2) U11. This error signal is thus related to the magnitude and sense of the difference between the set point and the actual temperature. R120 provides offset correction for U11. (A2) U20 and its associated components is an integrator operating on the output of the error amplifier; the integrator is reset by (A2) Q14 through (A2) Q16 whenever the machine is in standby mode or in PATIENT TEMP NO THERAPY mode. Otherwise, the output of (A2) U20 is the integral of the difference signal from the error amplifier. (A2) U21 provides unity gain inversion. The difference signal and the

integral signal are summed and offset by the circuit including (A2) U10. The resulting control signal is, at (A2) U8A and (A2) U8B, compared to a low frequency sawtooth from (A2) U9. The outputs of (A2) U8A and (A2) U8B are complementary pulse trains whose duty cycle depends on the magnitude and sense of the control signal. That is, while the outputs are either on or off, the ratio of on to off time is proportional to the control signal amplitude. For large differences between set point and probe temperatures, the controller outputs will be either on or off. For differences approaching zero, the outputs will switch on and off with the on and off times automatically adjusted to maintain a probe temperature equal to the set point. Gates (A2) U7A and (A2) U7D enable the controller outputs only in the manual and automatic control modes as commanded by mode selection circuits via A2J3 pin 1. Transistors (A2) Q10 and (A2) Q11 buffer the gate outputs and drive the heater, hot solenoid and cold solenoid through outputs on A2P2 pins 18, 17, and 16 respectively.

G) The output of (A2) U11 is tied to inputs of (A2) U14 where it is compared to voltages of plus two volts and minus two volts; these two voltages are equal to the error amplifier outputs when the actual temperature differs from the set point temperature by minus or plus one degree Celsius. Therefore, if the actual temperature differs from the set point temperature by more than one degree Celsius, one output of (A2) U14 will be low and a high output on (A2) J9 pin 9 or 11 will command either the COOL or HEAT status light on. If, on the other hand, there is less than one degree Celsius difference between set point and actual temperatures, both outputs of (A2) U14 will be high, the HEAT and COOL lights will be off, and a high output on (A2) J3 pin 10 will command the IN TEMP ZONE status light on. (A2) U16B, C, and D provide the logic to enable these status indicators only when AUTOMATIC or MANUAL CONTROL mode has been selected (low level input on A2J3 pin 1).

H) When automatic control is selected (low level at A2J3 pin 2) U16A is enabled. Thus, when in AUTOMATIC mode and the patient temperature is more than one degree different than the set point,

U17 is enabled and outputs a pulse waveform. A3J3 pin 3 is low anytime the Patient Probe is in use; A2J3 pin 4 will then also be a pulse waveform that will cause the patient temperature display to flash on and off. For all other conditions requiring patient temperature display, the display will remain on without flashing.

I) Alert Circuits

"CHECK PATIENT PROBE" - The function of this circuit is to verify the integrity of the patient probe system. To this end, the output of the patient probe circuit (A2) U4 is brought to (A2) U6 where it is compared to two limits; these limits are set to correspond to patient temperatures of 32°C and 45°C. In the normal case where the output of (A2) U4 represents a patient probe temperature between the two limits, the outputs of (A2) U6 will both be high. When the probe appears to be at a temperature outside the limits, one output of (A2) U6 will go low. (A2) U15C, enabled whenever the probe is in use (A2J3 pin 3 low), will then command the CHECK PATIENT PROBE light on (A2J3 pin 12 high). The output of (A2) U7C will drive the audible alarm on. One-half of (A2) U18 is a nominal five minute timer; pressing the ALARM SILENCER Switch, S6, momentarily will start the timer which will disable U7C thereby turning off the alarm tone giving the operator approximately five minutes of silence to investigate the problem.

(A2) U15B is enabled only in the AUTOMATIC mode (A2J3 pin 2 low); a "CHECK PATIENT PROBE" condition then will turn on (A2) Q8 and (A2) Q9. Regardless of what the controller is requiring, (A2) Q8 will turn off the heater and close the cold solenoid while (A2) Q9 will open the hot solenoid. This will prevent the machine from controlling based on a patient probe that is disconnected, dislodged, defective, or for any other reason appears to be at a temperature less than 32°C or above 45°C. In addition to discontinuing therapy, the output of (A2) U15B, through diode (A2) CR15, disables the HEAT, COOL, and IN TEMP ZONE status lights so that there is also no indication of therapy.

"CHECK PATIENT TEMP SETTING" - The function of this circuitry is to prevent the machine from controlling patient temperature at a

set point that is abnormal. The output of the set point circuit is compared to two limits by (A2) U13; the limits correspond to temperatures of 32°C and 41°C. When the set point is between these limits, the outputs of (A2) U13 are high. Otherwise, one output will go low and (A2) U15A, enabled only in the AUTOMATIC mode, provides a high output at A2J3 pin 13 to command the CHECK PATIENT TEMP SETTING light on. This same output, through (A2) CR23, turns off the status lamps; it also turns on (A2) Q8 and (A2) Q9 whose functions are as described in the CHECK PATIENT PROBE discussion. In automatic control, the controller will not respond to a set point below 32°C or above 41°C.

"CHECK WATER FLOW" - The function of this circuitry is to indicate when the flow through the unit drops below 12 ± 2 GPH (45.42 ± 7.57 liters/hr.). This indicator can only be enabled in the MANUAL or AUTOMATIC mode. This enable is controlled by (A1) U2C, (A1) U3D, and (A1) U5C. The contacts of the flow switch, S5, are closed with low flow. A signal is then fed to (A1) Q9 which enables the CHECK WATER FLOW indicator.

"MACHINE SHUT-DOWN REMOVE FROM SERVICE" - (See Section 2.2.2.3)

J) Whenever any alert condition occurs, A2J3 pin 14 goes low, (A2) Q12 turns off and one-half of (A2) U18 outputs a pulse waveform on A2J3 pin 8 to flash the ALERT light on and off.

(A2) U19 provides the signal to drive AA1, the audible alarm. (A2) U19 generates a low frequency square wave to turn on and off the piezoelectric sounder AA1. This entire circuit is turned on by (A2) Q13 in response to CHECK PATIENT PROBE, MACHINE SHUT-DOWN REMOVE FROM SERVICE or TEST LIGHTS.

2.2.2.5 MODE SELECTION AND DISPLAY CIRCUITS

Mode selection is accomplished by momentary operation of one of three pressure sensitive mode switches attached to the A1 Display Board. These momentary signals set and reset the appropriate latch circuits of (A1) U2 to retain the selected mode. These latch circuits include power-on-reset networks to assure that the standby mode is established at the time of initial machine turn on.

(A1) U3A, B, C, D buffer the latch outputs. (A1) U4A, B, C provide the logic to allow use of a patient probe during manual control. Latch outputs to the control circuits are provided where required; the outputs are also used to light front panel legends and displays as required. In the event of a MACHINE SHUT-DOWN REMOVE FROM SERVICE condition (A1J2) pin 13 high) all latches are reset to the standby condition. The various status and alert lights are turned on by their respective driver transistors in response to appropriate inputs to the A1 Board. Amplifier circuit (A1) U17 implements the conversion of Blanket Water Temperature from degrees Celsius to degrees Fahrenheit. Arithmetically, conversion requires multiplication by 1.8 (equivalent to gain) and addition of 32 (equivalent to offset). (A1) R84 provides the adjustment of offset while (A1) R73 allows adjustment of gain. (A1) CR44 provides a stable level from which to derive the offset voltage. Amplifier circuit (A1) U19 performs the same function for PATIENT temperature.

The input to and output from (A1) U17 are fed to multiplexer (A1) U18; similarly, the input and output of (A1) U19 are also fed to the multiplexer. Ordinarily, the amplifier inputs (temperatures in degrees Celsius) pass through the multiplexer and become inputs to the temperature displays. At the same time, +5 volts passes through (A1) U18 to form a °C indicator in the trailing seven segment displays, (A1) U13 and (A1) U15. However, when the temperature conversion switch is pressed, the outputs (temperatures in degrees Fahrenheit) of (A1) U17 and (A1) U19 pass through (A1) U18 to become inputs to the temperature displays. At the same time, +5 volts passes through (A1) U18 to (A1) U1G and a °F indicator is formed in each temperature display. Analog to digital converter (A1) U6 and digital displays (A1) U7, U8 and U14 constitute a digital meter whose sensitivity is adjusted by (A1) R46. Its input is blanket water temperature; the resultant display is blanket water temperature to the nearest degree. Similarly, (A1) U9, 10, 11, 12, and U16 constitute another digital meter with sensitivity adjusted by (A1) R51. Its input is patient temperature; the resultant display is patient temperature to the nearest one-tenth of a degree.

The output from the TEST LIGHTS switch goes off the board (A1J1 pin 7) to turn on the audible alarm. It also turns on (A1) Q12 and (A1) Q13 which turn on all status, alert, and legend lamps. It also applies +5 volts to pin 37 of (A1) U6 and (A1) U12 to cause all the display digit segments to illuminate.

2.3 REFRIGERATION SYSTEM (refer to Figure 6.11 on page 6-8)

The refrigeration circuit 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 another 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 being cooled which surrounds the evaporator coil is controlled by the set temperature of the controller whose sensing bulb is located adjacent to the evaporator coil. The controller will turn the compressor on and off at the set temperatures. See Figure 6.11 on page 6-8.

3.1 RECEIVING INSPECTION PROCEDURES

C O N C E A L E D L O S S O R D A M A G E

After unpacking unit, inspect the unit for concealed loss or 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 unit to GAYMAR---call our Technical Service Department for advice.

Perform a visual and mechanical inspection of the unit by removing the wrap around on the cabinet and the top cover. To remove the wrap around and top cover, see Figure 6.18 on page 6-11.

I M P O R T A N T !!

BEFORE THE UNIT IS OPERABLE, THE COMPRESSOR TIE-DOWNS MUST BE REMOVED. SEE FIGURE 6.25, PAGE 6-18.

The following functional checks should be made on the Hyper/Hypothermia Unit:

TEST EQUIPMENT SUGGESTED:

1 - GAYMAR TPT-9 Tester

1 - Mercury thermometer (±1°C accuracy) -2°C to 52°C, Brooklyn Thermometer, Type 73544, Gaymar P/N: TFC-1, or equivalent

1 - GAYMAR Hyper/Hypothermia Pad, DHP-901

1 - Blanket Connecting Hose, DBK-5

1 - Current Leakage Tester

NOTE: FABRICATION DRAWINGS WILL BE FURNISHED UPON REQUEST FOR SPECIAL TEST EQUIPMENT.

a) Connect the unit as shown in Figure 6.12 on page 6-9.

b) Fill the unit with distilled water per instructions on unit.

c) Set the Thumbwheel Switch to 30°C. Turn unit on.

d) Press the MANUAL CONTROL Switch.

e) The flow rate on the TPT-9 Tester should indicate above 16 GPH (60.57 liters/hr.)

f) After the unit has stabilized, the mercury thermometer should indicate 30 ± 1°C.

g) The BLANKET WATER display on the unit should indicate 30 ± 1°C.

h) Set the Thumbwheel Switch to 49°C. The maximum blanket water temperature should be 41° ± 0.5°C.

i) Set the Thumbwheel Switch to 0°C. The minimum blanket water temperature should be 4° ± 1°C.

j) Perform current leakage test.

k) Initial check-out procedure is complete.

3.2 CLEANING PROCEDURES

3.2.1 FLUID SYSTEM

The water circulation system, including blankets, should be cleaned every month to retard algae growth. Drain the unit and prepare a germicidal solution (Airwick A-33 or equivalent) according to manufacturer's instructions. Add the solution to the unit, attach blankets, and circulate with the Temperature Control Dial set at 27°C for 12 hours. Drain the solution and refill the unit with distilled water.

Algae growth may be retarded by using distilled water and changing it regularly and by adding the recommended amount of germicide or sanitizer (Airwick A-33 or equivalent) to the water.

CAUTION: DO NOT use bleach (sodium hypochlorite).

NOTE:
1. Distilled water is recommended to retard algae growth and mineral build-up. It should be changed monthly or more often depending upon use.
2. Do not exceed proper germicidal solution concentration; damage could occur to the circulating pump (from foaming).

3.2.2 COMPRESSOR

Dirt that has accumulated on the condenser cooling fins within the machine should be removed with a vacuum cleaner or compressed air hose. This will require removal of the wrap around panel. This should be checked monthly or more frequently depending upon use. See Figure 6.18 on page 6-11.

* To oil compressor fan motor, remove rubber plug on top of fan motor, add 3-4 drops of a general purpose motor oil once a year and reinstall plug.

3.2.3 PUMP

Pump motor should be oiled with 3-4 drops of general purpose motor oil (typical 2 places) once a year.

3.2.4 PANEL EXTERIOR

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

3.2.5 BLANKETS

Standard blankets may be cleaned with a damp cloth and mild detergent to prevent algae growth. Attach the blankets to the unit and follow instructions under Section 3.2.1.

If blankets must be sterilized, use any cold sterilization means except alcohol. If gas sterilization is necessary, pads are made of PVC and should be handled like any other PVC product.

NOTE: Gas Sterilization temperature must not exceed 63°C (145°F).

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

3.2.6 PROBE CHECK WELL

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

3.2.7 PROBES, REUSABLE

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

If probe must be sterilized, use any cold sterilization means except alcohol. Always wipe dry. If gas sterilization is necessary, probes are made of PVC and should be handled like any other PVC product.

NOTE: Gas sterilization temperature must not exceed 63°C (145°F).

ALSO 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.

3.2.8 PROBES, DISPOSABLE

Be certain proper adaptor is used. (See specifications, page 1-8).

3.3 FUNCTIONAL CHECK-OUT AND SAFETY INSPECTION

To assure the optimum performance, dependability and safety, the following preventive maintenance procedures should be performed every three (3) months. An Inspection Form is provided at the end of this section to facilitate the Inspection Process.

IMPORTANT - ALWAYS PERFORM FUNCTIONAL CHECK-OUT AND SAFETY INSPECTION AFTER MAKING REPAIRS AND BEFORE RETURNING MEDITHERM FOR PATIENT USE. IMPROPER REPAIR COULD RESULT IN PATIENT INJURY.

3.3.1 PROCEDURES/EQUIPMENT

The following test equipment is suggested to perform the preventive maintenance procedures:

-- GAYMAR TPT-9 Tester
-- Mercury Thermometer (±1°C accuracy) -2°C to 52°C
Brooklyn Thermometer Type 73544, Gaymar P/N: TFC-1, or equivalent
-- Blanket Connecting Hose DBK-5
-- Precision Decade Box* (0-9999 OHMS, 0.2% accuracy, 1 OHM steps)
-- GAYMAR Hyper/Hypothermia Pad DHP-901
-- Ground Resistance Checker
-- Current Leakage Tester

NOTE: If you do not wish to purchase a precision decade box, precision resistors (prewired to ¼" phone plugs) are available from Gaymar (order PRK-2, Precision Resistor Kit).

Optional Test Equipment - Gaymar testers TA-700 (top) and TMT-4000 (base) are dedicated test tools available from Gaymar Industries. These tools allow independent testing of top and base and provide all connections and inputs for easier calibration. Consult the Technical Service Department.

a) Condition of Chassis. Examine the exterior of the unit for overall condition. The chassis should be clean and relatively free of rust and corrosion. Exterior screws should be tight. Legends and markings should be legible. 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 chassis wrap around. Check that the casters are functioning properly.

   The metal quick-disconnect fittings on the unit may become stiff and difficult to engage. The problem can be eliminated by applying a silicone base lubricant to the inside of the machine fittings and the outside of the blanket connector. Clean Probe Check Well according to procedures described in Section 3.2.6.

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

c) 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 0.15 ohms.

d) Line Cord and Strain Reliefs. Examine the line cord along its entire length for physical damage, such as cut 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.

e) Circuit Breaker. Examine the physical condition of the circuit breaker.

f) Position of Thumbwheel Switch. Before moving the temperature control, note whether it was left in normal positions by previous user. A temperature control that is at the end of its range, for example, might indicate a machine malfunction or inadequate training of clinical personnel.

g) Condition of Lights, Alarm, and Temperature Indicators. Plug in and turn unit on. Press "TEST LIGHTS" switch. Temperature displays should indicate "188°E" and "188.8°E", all machine status legends, 3 mode legends and 2 thumbwheel legends should be lit. The audio alarm should sound.

h) 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). The current leakage should not exceed microamperage indicated in table below.

Current Leakage, GROUNDED 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. (See table below.)

Chassis Leakage	MTA-4700/4701	MTA-4702
Unit Grounded	10 microamps	20 microamps
Unit Ungrounded	100 microamps	200 microamps
Probe Leakage	50 microamps	100 microamps

NOTE: If additional information is required, refer to AAMI Safety Standard for Safe Current Limits or contact GAYMAR INDUSTRIES, Technical Service Department.

i) Flow Rate. To measure the unit's flow rate, perform the following:

1. Make sure unit is filled with distilled water.
2. Connect the test set-up shown in Figure 6.12 on page 6-9.
3. Set the temperature control to 30°C.
4. Turn unit on. Set unit in MANUAL mode.
5. The flow rate should exceed 16 GPH (60.57 liters/hr.).
6. Test is complete.

j) Flow Switch Activation (S5). To measure the level at which the flow switch activates, perform the following:

1. Connect the test set-up as shown in Figure 6.12 on page 6-9.
2. Set the temperature control to 30°C.
3. Turn unit on. Set unit in MANUAL mode.
4. The flow rate should be at least 16 GPH (60.57 liters/hr.).
5. By kinking the hose, the flow rate should drop. When the flow drops to 12 ± 2 GPH (45.42 ± 7.57 liters/hr.), the CHECK WATER FLOW indicator should light and the ALERT indicator should flash on and off.
6. Test is complete.

k) Third High Temperature Back-Up Thermostat (S3). To measure the setting of the third back-up thermostat, perform the following:

1. Disconnect from wall outlet.
2. Connect the test set-up as shown in Figure 6.12 on page 6-9 and remove wrap around cover (Figure 6.18 on page 6-11).
3. Disconnect J2 and P2 at the warm water reservoir (Figure 6.18 on page 6-11).
4. Remove cover from terminal block (TB1); cover is white plastic located to the right and below the J2P2 connector shown in Figure 6-18 on page 6-11. Short out terminals 8 and 9. Install neon test light across terminals 8 and 10.
   NOTE: Be sure leads are long enough to extend outside the wrap around cover.
5. Replace wrap around cover. It is not necessary to install screws. Be sure to expose neon test light.

6. Set thumbwheel switch to 41°C. Reconnect unit to wall outlet and turn on. Set in MANUAL mode.
7. Run unit for 15 minutes after water temperature reaches 41°C.
8. Turn unit off. Raise A-700 Top Cover and locate A2 Control Board.
9. Unplug thumbwheel switch, connector J1 on A2 Control Board. Replace Top Cover to normal position. Turn unit on and set in MANUAL mode.

   The temperature on the mercury thermometer should be 47° to 50°C when the neon test light goes out.

   NOTE: The neon test light will not cycle back on until the temperature drops between 36° and 42°C. Observe a few cycles to verify the CUT-OUT temperature.
10. Turn unit off.

    NOTE: Since the temperature of the S2 thermostat has been exceeded, it will be necessary to cool the machine before proceeding to paragraph "l".
11. Plug in thumbwheel switch and set at 30°C. Run machine in MANUAL mode for 3 minutes.
12. Turn off machine. Remove neon light and shorting cable.
13. Reconnect J2 and P2.
14. Test is complete.

l) Second High Temperature Back-Up Thermostat (S2). To measure the setting of the second back-up thermostat, perform the following:

1. Connect the test set-up as shown in Figure 6.12 on page 6-9 and remove wrap around cover (see Figure 6.18 on page 6-11).
2. Disconnect J2 and P2 at warm water reservoir (Figure 6.18 on page 6-11). Replace wrap around cover. It is not necessary to install screws.
3. Set the Thumbwheel Switch at 41°C. Turn unit on. Set in the MANUAL mode.
4. Run unit for 15 minutes after water temperature reaches 41°C.

5. Set Thumbwheel Switch to 49.9°C and run unit until it shuts down. The temperature on the mercury thermometer should be between 43° and 46.5°C when the unit shuts down; the MACHINE SHUT-DOWN REMOVE FROM SERVICE indicator should light and the audible alarm sound.
6. Turn unit off.

   NOTE: Since the temperature of the S2 thermostat has been exceeded, it will be necessary to cool the machine before proceeding to paragraph "m".
7. Short terminals 8 and 9 on TB1.
8. Set thumbwheel switch at 30°C. Run machine in MANUAL mode for 3 minutes.
9. Turn machine off. Remove shorting cable.
10. Reconnect J2 and P2.
11. Test is complete.

m) Primary High Temp Sensor (RT1). To measure the setting of the Primary Sensor, perform the following:

1. Connect the test set-up shown in Figure 6.12 on page 6-9.
2. Set the Thumbwheel Switch at 49°C.
3. Turn unit on. Set in MANUAL mode. The average water temperature on the mercury thermometer should stabilize at 41° ± 0.5°C. See Section 3.5.1, paragraph "e", for proper measurement procedure.
4. See Primary Back-Up Adjustment, Section 3.5.1, if adjustment is necessary.
5. Test is complete.

n) Low Temperature Back-Up Thermostat (S1). The low temperature back-up thermostat is factory set to limit low temperatures between +2.5°C and -3.0°C. It is not necessary to test the set point as part of this functional test. If there is reason to test this thermostat, perform the following:

1. Disconnect unit from wall outlet.
2. Remove top cover from unit and disconnect J1 from top cover (Figure 6.18 on page 6-11).
3. Connect GAYMAR shorting plug, P/N 77352-000 to J1.

4. Place the ohmmeter across the contacts of S1 (Figure 6.6 on page 6-3). The resistance should be zero.
5. Connect Jumpers onto refrigeration control (S4) shown in Figure 6.13 on page 6-9.
6. Add seven (7) quarts (6.62 liters) of water and two (2) quarts (1.89 liters) of alcohol to reservoir.
7. Connect the test set-up shown in Figure 6.13 on page 6-9.
8. Reconnect unit to wall outlet and turn on.
9. When the contacts of S1 open up, the ohmmeter should read infinity and the mercury thermometer should reach between +2.5° to -3.0°C.
10. Turn unit off.
11. Remove ohmmeter.
12. Turn unit on.
13. Drain unit of water and alcohol mixture by connecting a DBK-5 connector to the supply fitting on unit. Turn unit off and disconnect DBK-5.
14. Remove shorting plug and reinstall top cover.
15. Refill with distilled water.

o) Refrigeration Controller (S4). To measure the setting of the refrigeration controller, perform the following:
1. Connect the test set-up shown in Figure 6.12 on page 6-9.
2. Set the Thumbwheel Switch to 0°C.
3. Turn unit on and set in MANUAL mode.
4. After the temperature stabilizes, the refrigeration unit should turn on when the water temperature reaches 5.2° to 6.5°C and turn off when the water temperature reaches 3.9° to 4.5°C.

p) Blanket Water Temperature Controller and Display. To check the accuracy of the temperature controller and display, perform the following:
1. Connect the test set-up shown in Figure 6.12 on page 6-9.
2. Turn unit on. Set in MANUAL mode.
3. Set the Thumbwheel Switch to the various settings specified on the Log Sheet and record the temperature of the mercury

thermometer and that shown on the display.

q) Check Patient Probe Indicator and Alarm. To measure the accuracy of the trip points for the check probe signal, perform the following:

1. Connect the test set-up shown in Figure 6.14 on page 6-9.
2. Turn unit on. Set in AUTOMATIC mode.
3. Set the decade box to the various settings specified on the Log Sheet and check that the CHECK PATIENT PROBE indicator, the flashing ALERT, and alarm tone are tripping at the proper points.

r) CHECK PATIENT PROBE ALARM SILENCER Delay. To measure the delay time for the ALARM SILENCER, perform the following:

1. Turn unit on and set the unit in the PATIENT TEMP NO THERAPY mode without plugging in the patient probe.
2. The CHECK PATIENT PROBE indicator should be lit. The ALERT indicator should flash on and off, and the audible alarm should sound.
3. Press the ALARM SILENCER switch; the audio alarm should turn off and stay off for 4 to 8 minutes.

s) CHECK PATIENT TEMP SETTING. To measure the trip points for the CHECK PATIENT TEMP SETTING indicator, perform the following:

1. Connect the test set-up shown in Figure 6.14 on page 6-9.
2. Set the decade box to 1355 ohms (or 37°C Probe - PRK-2).
3. Turn the unit on and set it in the AUTOMATIC mode.
4. Set the thumbwheel switch to the various settings specified on the Inspection Form and check that the "CHECK PATIENT TEMP SETTING" indicator turns on and off at the proper points.

t) AUTOMATIC CONTROL Mode Check.

1. Connect the test set-up as shown in Figure 6.14 on page 6-9.
2. Set the decade box to 1355 ohms (or 37°C Probe - PRK-2).
3. Turn unit on and set it in the AUTOMATIC mode.
4. Set the thumbwheel switch to the various settings specified on the Inspection Form and check that the status lights indicate at the proper settings.

u) Check PATIENT Temperature Display Accuracy.

1. Connect the test set-up as shown in Figure 6.14 on page 6-9.
2. Set the decade box to 1355 ohms (or 37°C Probe - PRK-2).
3. Turn unit on and set it in the MANUAL mode.
4. PATIENT Temperature Display should indicate 37° ± 0.5°C. Log appropriate value on Inspection Form.
5. Press the Celsius to Fahrenheit Conversion Switch. The Patient Temperature Display should indicate 98.6°F ± 0.5°F.

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

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

HYPER/HYPOTHERMIA
FUNCTIONAL CHECKOUT/INSPECTION FORM *

LOCATION _____ SERIAL NO.'S (BASE)_____
(TOP)_____

	OK	ACTION NEEDED	ACTION TAKEN (DATE & INITIALS)
a) Condition of Chassis			
b) Condition of Attachment Plug			
c) Ground Resistance less than 0.15 OHMS			
d) Line Cord and Strain Reliefs			
e) Circuit Breaker			
f) Position of Thumbwheel Switch between 4°C and 42°C			
g) Condition of lights and alarm			
h) Current Leakage CHASSIS: MTA-4700/4701 MTA-4702 Ungrounded (microamps max.) 100 200 Grounded 10 20 PATIENT PROBE: Grounded 50 100			
i) Flow Rate: Greater than 16 GPH (60.57 litres/hour)			
j) Flow Switch Activation: 12 ±2GPH (45.42 ±7.57 litres/hour)			
k) Third High Temperature Back-Up Thermostat (S3): 47°C to 50°C			
l) Second High Temperature Back-Up Thermostat (S2): 43°C to 46.5°C			
m) Primary Back-Up High Temperature Sensor (RT1) 41 ±0.5°C			
n) Low Temperature Back-Up Thermostat(S1): +2.5°C to -3.0°C			
o) Cold Water Reservoir Controller (S4): 3.9°C to 6.5°C			

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

	OK	ACTION NEEDED	ACTION TAKEN (DATE & INITIALS)
p) Temperature Controller Display: Thumbwheel Setting: 10°C, 25°C, 37°C Display Reading: Mercury Thermometer Reading: Display Readings within 1°C of Thumbwheel Mercury Thermometer Reading within 1°C of Thumbwheel			
q) Check Probe Indicator and Alarm Temp. 31.5°C: PRK-2 or Decade Box Setting (OHMS) 1703; Alarm On; Check Probe Alert On Temp. 32°C: 1667; Off; Off Temp. 44°C: 1023; Off; Off Temp. 45.5°C: 965; On; On			
r) Alarm stays off for four (4) to eight (8) minutes			
s) Check Patient Temperature Setting Thumbwheel Switch Setting: 31, 33, 40, 42 Check Patient Temperature Alert: On, Off, Off, On			
t) Check Automatic Mode Decade Box Setting: 37°C/1355; Thumbwheel Setting: 35.5; IN TEMP LIGHT: Off; COOL LIGHT: On; HEAT LIGHT: Off Decade Box Setting: 37°C/1355; Thumbwheel Setting: 38.5; IN TEMP LIGHT: Off; COOL LIGHT: Off; HEAT LIGHT: On			
u) Check Patient Temperature Display Decade Box Setting: 1335 Patient Temp. Display: 37°C±1/2°C (98.6°F±1/2°F)			

3.4 P.C. BOARD CALIBRATION PROCEDURE

IF YOU ARE TROUBLESHOOTING DO NOT USE THIS SECTION UNTIL YOU HAVE COMPLETED ALL THE FUNCTIONAL TESTS OUTLINED IN SECTION 3.3. EXPERIENCE HAS SHOWN THAT CALIBRATION ADJUSTMENTS ARE SELDOM NEEDED. MAKE CALIBRATION ADJUSTMENTS ONLY WHEN YOU HAVE EXHAUSTED ALL OTHER POSSIBLE PROBLEM SOURCES.

EQUIPMENT REQUIRED

1. Precision Decade Box — 0 to 99,999 ohms, 1 ohm steps, ±0.2%
2. Digital Voltmeter — 3½ digit, 1.999 volts full scale
   19.99 volts full scale
3. Two Conductor (Tip and Sleeve) Phone Plug
4. Test connector Gaymar P/N 05559-000.
5. Optional Test Equipment - Gaymar testers TA-700 (top) and TMT-4000 (base) are dedicated test tools available from Gaymar Industries. These tools allow independent testing of top and base and provide all connections and inputs for easier calibration. Consult the Technical Service Department.

3.4.1 A3 POWER SUPPLY BOARD (REFER TO FIGURE 6.24, PAGE 6-17)

IMPORTANT --- STEPS 1 THRU 6 VERIFY POWER SUPPLY BOARD VOLTAGES. CALIBRATION OF R1 ON THE POWER SUPPLY BOARD REQUIRES A COMPLETELY ASSEMBLED MEDITHERM, AND IS OUTLINED IN SECTION 3.5.1.

1. Install Power Supply Board in top cover.
2. Connect 115 VAC to board as follows using test connector Gaymar P/N 05559-000:
   High side to A3P1 pin 13 (black wire)
   Common side to A3P1 pin 7 (white wire)
   NOTE: When using A-702 (220 Volt), maximum voltage for calibration procedure is 115 volts AC. For A-701, maximum voltage is 100 V.
3. Transformer T1 connected to A3P2.
4. Connect common lead of digital voltmeter to A3P3 pin 4 or pin 8.
5. Turn 115 VAC on.

6. Measure the following:

A3P3	
Pin 5	-11.5 to -12.5 volts D.C.
Pin 6	-4.8 to -5.2 volts D.C.
Pin 9	+11.5 to +12.5 volts D.C.
Pin 10	+4.8 to +5.2 volts D.C.

7. Turn off 115 VAC.

3.4.2 A2 CONTROL BOARD (REFER TO FIGURE 6.23, PAGE 6-16 and FIGURE 6.18, PAGE 6-11)

1. Disconnect cover from the base. Connect the decade resistor between pins 9 (red wire) and 15 (blue wire) of A3P1 of the Power Supply Board. Connect the common side of the digital meter to ground at TP1 (Test Point One). (See Figure 6.23 on page 6-16.) Connect 115 VAC to Power Supply Board as follows:

   High Side to A3P1 pin 13 (black wire)
   Common Side to A3P1 pin 7 (white wire)

2. Measure the following:

A2P2	
Pin 4	-4.8 to -5.2 VDC
Pin 5	+4.8 to +5.2 VDC
Pin 13	+11.5 to +12.5 VDC
Pin 14	-11.5 to -12.5 VDC
TP 10	+2.39 to +2.59 VDC
TP 5	+4.69 to +5.28 VDC
TP 2	-4.60 to - 5.39 VDC

3. Select MANUAL mode. Set the decade box to 23920 ohms (0°C water probe) and adjust R9 for 0.000 VDC at TP4.

4. Set the decade box to 7946 ohms (40°C water probe) and adjust R6 for 0.400 VDC at TP4.

5. Set the decade box for 10072 ohms (30°C water probe); the voltage at TP4 should be 0.300 ± .003 VDC.

6. Set the decade box to 7946 ohms and adjust R117 for 0.400 VDC at TP9.

7. Connect the decade box to the tip and sleeve of a phone plug and plug into the patient probe jack.

8. Set the decade box to 7355 ohms (0°C patient probe) and adjust R17 for 0.000 VDC at TP6.

9. Set the decade box to 4005 ohms and adjust R14 for 0.100 VDC at TP6.

10. Set the decade box for 1200 ohms and adjust R17 for 0.400 VDC at TP6.

11. Set the decade box for 1815 ohms; the voltage at TP6 should be 0.300 VDC. If not, repeat Steps 8 through 10.

12. Set the decade box to 1355 ohms; the voltage at TP6 should be 0.370 ± .002 VDC.

13. Press AUTO CONTROL; the level at TP9 should be 0.370 ± .002 VDC.

14. Press MANUAL CONTROL.

15. Set the Thumbwheel Switch to 00.0 and adjust R38 for 0.000 VDC at TP13.

16. Set the Thumbwheel Switch to 40.0 and adjust R35 for -0.400 VDC at TP13.

17. Check the following:

Thumbwheel	TP 13
20.0	-0.200 ± .002 VDC
25.0	-0.250 ± .002 VDC
25.5	-0.255 ± .002 VDC

18. Press AUTO CONTROL; set the decade resistor to 1200 ohms (40°C patient probe); set the Thumbwheel Switch to 40.0. Adjust R120 for 0.0 ± .01 VDC at TP7.

19. Press PATIENT TEMP NO THERAPY. Adjust R72 for 6.0 ± .05 VDC at TP14.

20. Set the Thumbwheel Switch to 31.5. Adjust R85 for -.315V at TP12.

21. Set the Thumbwheel Switch to 41.5. Voltage range should be -.412 to -.418 VDC at TP11.

22. Set the decade resistor to 965 ohms (45.5°C patient probe) and adjust R55 for .452V at TP3. The CHECK PATIENT PROBE light should be on.

23. Set the Thumbwheel Switch to 37.0. Set the decade resistor at 1703 ohms (31.5°C patient probe). Voltage range should be .311-.319 VDC at TP8. The CHECK PATIENT PROBE light should be on.

3.4.3 A1 DISPLAY BOARD (REFER TO FIGURE 6.22 ON PAGE 6-15)

1. Set the decade resistor at 1200 ohms (40°C patient probe) and adjust R51 on the Display Board so that the three digit display indicates 40.0.

Connect a jumper wire across A1P1. Set the decade resistor to 1815 ohms and adjust R76 until the patient temperature displays indicates 86.0. Set the decade resistor to 1200 ohms and adjust R81 until the display indicates 104.0. Repeat these adjustments until decade resistor settings of 1815 and 1200 ohms result in display indications of 86.0 and 104.0 respectively.

2. Remove jumper.

3. Turn power off and connect the decade resistor between pins 9 (red wire) and 15 (blue wire) of A3P1 on the Power Supply Board.

4. Turn power on, set the decade resistor to 7946 ohms (40°C water probe) and adjust R46 on the Display Board until the two digit display indicates 40.

   Connect a jumper across A1P1.

   Set the decade resistor to 56045 ohms and adjust R84 until the BLANKET Temperature display indicates 000. Set the decade resistor to 7946 ohms and adjust R73 until the display indicates 104. Recheck the display with the decade resistor set to 56045 ohms and repeat the procedure if necessary.

5. Remove jumper.

3.5 REFRIGERATION CONTROLLER (S4) ADJUSTMENT

The following test equipment is suggested to complete adjustment of the refrigeration controller (S4):

-- GAYMAR TPT-9 Tester

-- Mercury Thermometer (±1°C accuracy), -2°C to 52°C, Brooklyn Thermometer, Type 73544, Gaymar P/N: TFC-1, or equivalent

-- DBK-5 Connector Hose

a) Check water level and add distilled water if necessary.

b) Connect the test set-up as shown in Figure 6.15, page 6-10.

c) Adjust Thumbwheel Switch to "00".

d) Turn unit on.

e) Note that Refrigeration Controller S4 scales are approximate only. Set temperature CUT IN (see Figure 6.15, page 6-10) at 42°F (6.5° - 5.2°C). Set differential at 5°F. Monitor output water temperature with mercury thermometer. Observe two cycles and readjust if necessary.

f) Test is complete.

3.5.1 PRIMARY BACK-UP ADJUSTMENT

Also required, in addition to the equipment required in Section 3.5:
(1) Gaymar Hyper/Hypothermia Pad, Model #DHP-901

a) Connect unit as shown in Figure 6.12, page 6-9.
NOTE: Leave cover assembly (A-700) tipped up.

b) Turn 115 VAC on.

c) Set Thumbwheel Switch to 49°C.

d) Select MANUAL mode and allow unit to come to a steady temperature (approximately 30 minutes).

e) Observe the thermometer and note that the temperature cycles up and down; a complete cycle takes approximately one (1) minute. Record the maximum and minimum indications for two (2) consecutive cycles. The average of these four readings should be 41° ± 0.5°C. If not, it will be necessary to adjust the trim pot, R1 on the A3 Power Supply Board. Remove the seal from the potentiometer adjustment screw. Turning the adjustment screw clockwise will lower the water temperature and counter-clockwise rotation will raise the water temperature.

f) If proper calibration cannot be achieved, disconnect J2 and P2 in the MT-4000 base unit. See Figure 6-18, page 6-11. Set the thumbwheel switch to 41.0°C, run unit for fifteen (15) minutes (unit will indicate "IN TEMP ZONE"), and check the blanket water temperature on the thermometer inserted into TPT-9. If necessary, adjust the thumbwheel switch for a stable temperature indication of 41°C on the thermometer. Remove RT1 from its location in the heater manifold. Clean off white thermal grease. Remove the thermometer from the TPT-9 and place RT1 into the TPT-9. With an ohmmeter (select a range that drives no more than 0.6 milliamps through the unknown) measure the resistance of RT1 by making contact at the contacts in J2. The value obtained should be 1100 ± 20 ohms. If not, discard RT1 and replace with a new RT1, Gaymar P/N 04910-000.

3.6 FLOW SWITCH CLEANING PROCEDURE

See Figure 6.16, Page 6-10.

4.0 * TROUBLESHOOTING & SERVICE DATA

4.1 This section contains a Troubleshooting Guide to assist the service technician in diagnosing and correcting problems with the Hyper/Hypothermia Unit.

	SYMPTOM	PROBABLE CAUSE	RESOLUTION
1)	CHECK WATER FLOW	Low water level.	Add distilled water.
	(CHECK WATER FLOW light on, machine in MANUAL or AUTOMATIC mode)	Blanket hoses kinked off.	Eliminate kink.
		Blanket hose pinch clamps are closed.	Unclamp.
		Quick disconnects are not fully engaged, improperly connected, or plugged.	Correct. On older units, the Quick Disconnects may be hard to operate. See Symptom 8 of this section.
		Blocked or stuck solenoid valves.	Disassemble solenoid and eliminate the obstruction.
		Pump not running.	Measure the voltage between terminals 7 and 8 of TB1 with the machine turned on. (Machine can be in either MANUAL or AUTO mode.) If it is 115 VAC, replace the pump. If the voltage is 0, repair or replace the top cover.
		Clogged flow switch.	Refer to Figure 6.16 on page 6-10 for cleaning instructions.

* ALWAYS PERFORM FUNCTIONAL CHECKOUT/INSPECTION (PAGE 3-4, SECTION 3.3) PRIOR TO TROUBLESHOOTING UNIT.

	SYMPTOM	PROBABLE CAUSE	RESOLUTION
2)	CHECK WATER FLOW Indicator Does Not Light	Burned out bulb.	Press TEST LIGHTS switch. If light does not light, replace bulb.
	(when quick disconnect supply line is disconnected and unit is turned on)	Clogged flow switch.	If CHECK WATER FLOW light lights when Test Switch is pressed but will not turn on when a blanket connector is removed, the Flow Switch should be removed and cleaned (*Figure 6.16, page 6-10*). Test switch contact opening and closing before reinstalling.
		A1 Control Board defective.	Repair or replace Control Board.
3)	Blanket Will Not Cool (Thumbwheel set at 00 and unit in MANUAL mode)	S4 Refrigeration controller is defective.	Jumper contacts of S4. If unit cools down, replace S4. If not, S4 is okay. See Figure 6.13, page 6-9 for jumper locations only.
		Defective solenoid.	When COOL light is lit, check for 115 VAC at terminals #3 and #5 on TB1. If voltage is present, repair or replace solenoid. If 0 volts, replace top cover.
		Dirty or restricted refrigeration condenser.	Insure that side air-exchange grill work is not restricted at operating location. Insure condenser fan is free to rotate and is not binding. Insure condenser unit is free of lint and dust buildup.
		Refrigeration unit has lost its charge.	Recharge refrigeration system according to Section 4.2.1, paragraph "y". Be sure to check for Freon leaks.

SYMPTOM	PROBABLE CAUSE	RESOLUTION
	Faulty refrigeration unit.	Audibly confirm compressor operation. Do not confuse with the motor fan noise. If not running, the compressor unit starter relay, the thermal overload unit or the capacitor is faulty and must be replaced. See Figure 6.9, page 6-6.
4) Blanket Will Not Cool in the Correct Range 5° ± 1°C.	Refrigeration controller (S4) out of calibration.	Calibrate. See Section 3.5.
	Faulty cooling system.	See Symptom #3.
5) Blanket Will Not Heat in any Mode (set Thumbwheel at 40°C)	Faulty top cover or temperature probe assembly.	Remove wrap around. Set Thumbwheel Switch at 40°C. HEAT light should be on. 115 VAC should be present between terminals #8 and #10 of TB1. If voltage is 0, the top cover or the Temp. Probe Assembly is defective and must be replaced or repaired.
	Defective solenoid.	When the HEAT light is lit, check for 115 VAC between terminals #4 and #5 on TB1. If voltage is present, repair or replace the solenoid. If voltage is 0, replace the top cover.
	Faulty heater or S3 thermostat.	Set Thumbwheel Switch to 40°C. HEAT light should be on. With wrap around removed, verify current flow to the heater (through temperature limiting thermostat). If open circuit exists, thermostat must be replaced. If open circuits persist, the heater assembly is defective and must be replaced.
	Cold solenoid (K1) not properly closed.	Heater and thermostats check out okay. Disassemble and clean (K1) Cold Solenoid and Plunger.
	Primary Back-Up high temperature controller is out of calibration.	See Section 3.3.1, paragraph "m".

	SYMPTOM	PROBABLE CAUSE	RESOLUTION
6)	MACHINE SHUT-DOWN REMOVE FROM SERVICE light is on (when machine was previously OFF for more than 2 hours)	S1 or S2 thermostats are damaged or defective.	Short out terminals 8 & 9 at TB1 (Figure 6.18, page 6-11). Start machine. (1) if "MACHINE SHUT-DOWN REMOVE FROM SERVICE" light goes out, S1 or S2 is defective (open). Find open thermostat and replace. Check calibration after replacement. (2) If "MACHINE SHUT-DOWN REMOVE FROM SERVICE" light stays on, defect is on the Power Supply Board.
7)	MACHINE SHUT-DOWN REMOVE FROM SERVICE light is on (when machine has been operating for approximately 30 minutes)	Primary Temperature Control is out of calibration.	Check calibration per Section 3.3.1, paragraph "m".
		S2 Thermostat out of calibration.	Check calibration per Section 3.3.1, paragraph "l". If faulty, repair or replace.
		S2 Thermostat out of calibration.	Check per Section 3.3.1, paragraph "n". If faulty, repair or replace.
		Power Board is defective.	Repair or replace.
		S4 refrigeration controller is out of calibration.	Check calibration per Section 3.3.1, paragraph "o". If faulty, repair or replace.
8)	Quick Disconnects on Unit Hard to Operate	If machine is not used regularly, the metal quick disconnect fittings on the unit may become stiff and difficult to engage.	Problem can be eliminated by applying a silicone-base or light machine oil to the inside of the blanket connector.

	SYMPTOM	PROBABLE CAUSE	RESOLUTION
9)	High Current Leakage (frost on suction line)	Excessive Freon charge.	Recharge to specifications in Section 4.2.1, paragraph "y".
		Defective heater.	Disconnect heater and measure again. Replace heater if necessary.
10)	No Lights on Front Panel (Circuit breaker is on and TEST LIGHTS button is depressed)	Faulty transformer (T1).	Measure input voltage to transformer at A3J2 plug (see *Figure 6.24, page 6-17*), *pins 5 and 6*. Voltage should be 115 VAC. Measure output voltage of transformer at A3J2 plug, pins 2 and 3. This should be 24 VAC. If not, replace the transformer.
11)	PATIENT Temperature Display reads approx. 19° - 20°C.	Defective Probe or Adaptor.	Replace probe or adaptor.
12)	Operator complains blanket water is too cold in AUTOMATIC mode.	No defect. Operator doesn't understand AUTOMATIC mode operation.	Explain AUTOMATIC mode or seek assistance from your sales representative.

4.2 REPAIR PROCEDURES

4.2.1 RECHARGING REFRIGERATION UNIT

The following procedures detail leak checking, evacuation and recharging of the refrigeration unit. Completion of these procedures requires the following special tools and/or test equipment:

- Refrigeration Test Gauge Assembly
- Freon 12 Tank or Charging Cylinder
- Halogen Leak Detector
- Dry Nitrogen Charging Cylinder

For further clarification refer to proper test equipment configuration shown in Figure 6.17, Page 6-11.

a) Remove large valve stem caps from service valves and turn both valve stems counterclockwise until they stop.

b) Remove small side cap from gauge port fitting on each service valve.

c) Turn lower service valve stem slowly clockwise and allow gas to escape until almost empty, then turn valve stem counterclockwise.

d) Loosely connect hoses from refrigeration test gauge assembly to gauge port fittings of each service valve.

NOTE: Lower service valve is the pressure (high) side, and the upper service valve on the compressor is the suction (low) side.

e) Open both valves on refrigeration test gauge assembly.

f) Connect center hose from the refrigeration test gauge assembly to Freon 12 tank with its valve up or to top valve of a Freon 12 charging cylinder.

g) Open Freon supply valve and allow the gas to purge air from both test gauge hoses while tightening hose nuts on gauge port fitting of each valve.

h) Turn both service valve stems clockwise to open and allow the Freon to pressurize the unit to 45 psi, then close Freon supply valve.

i) Close both valves on refrigeration test gauge assembly, remove center hose from Freon gas supply, and connect immediately to dry nitrogen tank through pressure control valve.

NOTE: Insure nitrogen pressure regulator handle is turned counterclockwise.

j) Open both valves on refrigeration test gauge assembly.

k) Open nitrogen tank valve and turn nitrogen pressure regulator handle clockwise until gauge reads 150 psi.

l) Close both valves on refrigeration test gauge assembly and close nitrogen tank valve.

m) Turn nitrogen pressure regulator handle fully counterclockwise and disconnect hose from nitrogen supply.

n) Check all tubing and valve joints in the system with a halogen leak detector and repair any refrigerant leaks after purging pressure.

o) Make certain that all pressure is purged from the system before proceeding.

p) Connect center hose from refrigeration test gauge assembly to vacuum pump and open both test gauge valves approximately two turns.

q) Allow the vacuum pump to run until the low pressure gauge reads 27 or more in. Hg. vacuum for 15 minutes; then shut off vacuum pump.

r) Turn both service valve stems counterclockwise and reconnect center hose to Freon tank with valve up or to top valve of charging cylinder.

s) Loosen hose nut at center connector on manifold; open Freon supply valve; purge hose until liquid appears; then tighten hose nut.

t) Turn suction service valve stem clockwise two turns and allow Freon to build up to tank pressure by opening suction gauge valve on manifold.

u) CLOSE LEFT SIDE VALVE ON REFRIGERATION TEST GAUGE ASSEMBLY TIGHTLY.

v) Insure water level is correct.

w) Connect DBK-5 hose on unit between one supply and one return fitting.

x) Set Thumbwheel Switch to "00". Turn unit on and press MANUAL mode.

y) To add Freon while unit is running, make sure both service valve stems are turned clockwise about two turns. With Freon supply valve open, open left-hand gauge valve and observe pressures. Close left-hand gauge valve when suction pressure gauge reads 30 psi. When the temperature of the water in the reservoir reaches 40°F (4.4° to 4.5°C), the proper suction pressure should be 22-25 psi. The proper high side pressure is 125-150 psi. Add or purge Freon as necessary to obtain proper readings. With the suction pressure being the critical reading for proper performance, approximately 16 ounces of Freon 12 is the correct charge.

z) Turn unit off.

aa) Perform leak test and repeat leak test with unit running.

bb) Allow unit to run until compressor cycles off; then check BLANKET WATER temperature display to insure refrigeration controller cycles the compressor between 3.9° and 6.5°C.

cc) Turn unit off and allow suction and high side pressures to equalize. Close both service valves and Freon supply valve.

dd) Disconnect hoses.

ee) Replace caps on both service valve gauge ports and valve stems immediately. Make sure packing nuts on valve stems are tight. Tighten caps sufficiently to prevent leakage.

4.2.2 REPLACING A3 POWER SUPPLY BOARD

The following procedures describe replacement of the A3 Power Supply Board. A Digital Voltmeter is required.

a) After replacing the board in the cover, reconnect all connectors to the A3 board, except the connector from the A2 Control Board to the Power Supply Board.

b) Turn unit on.

c) Measure the following voltages at connector A3P3 (see page 6-17).

DVM Common to Pin	DVM + Lead to Pin	Voltage Reading
8	5	-12 ± 0.5V
8	6	- 5 ± 0.2V
8	9	+12 ± 0.5V
8	10	+ 5 ± 0.2V

See page 6-17 for pin number 8 location.

d) Turn unit off.

e) Connect the power supply board to the control board.

f) Perform the following operational checks from Section 3.3 of the Preventive Maintenance Procedures.

Check Out No.	Description
g	Condition of lights, alarm and temperature indicators.
j	Flow switch activation.
l	Second high temperature back-up thermostat (S2).
m	Primary high sensor temperature.

4.2.3 REPLACING THE A2 CONTROL BOARD

a) It is not necessary to calibrate the control board since it comes set from the factory.

b) After installing the Control Board, perform the checkout from Section 3.3 of the Preventive Maintenance Procedure.

Check Out No.	Description
g	Condition of lights, alarm and temperature indicators.
p	Blanket water temperature controller and display.

4.2.4 REPLACING THE A1 DISPLAY BOARD

a) It is not necessary to calibrate the display board since it comes set from the factory.

b) After installing the display board, perform the checkout from Section 3.3 of the Preventive Maintenance Procedure.

Check Out No.	Description
g	Condition of lights, alarm, and temperature indicators.
p	Blanket water temperature controller and display.

4.2.5 THERMOSTATS

After thermostats have been replaced, the appropriate checkout should be performed. These are detailed in Section 3.3 of the Preventive Maintenance Procedures as outlined below:

Control Thermostat	Check #	Description
S1	N	Low temperature back-up thermostat (S1)
S2	L	Second high temperature back-up thermostat (S2)
S3	K	Third back-up thermostat (S3)
S4*	O	Refrigeration controller (S4)

*When replacing S4, it is also necessary to calibrate the S4 according to Section 3.5 before performing the checkout.

4.2.6 TOP COVER

If a complete new cover from Gaymar is being installed, adjustments may be needed. See Section 3.5.1.

a) Turn unit off.

b) Remove old top cover from unit by removing 4 screws underneath top cover and disconnecting cable. See Figure 6.18, page 6-11.

c) Install new top cover.

d) Connect the test set-up shown in Figure 6.12 on page 6-9.

e) Set the Thumbwheel Switch to 49°C. Turn unit on. Set in MANUAL mode.

f) The average water temperature on the mercury thermometer should stabilize at 41° ± 0.5°C.

g) If unit does not stabilize, see Primary Back-up Adjustment, Section 3.5.1.

4.3 SPARE PARTS

The following pages contain a Spare Parts List to aid you with any repair that may be needed on your Medi-Therm machine.

Illustrations which correspond with the items below are located in Figure 6.20, page 6-13 and Figure 6.21, page 6-14.

Please remember, repairs should only be performed by a qualified bio-medical technician, familiar with repair practices for servicing medical devices.

ITEM	DESCRIPTION	PART NUMBER	MTA-4700	MTA-4701	MTA-4702
1	COMPRESSOR, ALTERED	04912-000	*	*	-
	COMPRESSOR, ALTERED	04912-001	-	-	*
	A. CAPACITOR, START	77428-000	*	*	-
	CAPACITOR, START	77427-000	-	-	*
	B. RELAY	77237-000	*	*	-
	RELAY	77425-000	-	-	*
	C. THERMAL OVERLOAD	77238-000	*	*	-
	THERMAL OVERLOAD	77426-000	-	-	*
2	THERMOSTAT, ORANGE DOT (S2)	04939-003	*	*	*
3	THERMOSTAT, BLUE DOT (S3)	04939-004	*	*	*
4	TEMP. PROBE ASSY (RT2/RT3)	05542-000	*	*	*
5	THERMOSTAT (S1)	04939-005	*	*	*
6	CIRCUIT BREAKER (CB1)	90767-000	*	*	-
	CIRCUIT BREAKER (CB1)	90690-000	-	-	*
7	SOLENOID VALVE (K1) & (K2)	90851-000	*	*	*
8	TEMP. PROBE ASSEMBLY (RT1)	77454-000	*	*	*
9	TRANSFORMER (220/110 VAC)	90687-000	-	-	*
10	SOLENOID VALVE KIT	77541-000	*	*	*
12	QUICK DISCONNECT (1/8 NPT F)	01080-000	*	*	*
13	FLOW SWITCH, ALTERED	05541-000	*	*	*
14	PUMP, ALTERED (M1)	04913-000	*	*	*
	A. PUMP HOUSING	77156-000	*	*	*
	B. O-RING, 2-3/4" I.D.	77174-000	*	*	*
	C. PUMP HOUSING COVER	77173-000	*	*	*
	D. O-RING	77158-000	*	*	*
	E. IMPELLER SPINDLE	77157-000	*	*	*
	F. IMP.MAG.ASSY W/SS COLLAR	77159-000	*	*	*
15	CONTROLLER (S4)	90888-000	*	*	*
16	FILTER DRYER ASSEMBLY	04904-000	*	*	*
17	CASTER, R.H.	77101-001	*	*	*
18	CASTER, L.H.	77101-000	*	*	*
19	RACK W/STRAP	05123-000	*	*	*

ITEM	DESCRIPTION	PART NUMBER	MTA-4700	MTA-4701	MTA-4702
20	STRAIN RELIEF STRAIN RELIEF	90634-000 90426-000	- *	- *	* -
21	POWER CORD POWER CORD	04896-000 05138-000	* -	* -	- *
22	WRAP AROUND W/LABELS (NS)	05103-000	*	*	*
23	HEATER ASSEMBLY (HR1) HEATER ASSEMBLY	04969-000 04969-001	* -	- *	* -
24	OPERATING INSTR. - (CARD#1) START UP INSTR. - (CARD#2) MANUAL BLKT CONT. - (CARD#3) AUTO PATIENT CONT.- (CARD#4) TEMP. MONITOR - (CARD#5)	05837-000 05838-000 05839-000 05840-000 05841-000	* * * * *	* * * * *	* * * * *
25	ALARM SWITCH ASSEMBLY	05050-000	*	*	*
26	CLAMP	90662-000	*	*	*
27	TRANSFORMER ASSEMBLY TRANSFORMER ASSEMBLY	05075-000 05075-001	* -	- *	* -
28	STANDOFF	90665-000	*	*	*
29	POWER SUPPLY BOARD	77455-000	*	*	*
30	MAIN CONTROL BOARD	05865-000	*	*	*
31	DISPLAY BOARD	05864-000	*	*	*
32	CONTROL PANEL ASSEMBLY	05842-000	*	*	*
33	THUMBWHEEL SWITCH ASSEMBLY	04985-000	*	*	*
34	COVER COVER	04980-000 04980-001	- *	* -	* -
35	COMPLETE A-700 COVER ASSY. COMPLETE A-701 COVER ASSY. COMPLETE A-702 COVER ASSY.	05833-001 05833-002 05833-003	* - -	- * -	- - *
36	REAR LABEL. NAMEPLATE REAR LABEL. NAMEPLATE REAR LABEL. NAMEPLATE	05119-000 05125-000 05134-000	* - -	- * -	- - *
37	POP RIVET	90032-005	*	*	*
39	°C To °F CONVERSION SWITCH	05050-000	*	-	-

GAYMAR TEST TOOLS REFERRED TO THROUGHOUT THIS MANUAL

TPT-9 Tester
Shorting Plug, P/N 77352-000
DBK-5 Blanket Connecting Hose
Substitute Precision Resistor Kit PRK-2
Test Connector P/N 05559-000
Models TA-700 and TMT-4000
TFC-1 Mercury Thermometer (±1°C accuracy) -2° to 52°C
(or use standard Brooklyn Thermometer, Type 73544, or equivalent.

Dedicated test tool assemblies are available for independent testing of top and base. Consult Gaymar Industries, Technical Service Department for details.

4.4 SHIPPING/REPACKAGING INSTRUCTIONS

See Figure 6.25, page 6-18 for drawing with complete repackaging instructions for shipping the Medi-Therm back to Gaymar or to a qualified Service Center. If you do not have the original packing materials, please contact Gaymar Technical Service and a complete Customer Return Kit will be sent to you. Be sure to contact our Technical Service Department before shipping for "Return Authorization".

5.0 REFERENCE TABLES

5.1 CELSIUS — FAHRENHEIT CONVERSION TABLE

°C	°F
0	32
.5	32.9
1	33.8
1.5	34.7
2	35.6
2.5	36.5
3	37.4
3.5	38.3
4	39.2
4.5	40.1
5	41
5.5	41.9
6	42.8
6.5	43.7
7	44.6
7.5	45.5
8	46.4
8.5	47.3
9	48.2
9.5	49.1
10	50
10.5	50.9
11	51.8
11.5	52.7
12	53.6
12.5	54.5
13	55.4
13.5	56.3
14	57.2
14.5	58.1
15	59
15.5	59.9
16	60.8
16.5	61.7
17	62.6
17.5	63.5
18	64.4
18.5	65.3
19	66.2
19.5	67.1
20	68
20.5	68.9
21	69.8
21.5	70.7
22	71.6
22.5	72.5

°C	°F
23	73.4
23.5	74.3
24	75.2
24.5	76.1
25	77.0
25.5	77.9
26	78.8
26.5	79.7
27	80.6
27.5	81.5
28	82.4
28.5	83.3
29	84.2
29.5	85.1
30	86
30.5	86.9
31	87.8
31.5	88.7
32	89.6
32.5	90.5
33	91.4
33.5	92.3
34	93.2
34.5	94.1
35	95
35.5	95.9
36	96.8
36.5	97.7
37	98.6
37.5	99.5
38	100.4
38.5	101.3
39	102.2
39.5	103.1
40	104
40.5	104.5
41	105.8
41.5	106.7
42	107.6
42.5	108.5
43	109.4
43.5	110.3
44	111.2
44.5	112.1
45	113

5.2 The following charts are for assistance in substituting resistance values for temperatures:

5.2.1

PATIENT PROBE TEMPERATURE vs RESISTANCE		
TEMPERATURE °C	TEMPERATURE °F	RESISTANCE (OHMS)
+20	68	2814
21	69.8	2690
22	71.6	2572
23	73.4	2460
24	75.2	2354
25	77	2252
26	78.8	2156
27	80.6	2064
28	82.4	1977
29	84.2	1894
30	86	1815
31	87.8	1739
32	89.6	1667
33	91.4	1599
34	93.2	1533
35	95	1471
36	96.8	1412
37	98.6	1355
38	100.4	1301
39	102.2	1249
40	104	1200
41	105.8	1152
42	107.6	1107
43	109.4	1064
44	111.2	1023
45	113	983.8

5.2.2

PRIMARY BACK-UP THERMISTOR (RT1) TEMPERATURE vs RESISTANCE	
TEMPERATURE (°C)	RESISTANCE (OHMS)
+10	3660
15	2940
20	2460
25	2000
30	1660
35	1380
37.8	1240
40	1140
41	1100
45	950
50	820
55	680
60	580

5.2.3

WATER PROBE(RT2)
TEMPERATURE vs. RESISTANCE

TEMPERATURE °C	RESISTANCE (OHMS)
+ 0	19.59K
1	18.62K
2	17.70K
3	16.83K
4	16.01K
5	15.24K
6	14.50K
7	13.81K
8	13.15K
9	12.53K
10	11.94K
11	11.38K
12	10.85K
13	10.35K
14	9878
15	9428
16	9000
17	8594
18	8210
19	7844
20	7496
21	7166
22	6852
23	6554
24	6270
25	6000
26	5744
27	5500
28	5266
29	5046
30	4834
31	4634
32	4442
33	4260
34	4084
35	3918
36	3760
37	3610
38	3466
39	3328
40	3196
41	3070
42	2950
43	2836
44	2726
45	2620
46	2520
47	2424
48	2334
49	2246
50	2162

5.2.4

WATER PROBE(RT3)
TEMPERATURE vs. RESISTANCE

TEMPERATURE °C	RESISTANCE (OHMS)
+ 0	94.98K
1	90.41K
2	86.09K
3	81.99K
4	78.11K
5	74.44K
6	70.96K
7	67.66K
8	64.53K
9	61.56K
10	58.75K
11	56.07K
12	53.54K
13	51.13K
14	48.84K
15	46.67K
16	44.60K
17	42.64K
18	40.77K
19	38.99K
20	37.30K
21	35.70K
22	34.17K
23	32.71K
24	31.32K
25	30.00K
26	28.74K
27	27.54K
28	26.40K
29	25.31K
30	24.27K
31	23.28K
32	22.33K
33	21.43K
34	20.57K
35	19.74K
36	18.96K
37	18.21K
38	17.49K
39	16.80K
40	16.15K
41	15.52K
42	14.92K
43	14.35K
44	13.80K
45	13.28K
46	12.77K
47	12.29K
48	11.83K
49	11.39K
50	10.97K