081-874-0023

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) ON A MONITOR-RECORDER

CONDITIONS

You have received DD Form 314 and DA Form 2404 on a monitor-recorder scheduled for PMCS. Necessary materials and equipment: TB 38-750-2, manufacturer's service literature, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled PMCS is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the PMCS. The PMCS is recorded on DD Form 314.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**
1. Perform a visual check.	P F
a. Remove the monitor-recorder from the case to access components as necessary.	
b. Inspect all external surfaces of the monitor-recorder module for--	
(1) Physical damage.	
(2) Breakage.	
(3) Loose or dirty contacts.	
(4) Missing components.	
c. Inspect the printed circuit board surfaces for--	
(1) Discoloration.	
(2) Cracks.	
(3) Breaks.	

Performance Measures **Results**

(4) Warping.

d. Inspect all assemblies for burned or loose components.

e. Inspect all chassis and panel mounted components for--

(1) Looseness.

(2) Breakage.

(3) Loose contacts or conductors.

f. Inspect for disconnected, broken, cut, loose, or frayed cables or wires.

2. Perform an operational check. P F

a. Plug the unit into an AC power outlet.

(1) Press the POWER OFF/RECHARGE button.

(2) Verify the BATTERY CHARGE indicator lights.

b. Unplug the power cord.

(1) Press the POWER ON button.

(2) Verify all indicator lights except the BATTERY CHARGE function.

(3) Verify the CRT is illuminated.

NOTE: Some systems have an audible tone that will sound.

(4) Verify the BEEPER, ALARMS OFF, and REC indicators are on, and that the CRT displays a flat, moving trace.

NOTE: The DEPMEDS unit will display an O P on the CRT screen.

NOTE: If the monitor-recorder module is equipped with a defibrillator and it is not connected, the CRT should indicate NO DEFIB, as required.

(5) Verify that a flat ECG remains on the screen for 4 seconds.

Performance Measures **Results**

c. Press the ALARMS ON/OFF key ON.

(1) Verify that the ALARMS OFF indicator light goes off.

(2) Verify that the ALARM tone sounds within 4 seconds, and the recorder prints out a chart strip with a flat ECG trace.

NOTE: The DEPMEDS unit prints ALARM in the margin.

d. Press the ALARM ON/OFF switch.

(1) Verify that the indicator light turns on and that the ALARM tone quits.

(2) Verify that the recorder stops after approximately 10 seconds.

e. Press the ECG SOURCE LEAD SELECT switch, and verify that the CRT screen displays I, II, III, aVR, aVL, aVF, and V for chest.

NOTE: The DEPMEDS unit has a feature where the ECG complex can be obtained through the paddles. To ensure that this feature is functional, press the PADDLES switch and verify that the CRT displays P.

NOTE: If the defibrillator module is turned off or is not connected, the CRT for most monitor-recorders will display NO DEFIB.

f. Press the SELECT key of the HIGH ALARM switch until the HI ALARM indicator lights.

(1) Verify that the CRT displays 40 and 140 with the 140 flashing.

(2) Use the UP/DOWN arrows or the HI ALARM set switches to verify that the 140 increases and decreases.

(3) Reset the HI ALARM to 140.

g. Press the SELECT key or the LO ALARM set switch until the LO ALARM indicator lights.

(1) Verify that the CRT displays 40 and 140 with the 40 flashing.

(2) Use the UP/DOWN arrows or the LO ALARM set switches to verify that the 40 increases and decreases.

Performance Measures **Results**

(3) Reset the LO ALARM to 40.

h. Press the SELECT key until the BEEPER indicator lights.

i. Press the RUN/STOP key, turn the recorder on, and verify the recorder starts to print.

(1) Ensure the ECG trace on the recorder is the same as displayed on the CRT screen.

NOTE: The DEPMEDS unit will annotate heart rate (HR 0), ECG source (PADDLES), and ECG gain (AUTOGAIN 40 mm/mV) in the margin.

(2) Press the 1mV CAL key and ensure a pulse is generated on both the CRT and the recorder.

(3) Press the RUN/STOP key, turn the recorder off, and verify the recorder stops.

j. Press the ECG MEMORY MODE key until the PLAY indicator lights and then verify that PLAYBACK appears on the CRT screen.

k. Scan through the memory section, using the LEFT/RIGHT arrow, to find the messages PLAY BEGIN, PLAY ALARM, and PLAY END.

l. Press the ECG MEMORY MODE key until the STOP indicator lights and verify the CRT screen momentarily displays STOP.

m. Press the SELECT key until the beeper indicator lights. Press and hold both the UP and DOWN arrow keys to verify the CRT screen display voltage between 11.2 and 14.3 volts.

3. Record the PMCS on DD Form 314. P F

4. Record deficiencies uncorrected on DA Form 2404 and complete the appropriate reports and forms. P F

5. Take the unit out of service if uncorrected deficiencies present any danger to patients or operator or if the machine could be damaged due to continued use. P F

REFERENCES:	***Required***	***Related***
	Manufacturer's Service Literature TB 38-750-2	AR 40-61

081-874-0024

CALIBRATE A MONITOR-RECORDER

CONDITIONS

You have received DD Form 314 and DA Form 2404 to perform calibration on a monitor-recorder. Necessary materials and equipment: TB 38-750-2, manufacturer's service literature, digital multimeter, oscilloscope with probes (25MHz bandwidth, dual trace), patient ECG simulator (output level 1mV, range 60 to 120 bpm normal sinus rhythm), signal generator (sinewave, 1 to 5 Vp-p at 5 Hz), logic probe, two 100 ohm resistors (±1%) five jumper wires, ruler (must measure in mm), and tool kit (medical equipment organization maintenance), and individual tool box.

STANDARDS

The schedule calibration is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the calibration. The calibration is recorded on DD Form 314.

TRAINING/EVALUATION

Training Information Outline

1. Remove the cover from the monitor-recorder.

CAUTION
Dangerous voltages are present when the case is removed.

   a. Disconnect the AC power cord from the AC power source.

   b. Press the POWER OFF key.

   c. Working from the front, remove the 18 screws and washers holding the monitor-recorder module front panel.

   d. Slide the monitor-recorder module out of the case.

2. Locate the A2A3 ECG/power supply circuit card assembly.

   a. Calibrate the ECG gain adjustment.

(1) Press the POWER OFF switch.

(2) Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform.

(3) Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Gain xxxx a" is displayed on the CRT screen.

(4) Press the SELECT key until ECG size indicator is on. Press the UP or DOWN arrow keys until "Gain 1000" is displayed on the CRT screen.

(5) Press the SELECT key until the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "NOISE x.xxv" is displayed on the CRT screen.

(6) Connect the signal generator and resistors as shown in Figure 3-43.

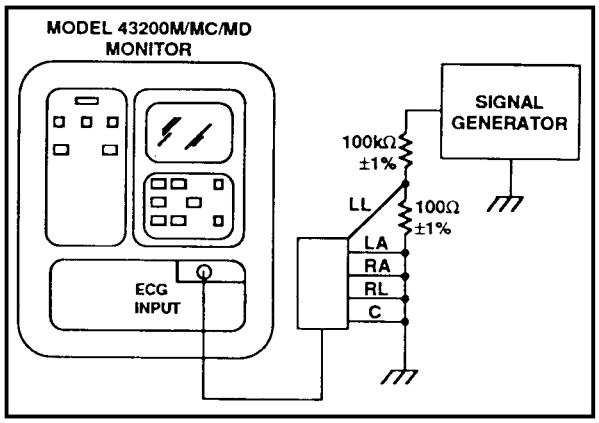

Figure 3-43

(7) Adjust the signal generator output to 3.0 Vp-p at 5Hz.

(8) Press the LEAD SELECTOR key until lead II is displayed on the CRT screen.

(9) Adjust A2A3R311 GAIN until THE CRT screen reads Noise 3.00v. (2.90 to 3.10.)

(10) Disconnect the signal generator and the resistors.

b. Calibrate the ECG offset adjustment.

(1) Press the POWER OFF key.

(2) Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform.

(3) Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Gain xxxx a" is displayed on the CRT screen.

(4) Press the SELECT key until the ECG size indicator is on. Press the UP or DOWN arrow keys until "Gain 4000" is displayed on the CRT screen.

(5) Press the SELECT key until the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Offset x.xxv" is displayed on the CRT screen.

(6) Using five jumper wires, short all five patient leads together. Press the LEAD SELECTOR key until lead II is displayed.

(7) Press the RUN/STOP key and allow the recorder to run.

(8) With a flat ECG baseline, adjust A2A3R308 (Offset) until CRT screen reads Offset 0.00v (<0.50) and a trace is centered on both the CRT screen and recorder strip.

(9) Press RUN/STOP key again to stop recorder run.

(10) Press the POWER OFF key and disconnect the jumper wires.

3. Locate the A2A5 CRT deflection circuit card assembly and A2L1 deflection yoke assembly (On the back of the CRT) and calibrate the CRT display adjustment.

NOTE: If the defibrillator module is connected, press the POWER OFF key.

a. Press the POWER OFF key, then press the POWER ON key on the monitor-recorder.

b. Adjust the ring magnet tabs on the CRT yoke (A2L1) to center the image on the CRT screen, if necessary.

c. Adjust the A2A5R38 (V) until the distance from the top of the P to the bottom of the NO DEFIB message on the CRT screen is 60 mm, ±1 mm.

d. Press the LEAD SELECTOR key until lead III is displayed on the CRT screen.

e. Adjust A2A5R37 (H) until the III is just on the screen and the ends of the ECG trace are readily visible.

4. Calibrate the printhead assembly.

NOTE: Always clean the printhead before performing the alignment procedures. This will verify misalignment instead of a dirty printhead.

a. Remove the BT1 battery assembly.

(1) Working from the left side of the monitor-recorder, disconnect the 3 wire cables (BT1P14) and the battery vent tube.

(2) Remove the two screws with washers and battery retainer.

(3) Remove the BT1 battery assembly.

NOTE: When installing the battery assembly, ensure the vent hole and BT1P14 are facing up.

(4) Disconnect the following wires:

NOTE: Tag and label wires before disconnecting.

(a) The 40 pin ribbon cable A3A1A2P4 (A2A2J4).

(b) The 2 wire cable A3A1A2P45 (A2A5J3).

(c) Remove the nut and washer holding the green/yellow ground wire (on the top left side). Disconnect the green/yellow ground wire.

b. Remove the chassis assembly.

(1) Disconnect the following wires:

NOTE: Tag and label wires before disconnecting.

(a) The 6 wire cable A3P26 (A2A2J26).

(b) The 14 pin ribbon cable A3A3P33 (A2A2J33).

(c) The 40 pin ribbon cable A3A1A2P4 (A2A2J4).

(d) The 2 wire cable A3P37 (A2A2J37).

(e) The 2 wire cable A3A1A2P45 (A2A5J3).

(f) Remove the nut and washer holding the green/yellow wire (on the top left side). Disconnect the green/yellow ground wire.

(2) Remove the four screws, washers, and spacers holding the A2 chassis assembly to the A3 front panel assembly. The two screws on the bottom (in front) remain in place.

(3) Separate the A2 chassis assembly from the A3 front panel assembly enough to disconnect the following wires:

(a) The 3 wire cable A3P19 (A2A3J26).

(b) The green/yellow ground wires on the bottom left side.

(4) Verify that all the cables and wires are clear from retaining clamps and wraps.

(5) Separate the A3 chassis assembly from the A3 front panel assembly.

NOTE: When installing the A2 chassis assembly, ensure the cables and wires are routed in the proper holes, clamps, and wraps.

c. Working from the rear, remove the two rubber cable retainers.

d. Working from the rear, remove the inner recorder shaft E ring clip and washer. Support the A3A1 recorder assembly and slide the shaft out.

e. Feed the cable through the hole and remove the A3A1 recorder assembly.

f. Remove the two screws in the bottom of the recorder next to the recorder latch and separate the recorder housing from the recorder door enough to gain access to the adjustment screw. The set screw is located underneath the flat ribbon cable on the upper printhead housing wall.

CAUTION

Take care when separating the housing from door not to damage any cables.

g. Position the recorder assembly next to the monitor-recorder and reconnect the following wires.

(1) The 40 pin ribbon cable A3A1A2P4 to A2A2J4.

(2) The 2 wire cable A3A1A2P45 to A2A5J3.

(3) The green/yellow ground wire to chassis with the nut and washer.

h. Press the POWER OFF key on the monitor-recorder.

i. Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform.

j. Press the RUN/STOP key and verify that the recorder prints the same ramp waveform followed by a stair step waveform as the CRT.

NOTE: It is normal for the ramp portion of the waveform to be clipped on the top and bottom of the printed output.

k. Use a hex key to adjust the set screw on the upper printhead housing wall until the bottom half of the paper is printing light, then back off the set screw until the bottom half darkens to the same intensity as the top half.

CAUTION

The recorder assembly may have to be physically held in order to perform adjustment. Dangerous voltages are present when the covers are removed.

NOTE: Adjusting for greater darkening on the top half can cause paper tracking problems.

l. Allow the recorder to run for approximately 30 seconds to verify that the intensity remains the same for the top and bottom, and that the paper tracks correctly. If not, repeat step 4k.

m. Reassemble the recorder housing and the recorder door and replace the two screws in the bottom of the recorder next to the recorder door latch.

n. Install the A3A1 recorder assembly and the monitor-recorder module back into the case.

o. Repeat step 4j and verify the printer intensity and tracking are correct. If not, repeat the procedure.

5. Record the results of the calibration on the appropriate forms and records.

Evaluation Guide

Performance Measures	**Results**	
1. Remove the cover from the monitor-recorder.	P	F
2. Locate the A2A3 ECG/power supply circuit card assembly.	P	F
3. Locate the A2A5 CRT deflection circuit card assembly and A2L1 deflection yoke assembly.	P	F

Performance Measures	Results
4. Calibrate the printhead assembly.	P F
5. Record the results of the calibration on the appropriate forms and records.	P F

REFERENCES:	*Required*	*Related*
	Manufacturer's Service Literature TB 38-750-2	AR 40-61

081-874-0025

REPAIR A MONITOR-RECORDER TO MODULE/BOARD LEVEL

CONDITIONS

You have received DA Form 2407 for repair of monitor-recorder. Necessary materials and equipment: DA Form 2409, TB Med 7, manufacturer's service literature, TB 38-750-2, digital multimeter, oscilloscope with probes (25MZ bandwidth, dual trace), patient ECG simulator (output level 1mv, range 60 to 120 bpm normal sinus rhythm), signal generator (sinewave, 1 to 5 Vp-p at 5 Hz), logic probe, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The malfunction is isolated to module/circuit board level and corrected. The unit is functional in accordance with operational standards specified in the manufacture's literature. Results are recorded on DA Forms 2407 and 2409.

TRAINING/EVALUATION

Training Information Outline

1. Review DA Form 2407 for operator's description of the equipment malfunction.

2. Determine the maintenance expenditure limits (MEL) for definite life equipment.

    a. Obtain the current replacement cost.

    b. Calculate the percentage of useful life remaining for the item by dividing the life remaining in months by the life expectancy in months.

    c. Use the chart at Figure 3-44 to determine the MEL factor. Read up vertically from the percent of useful life remaining to a point of intersection with the baseline.

    d. Project a horizontal line to the MEL factor.

    e. Multiply the MEL factor by the current replacement cost to determine the maximum allowable repair cost.

NOTE: Under certain conditions, the MEL may be waived. (See TB Med 7.)

NOTE: The MEL for definite life equipment which has reached or exceeded its life expectancy is 10%. This MEL remains constant for as long as the equipment is in use, regardless of age.

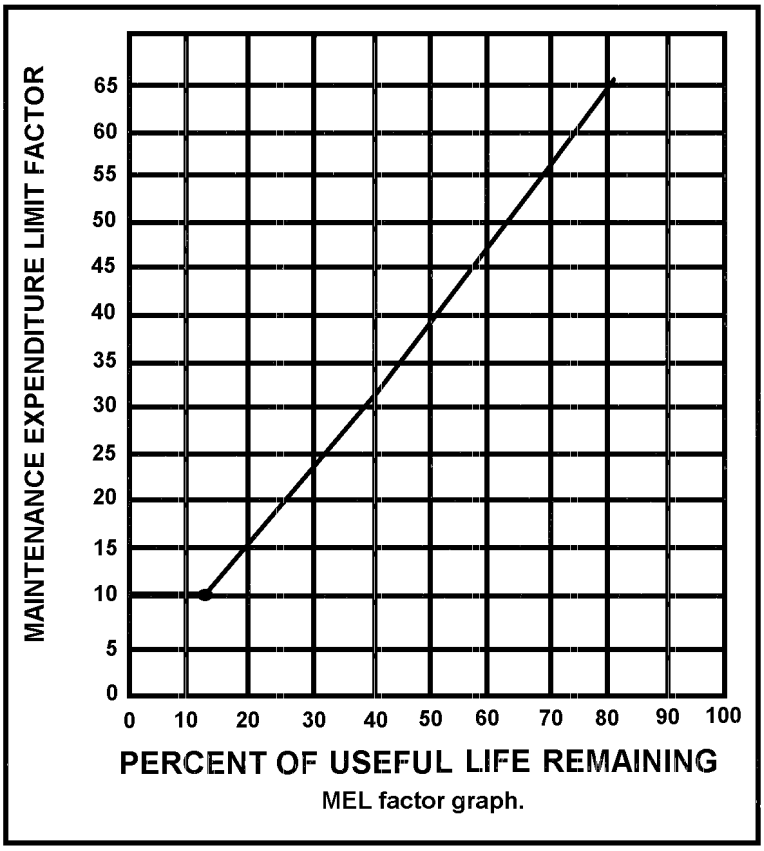

Figure 3-44

3. Inspect all external surfaces of the monitor-recorder for--

   a. Physical damage.

   b. Breakage.

   c. Loose or dirty contacts.

   d. Missing components.

4. Perform a function check to confirm symptoms listed on DA Form 2407.

NOTE: If the unit operates normally and no malfunctions are detected, complete DA Form 2407 and return the unit to the user. (See step 13.)

5. Place the monitor-recorder in the service mode.

a. Press the POWER OFF key.

b. Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform. Verify the presence of audio tone (beeping).

c. Press the SELECT key until the beeper indicator is on.

d. Press the UP and DOWN arrow keys simultaneously until "Batt xx.xV" is displayed on the screen.

e. Press the UP and DOWN arrow keys simultaneously until "Gain xxxx a" is displayed on the CRT screen. To change gain, press the SELECT key until ECG size indicator is on. Press the UP and DOWN keys until desired gain is displayed on the CRT screen.

f. Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Noise xx.xV" is displayed on the CRT screen.

g. Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Offst xx.xV" is displayed on the CRT screen.

h. Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "IR link xxx" is displayed on the CRT screen.

i. Verify the beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "LFREQ xx HZ" is displayed.

j. Exit the service mode by pressing the POWER OFF key.

6. Read and interpret the error messages. (See Figure 3-45.)

ERROR MESSAGES

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
CRT displays "error 0."	Main controller (A2A2U61) error.	See system dead problems.
CRT displays "error 1."	Recorder-controller error.	A2A2U1 (RAM/ROM).
CRT displays "error 2."	CRT and display controller error.	A2A2U31 (RAM/ROM).
CRT displays "error 3."	ECG memory error.	A2A4 ECG memory CCA.
CRT displays "error 6."	LV supply out of specification.	See low voltage supply problems.
CRT displays "error 7."	A/D converter	See system dead problems.
CRT displays "error 8."	Recorder motor failure.	See recorder problems.

Figure 3-45

7. Remove the monitor-recorder from the case.

CAUTION

The monitor-recorder module contains high voltages. After the power is removed, discharge capacitors to ground before working inside to prevent electrical shock. Disconnecting the AC power cord will not remove all dangerous voltages. The monitor-recorder module operates from battery as well as AC power.

CAUTION

Do not disconnect or remove any board assemblies in the monitor-recorder module unless the power is off. Some board assemblies contain devices that can be damaged if the board is removed when the power is on. Several components, including metal-oxide semiconductors (MOS) devices, can be damaged by electrostatic discharge. Use conductive foam and grounding straps when servicing is required around sensitive components. Use care when unplugging integrated circuits (ICs) from high-grip sockets.

a. Inspect the circuit board surfaces for--

(1) Discoloration.

(2) Cracks.

(3) Breaks.

(4) Warps.

b. Inspect the circuit board conductors for--

(1) Cracks.

(2) Breaks.

(3) Cuts.

(4) Corrosion.

(5) Looseness.

c. Inspect all assemblies for burned or loose components.

d. Inspect all the chassis and panel mounted components for looseness, breakage, or loose contacts or conductors.

e. Inspect for disconnected, broken, cut, loose, or frayed cables or wires.

8. Troubleshoot and isolate the malfunction(s) to module/board level. (See Figure 3-46, General Troubleshooting.)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
System dead.	Power.	Check battery voltage at A2A3J2 pins 8 and 9. Check for +14.3 V at A2A3J2 pins 2 and 3 when AC power cord is connected to AC source and BT1 is fully charged.
	A3A2 power on switch.	Check for continuity between A2A2J33 pin 11 and pin 14 (DGND) when power on key is pressed.
	A2A3K102	Use a jumper wire to force +12v across the coil and verify the relay operates (clicks). If A2A3K103 is closed, the instrument should be on.
	A2A3F101	Check fuse.

Figure 3-46

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Instrument will only stay on while the ON switch is held.	A3A2	Replace Control Circuit Card Assembly A3A2.
V battery, +8V, +5V, and -5V are correct, but instrument will not turn on.	Clock oscillator on A2A2.	Replace Control Circuit Card Assembly A2A2.
Continuous tone, with no CRT display.	A2A2.	Replace Control Circuit Card Assembly A2A2.
Unit turns on but no "READY" message and no power up tone.	A2A2.	Replace Control Circuit Card Assembly A2A2.
Unit turns on, CRT display frozen with "ERROR 0", may or may not be a continuous tone.	A2A2.	Replace Control Circuit Card Assembly A2A2.
Too bright or dim.	A2A2.	Replace Control Circuit Card Assembly A2A2.
Display jumps.	Horizontal sweep signal.	Replace Control Circuit Card Assembly A2A2.
No sync marker.	A2A2.	Replace Control Card Assembly A2A2.

Figure 3-46 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOMS	POSSIBLE CAUSE	CORRECTIVE ACTION
Character dots jitter.	A2A5 vertical deflection.	Replace Control Circuit Card Assembly A2A2.
Display baseline - no characters.	A2L1 deflection yoke.	Check A2L1 resistance approximately 6 ohms vertical and 40 ohms horizontal.
	A2A5 vertical deflection.	Replace Control Circuit Card Assembly A2A2.
Characters short.	-5 volt supply.	Replace Control Circuit Card Assembly A2A2.
Display blank.	A2A5, A2A2.	Replace Control Circuit Card Assemblies A2A5 and A2A2.
Intensity varies.	A2A5.	Replace Control Circuit Card Assembly A2A5.
Left side of display is different size than the right side.	A2A5.	Replace Control Circuit Card Assembly A2A5.
Top half of display different size than bottom half.	A2A5.	Replace Control Circuit Card Assembly A2A5.

Figure 3-46 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Vertical deflection shakes.	A2A5.	Replace Control Card Assembly A2A5.
No ECG.	A2A2.	Replace Control Card Assembly A2A2.
Flat trace-no characters.	A2A2 voltage reference.	Replace Control Card Assembly A2A2.
False "No paper" message.	Paper rotating on spindle.	Paper core inner diameter too large (improper paper). Use P/N 40453A.
No paper shut off.	A2A2 and A3A1.	Replace Control Circuit Card Assembly A2A2 or A3A1.
Will not run.	A2A2 and A2A1.	1 kHz signal variable duty cycle present.
	A3A1 motor.	Interrupter on the rear of the motor shaft turning freely.
	A3A1A3 front panel switch.	Signal not reaching A2A2U1.
Erratic speed.	A2A2 or A3A1.	Replace Control Circuit Card assembly A2A2 or A3A1.
Runs for short period then shuts off (doesn't detect paper).	No paper.	Replace paper roll.

Figure 3-46 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Runs for short period, then shuts off (doesn't detect paper). (Cont'd)	A2A2 or A3A1.	Replace Control Circuit Card Assembly A2A2 or A3A1.
	Optodetector.	Clean lens.
Printing light, or missing top or bottom half.	A3A1 printhead.	Adjust printhead.
Not printing.	A2A2 or A3A1.	Replace Control Circuit Card Assembly A2A2 or A3A1.
Light printing.	Battery low (<11.2 V).	Check voltage. Troubleshoot low battery shutdown circuit.
	A3A1 printhead.	Needs cleaning.
	Improper paper.	Use P/N 40453A.
	Door.	Door not closing completely.
50/60 Hz noise on ECG trace.	Electromagnetically noisy environment.	Check grounding of nearby equipment.
	High electrode impedance.	Use Redux (P/N 651-1024-050) creme, abrade skin.
	Patient cable.	Substitute patient cable.

Figure 3-46 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
ECG noise, not 50/60 Hz.	A2A3 isolated circuits.	Replace Control Circuit Card Assembly A2A3.
ECG amp does not meet 0.5Hz bandwidth spec.	A2A3.	Replace Control Circuit Card A2A3.
Leads ECG offset from center displays.	A2A3.	Replace Control Card Assembly A2A3.
Will not enter service mode.	A2A2, or A3A1.	Replace Control Circuit Card Assembly A2A2 or A3A1.
No service ramp-step waveform on CRT or recorder.	A2A2.	Replace Control Circuit Card Assembly A2A2.
Ramp waveform is non-linear.	A2A5.	Replace Control Circuit Card Assembly A2A5.
Battery not charging, but LED is on.	BT1 thermal fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).
	BT1 battery assembly.	Check open circuit battery volts. Load test battery.
Battery not charging, LED is off, AC is connected.	A2A1, A2A3.	Replace Control Circuit Card Assembly A2A1 or A2A3.

Figure 3-46 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Battery charging LED not working.	A2A3.	Replace Control Circuit Card Assembly A2A3.
Low battery shutdown not occurring. (Unit does not turn off when battery is below 11V.)	A2A3.	Replace Control Circuit Card Assembly A2A3.
	BT1 Battery Assembly.	If battery was discharged below 10.8 volts, capacity may not recover. Replace BT1.
+8V, +5V or -5V power supply not operating correctly.	A2A3.	Replace Control Circuit Card Assembly A2A3.
"NO DEFIB" - No communication between monitor-recorder and defibrillator modules.	Optical Window.	Clean the optical window on both instruments and check for scratches.
		Try a different defibrillator and a different monitor-recorder.
		Put unit in service mode and read number of optical link errors reported by message. IR LINK 0 errors is normal.
	A2A1, A2A2.	Replace Control Circuit Card A2A1 or A2A2.

Figure 3-46 (Continued)

9. Determine if the repair cost exceeds the MEL.

NOTE: If the repair cost exceeds the MEL, notify the supervisor.

10. Replace the malfunctioning module/circuit board.

11. Perform a function check.

12. Determine the disposition of the unit.

a. Prepare to release the unit to the user if the function check is satisfactory.

b. Take the unit out of service if uncorrected deficiencies are present and they present a danger to patients or operator or if the machine could be damaged due to combined use.

c. Refer to the next higher echelon of maintenance, if necessary.

13. Complete and file DA Forms 2407 and 2409 IAW TB 38-750-2.

a. Obtain the hand receipt copy of DA Form 2407 from the user if the equipment was repaired in the shop.

b. Obtain the user's signature for receipt of the unit, as appropriate.

c. Release the unit to the user.

Evaluation Guide

Performance Measures	**Results**	
1. Review DA Form 2407 for the operator's description of the equipment malfunction.	P	F
2. Determine the maintenance expenditure limits (MEL) for definite life equipment.	P	F
3. Inspect all external surfaces of the monitor-recorder.	P	F
4. Perform a function check to confirm symptoms listed on DA Form 2407.	P	F
5. Place the monitor-recorder in the service mode.	P	F
6. Read and interpret the error messages.	P	F
7. Remove the monitor-recorder from the case.	P	F
8. Troubleshoot and isolate the malfunction(s) to module/board level.	P	F

Performance Measures	Results
9. Determine if the repair cost exceeds the MEL.	P F
10. Replace the malfunctioning module/board.	P F
11. Perform a function check.	P F
12. Determine the disposition of the unit.	P F
13. Complete and file DA Forms 2407 and 2409 IAW TB 38-750-2.	P F

REFERENCES:	*Required*	*Related*
	Manufacturer's Service Literature TB MED 7 TB 38-750-2	AR 40-61 AR 710-2

081-874-0027

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) ON A DEFIBRILLATOR MODULE

CONDITIONS

You have received DD Form 314 and DA Form 2407 on a defibrillator scheduled for PMCS. Necessary materials and equipment: TB 38-750-2, manufacturer's service literature, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled PMCS is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the PMCS. The PMCS is recorded on DD Form 314.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**
1. Perform a visual check on the defibrillator.	P F
a. Remove the defibrillator from the case to access components.	
b. Inspect all external surfaces of the defibrillator module for--	
(1) Physical damage.	
(2) Breakage.	
(3) Loose or dirty contacts.	
(4) Missing components.	
c. Inspect printed circuit board surfaces for--	
(1) Discoloration.	
(2) Cracks and breaks.	
(3) Warping.	

Performance Measures	Results

d. Inspect all assemblies for burned or loose components.

e. Inspect all chassis and panel mounted components for looseness, breakage, loose contacts, or loose conductors.

f. Inspect for disconnected, broken, cut, loose, or frayed wires and cables.

g. Inspect the patient paddles for pitted conditions and excess buildup of electrolyte paste.

h. Inspect the patient's cables for discoloration, broken insulation, and loose connectors.

2. Perform an operational check on the defibrillator. P F

a. Connect the unit to AC power.

b. Verify that the BATTERY CHARGE indicator is on.

c. Verify that the adult paddle electrodes are installed.

d. Unplug the AC power cord.

(1) Press the POWER ON/DISARM button.

(2) Verify that all indicators light, except BATTERY CHARGE.

NOTE: The DEPMEDS unit will produce an audible tone for approximately one second. The ENERGY-JOULES display will alternately flash HP and 888 and then display 0.

e. Leave the paddles in their holders, select an ENERGY LEVEL and press the ENERGY CHARGE button.

NOTE: The DEPMEDS unit has a 100J test function button.

f. Verify that the ENERGY-JOULES display starts counting.

(1) Listen for a steady tone to sound.

(2) Verify that the ENERGY-JOULES display indicates the ENERGY LEVEL selected.

g. Press the paddles firmly in their holders; press and briefly hold the DISCHARGE buttons.

Performance Measures	Results	
(1) Verify that the NEON TEST LIGHT flashes.		
(2) Verify that the ENERGY-JOULES display indicates the ENERGY LEVEL selected.		
NOTE: Failure for the test light to operate may indicate that the defibrillator output is not capable of delivering the selected level to the patient.		
h. Repeat steps 2e through 2g with the paddle cables fully extended to verify that the cables do not have any broken wires or contacts.		
3. Record deficiencies uncorrected on DA Form 2404 and complete the appropriate reports and forms.	P	F
4. Take the unit out of service if uncorrected deficiencies present any danger to patients or operator or if the machine could be damaged due to continued use.	P	F

REFERENCES:	***Required***	***Related***
	Manufacturer's Service Literature TB 38-750-2	AR 40-61

081-874-0028

CALIBRATE A DEFIBRILLATOR MODULE

CONDITIONS

You have received DD Form 314 and DA Form 2404 to perform calibration on a defibrillator. Necessary materials and equipment: manufacturer's service literature, TB 38-750-2, monitor-recorder module HP 43200MD, digital multimeter, energy meter, stopwatch or timer, patient ECG simulator, signal generator (1 to 5 Vp-p at 5 Hz), two fixed 100k ohm resistors, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled calibration is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during calibration. The calibration is recorded on DD Form 314.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**
1. Remove the defibrillator from the case.	P F

CAUTION

The defibrillator must be disconnected from the AC power source before proceeding. This unit is battery powered, causing dangerous voltages to be present even with the AC power source removed.

a. Disconnect the AC power source.

b. Press the POWER OFF/RECHARGE key.

c. Remove the 18 screws and washers holding the defibrillator module front panel.

d. Slide the defibrillator module out of the case far enough to disconnect A1A11R link CCA 10 pin ribbon cable A1A1P36 from the A2A2 control CCA.

e. Remove the defibrillator module.

Performance Measures **Results**

f. Disconnect the three pin battery cable BT1P14.

2. Locate the control circuit card assembly. P F

a. Calibrate the defibrillator energy output. (See Figure 3-47 for test equipment hookup.)

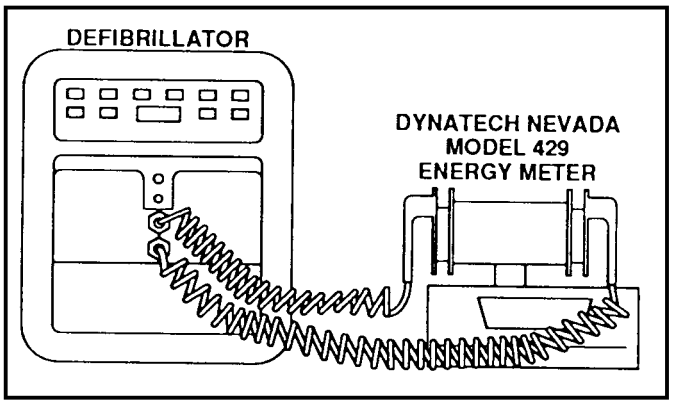

Figure 3-47

(1) Press the POWER ON/DISARM key.

(2) Press the ENERGY SELECT/CHARGE 100J/test key and allow the unit to charge. Verify that the Charge Done tone sounds and the Apex Paddle Charge indicator lights when the unit is ready to discharge.

(3) Firmly press the paddles to the energy meter contacts and press both DISCHARGE buttons simultaneously.

(a) Adjust the HV capacitor voltage signal by adjusting A2A2R119 (VCAP), if necessary, to obtain proper delivered energy.

(4) Press the ENERGY SELECT/CHARGE 360 key and allow the unit to charge. Verify that the Charge Done tone sounds and the Apex Paddle Charge Done indicator lights when the unit is ready to discharge.

(5) Firmly press the paddles to the energy meter contacts and press both DISCHARGE buttons simultaneously. Adjust A2A2R119 (VCAP), if necessary, to obtain proper delivered energy.

Performance Measures **Results**

(6) Refer to Figure 3-48 and perform all the energy levels. Compare the delivered energy levels indicated on the energy meter with the information below and verify that all readings are within specified limits.

Delivered Energy Accuracy

Energy Selected	Specified Limits	Delivered Energy (Joules)
40	40-46	_____
70	70-80	_____
100	100-115	_____
200	200-230	_____
300	300-345	_____
360	360-414	_____

Figure 3-48

(7) If readings are incorrect, repeat steps 2a(1) through 2a(6).

(8) Press the POWER OFF/RECHARGE key and disconnect the test equipment.

b. Calibrate the ECG Gain Amplifier.

(1) Connect the monitor-recorder module (using the optical link) and press the POWER OFF/RECHARGE key.

(2) Press the defibrillator POWER ON/DISARM key.

(3) On the monitor-recorder module--

(a) Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify that the CRT screen shows a triangle waveform followed by a stair step waveform.

(b) Verify that the Beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Gain xxxx a" is displayed on the CRT screen.

(4) Press the SELECT key until the ECG Size indicator is on. Press the UP or DOWN arrow keys until the"Gain 1000" is displayed on the CRT screen.

Performance Measures **Results**

(5) Press the SELECT key until the Beeper indicator is on. Press the UP and DOWN keys simultaneously until "Noise x.xxv" is displayed on the CRT screen.

(6) Connect the signal generator and resistors as shown in Figure 3-49.

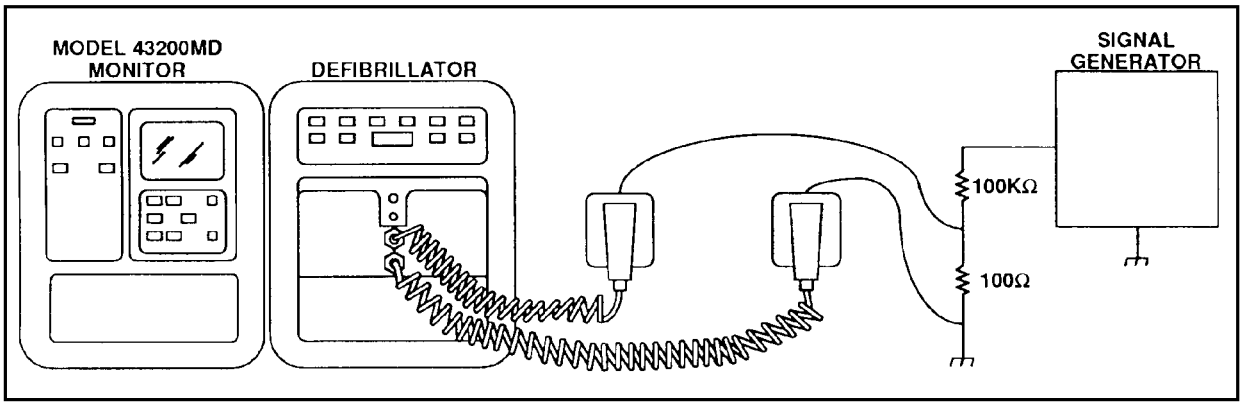

Figure 3-49

(7) Adjust the signal generator output to 3.0Vp-p at 5Hz sinewave.

(8) Adjust A2A2R331 "Gain" until the CRT screen reads Noise 3.00v (2.90 to 3.10).

(9) Press the POWER OFF/RECHARGE key and disconnect the test equipment.

c. Calibrate the ECG Offset adjustment.

(1) Connect the monitor-recorder module (using the optical link) and press the POWER OFF/RECHARGE key.

(2) Press the defibrillator POWER ON/DISARM key.

(3) ON the monitor-recorder module--

(a) Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a triangle waveform followed by a stair step waveform.

(b) Verify that the Beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until "Gain xxxx a" is displayed on the CRT screen.

Performance Measures **Results**

(4) Press the SELECT key until the ECG Size indicator in on. Press the UP or DOWN arrow keys until "Gain 4000" is displayed on the CRT screen.

(5) Press the SELECT key until the Beeper indicator is on. Press the UP and DOWN arrow keys simultaneously until the "Offset x.xxv" is displayed on the CRT screen.

(6) Leave the paddles installed in their storage position (apex on the right, sternum on the left).

(7) Adjust A2A2R328 "Offset" until the CRT screen reads Offst 0.00v (<0.50) with the trace centered.

(8) Press the POWER OFF/RECHARGE key and disconnect the test equipment.

NOTE: There is no field adjustment on the power supply circuit card assembly.

3. Record the results of the calibration on the appropriate forms and records. P F

REFERENCES:	***Required***	***Related***
	Manufacturer's Service Literature TB 38-750-2	AR 40-61

081-874-0029

REPAIR A DEFIBRILLATOR MODULE TO MODULE/BOARD LEVEL

CONDITION

You have received DA Form 2407 to repair a defibrillator module. Necessary materials and equipment: DA Form 2409, TB Med 7, TB 38-750-2, manufacturer's service literature, digital multimeter, energy meter, stopwatch patient ECG simulator, safety analyzer, signal generator, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARD

The malfunction is isolated to module/board level and corrected. The defibrillator is functional in accordance with operational standards specified in the manufacturer's service literature. Results are recorded on DA Form 2407 and 2409.

TRAINING/EVALUATION

Training Information Outline

1. Review DA Form 2407 for the operator's description of the equipment's malfunction.

2. Determine the maintenance expenditure limits (MEL) for definite life equipment.

   a. Obtain the current replacement cost.

   b. Calculate the percentage of useful life remaining for the item by dividing the life remaining in months by the life expectancy in months.

   c. Use the chart at Figure 3-50 to determine the MEL factor. Read up vertically from the percent of the useful life remaining to a point of intersection with the baseline.

   d. Project a horizontal line to the MEL factor.

   e. Multiply the MEL factor by the current replacement cost to determine the maximum allowable repair cost.

NOTE: Under certain conditions the MEL may be waived. (See TB Med 7.)

NOTE: The MEL for definite life equipment which has reached or exceeded its life expectancy is 10 percent. This MEL remains constant for as long as the equipment is in use, regardless of age.

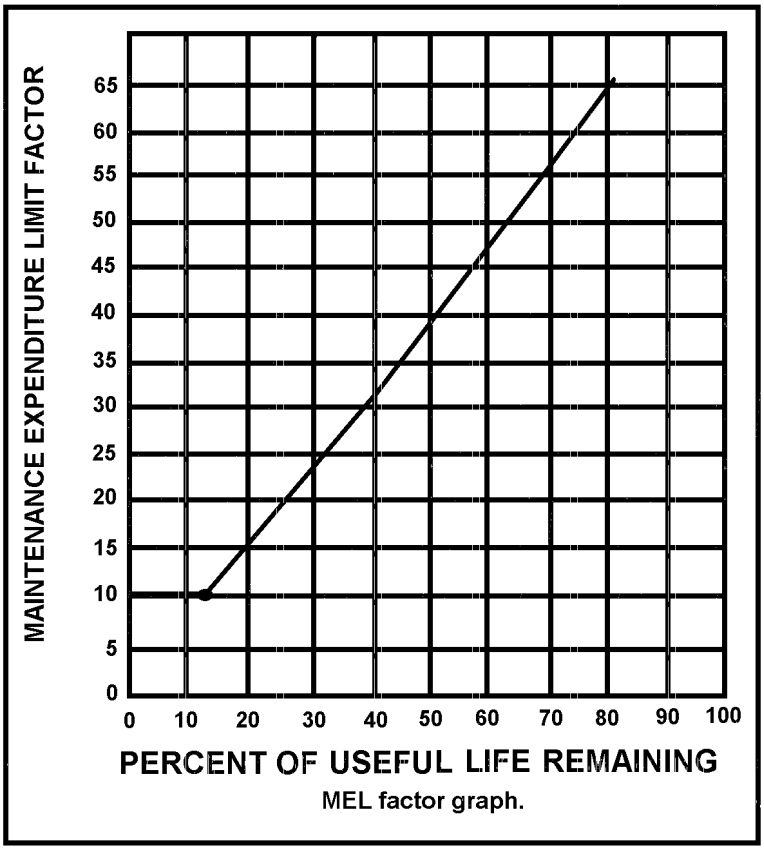

Figure 3-50

3. Inspect the external surfaces of the defibrillator for--

   a. Physical damage.

   b. Breakage.

   c. Loose or dirty contacts.

   d. Missing components.

4. Perform a function check to confirm symptoms listed on DA Form 2407.

NOTE: If the unit operates normally and no malfunctions are detected, complete DA Form 2407 and return the unit to the user. (See step 12.)

5. Read and interpret the error messages. (See Figure 3-51.)

ERROR MESSAGES

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Display flashes "E2."	Defibrillator charging too slowly.	See defibrillator problems.
Display flashes "E3."	Defibrillator capacitor arcing.	See defibrillator problems.
Display flashes "E4."	Defibrillator charged but shouldn't be.	See defibrillator problems.
Display flashes "E5."	Defibrillator overcharged.	See defibrillator problems.
Display flashes "E6."	LV Supply out of spec.	See low voltage supply problems.
Display flashes "E7."	A/D (A2AU102) won't respond.	See system dead problems.
Display flashes "E8."	Microcontroller A2A2U101 failed power up R0M test.	
Display flashes "EEE."	A1A1 infrared link.	Verify monitor-recorder module is turned on and properly connected.

Figure 3-51

6. Remove the defibrillator from the case.

CAUTION

Disconnect the defibrillator from the AC power source before proceeding. This unit is battery powered, causing dangerous voltages to be present even with the AC power source removed.

a. Inspect the circuit board surfaces for--

(1) Discoloration.

(2) Cracks.

(3) Breaks.

(4) Warps.

b. Inspect the circuit board conductors for--

(1) Cracks.

(2) Breaks.

(3) Cuts.

(4) Corrosion.

(5) Looseness.

c. Inspect all assemblies for burned or loose components.

d. Inspect all the chassis and panel mounted components for--

(1) Looseness.

(2) Breakage.

(3) Loose contacts.

(4) Loose conductors.

e. Inspect for disconnected, broken, cut, loose, or frayed cables or wires.

7. Troubleshoot and isolate malfunction(s) to module/board level. (See Figure 3-52.)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
System dead.	Power.	Check battery voltage at A2A2P12.
		Check for +14 .3 V at A2A2P13 when the AC power cord is connected source.
	A3A4 Power on switch.	Check for continuity between A2A2J2 pin 2 and pin 7 (GND) when Power On key is pressed.
	A2A3K402.	Replace A2A3.
	A2A3F401.	Check Fuse.
Instrument will only stay on while ON switch is held.	A2A2Q201.	Replace A2A2.
V battery, +8V, +5V - 5V correct but instrument not on.	Clock Oscillator on A2A2.	Replace A2A2.
Same symptoms as above with or without a continuous power up tone and display.	A2A2.	Replace A2A2.
Unit will not respond to Apex paddle charge button.	A3A1 Apex paddle.	Verify continuity between A2A2J7 pins 1 and 5 when charge button is pressed.
	A2A2U105 or U101.	Replace A2A2.

Figure 3-52

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Unit will not respond to front panel Energy Select/Charge keys.	A2A2U205.	Replace A2A2.
Unit does not respond to discharge switches.	A3A2 sternum paddle.	Verify continuity between A2A2J8 pins 1 and 3 when discharge switch is pressed.
	A3A1 Apex paddle.	Verify continuity between A2A2J7 pins 1 and 3 when discharge switch is pressed.
	A2A2U105.	Replace A2A2.
The defibrillator does not seem to charge. The display indicates 0 jouls, then in a few seconds displays "E2" and aborts charge.	The defibrillator is charging, but the capacitor voltage is not being recognized.	Replace A2A2 or A2A3 or both.
Slow charging (greater than 10 seconds to 360 jouls with fully charged battery) or charge aborted with "E2" flashing on display.	A2A3P15 is disconnected.	Check A2A3P15 connection.
	A2A3K1 not opening.	Replace A2A3.
Charging begins but then is aborted with "E3" flashing on the display.	HV Capacitor (A2C1) arc.	Replace A2A3.
"E4" flashing on the display.	A2A3 Capacitor voltage measurement problem.	Replace A2A3.

Figure 3-52 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Battery Charger LED not working.	Battery Charger off.	Verify instrument is connected to AC source.
	BT1 Thermal Fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).
	Signal path.	Follow BATT CHG LED signal from A2A2 to A3A3.
	A2A2U401.	Replace A2A2.
Displays bright; frequent burnout.	+8.4V too high.	Replace A2A2.
LEDs (A3A3 DS1, DS2, DS3) not lighting or dim.	+8.4V too low.	Replace A2A2.
LEDs (A3A3 DS1, DS2, DS3) not lighting correctly.	A3A3DS1, DS2, or DS3.	Replacer A2A2 or A3A3 or both.
One digit (A3A3DS4, DS5, DS6) not lighting correctly.	A3A3DS4, DS5, DS6, or A2A2U204.	Replace A2A2 or A2A3 or both.
One segment on one digit not lighting correctly.	A3A3DS4, DS5, DS6.	Replace A3A3.
Same segment on all digits not lighting correctly.	A2A2U202.	Replace A2A2.

Figure 3-52 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
BTI battery not charging or instrument will not operate on AC only.	AC power.	Verify AC connected to appropriate power.
	A2A1 dead.	Replace A2A2.
	BT1 Thermal fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).
+8V supply not operating correctly.	A2A2U405.	Replace A2A2.
+8.4V supply not operating correctly.	A2A2U404.	Replace A2A2.
+5V supply not operating correctly.	A2A2U406.	Replace A2A2.
-5V supply not operating correctly.	A2A2+5V circuit.	Replace A2A2.
50/60 Hz noise on ECG trace.	Electromagnetically noisy environment.	Check grounding of nearby equipment.
	High electrode impedance.	Use Redux (P/N 651-1008-50) paste, abrade skin, press with 25 lbs of force.

Figure 3-52 (Continued)

GENERAL TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
ECG noise,not 50/60 Hz.	A2A2 Isolated circuits.	Replace A2A2.
Paddles ECG Offset from center of displays.	A2A2R328.	Adjust ECG Offset.
	A2AU304.	Replace A2A2.
ECG Gain Incorrect.	A2A2R331.	Adjust ECG gain.
	A2A2U305.	Measure ON resistance for each of eight multiplexer channels.

Figure 3-52 (Continued)

8. Determine if the repair cost exceeds the MEL.

NOTE: If the repair cost exceeds the MEL, notify the supervisor.

9. Replace the malfunctioning module/board.

10. Perform a function check.

11. Determine the disposition of the unit.

a. Prepare to release the unit to the user if the function check is satisfactory.

b. Take the unit out of service if uncorrected deficiencies are present and they present danger to patients or operator or if the machine could be damaged due to continued use.

c. Refer to the next higher echelon of maintenance, if necessary.

12. Complete and file DA Form 2407 and 2409 IAW TB 38-750-2.

a. Obtain the hand receipt copy of DA Form 2407 from the user if the equipment was repaired in the shop.

b. Obtain the user's signature for receipt of the unit, as appropriate.

c. Release the unit to the user.

Evaluation Guide

Performance Measures	**Results**	
1. Review DA Form 2407 for operator's description of the equipment malfunction.	P	F
2. Determine maintenance expenditure limit (MEL) for definite life equipment.	P	F
3. Inspect the external surfaces of the defibrillator.	P	F
4. Perform a function check to confirm symptoms listed on DA Form 2407.	P	F
5. Read and interpret the error messages.	P	F
6. Remove the defibrillator from the case.	P	F
7. Troubleshoot and isolate the malfunction(s).	P	F
8. Determine if the repair cost exceeds the MEL.	P	F
9. Replace the malfunctioning module/board.	P	F
10. Perform a function check.	P	F
11. Determine the disposition of the unit.	P	F
12. Complete and file DA Forms 2407 and 2409 IAW TB 38-750-2.	P	F

REFERENCES:	***Required***	***Related***
	Manufacturer's Service Literature TB 38-750-2 TB Med 7	AR 40-61 AR 710-2

081-874-0031

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) ON A PORTABLE VENTILATOR

CONDITIONS

You have received DD Form 314 and DA Form 2404 on a ventilator scheduled for PMCS. Necessary materials and equipment: TM 8-6530-009-24&P, TB 38-750-2, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled PMCS is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the PMCS. The PMCS is recorded on DD Form 314.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**	
1. Inspect the case for--	P	F
a. Broken and or missing carrying handles.		
b. Broken or missing latches and hinges.		
c. Dented or missing battery compartment door.		
d. Broken, loose, or missing control knobs.		
e. Rusted and chipped surfaces.		
2. Inspect the air/oxygen regulator for cracks, loose fittings, and air leaks.	P	F
3. Inspect the tubing and hoses for dry rot, deterioration, crimps, and leaking or damaged connector fittings.	P	F
4. Inspect wires and connectors for frays, cracks, and improper insulation.	P	F
5. Inspect the circuit board for burns, cracks, and discolored components.	P	F

Performance Measures	Results	
6. Inspect the blender.	P	F
a. Test the operation of the alarm.		
b. Inspect the oxygen and air regulators to ensure proper adjustment to output pressure of 50 psi ±5 psi.		
7. Inspect the patient valve for--	P	F
a. Cracks.		
b. Leaks.		
c. Discoloration.		
8. Perform a function check.	P	F
a. Test the operation of the control module.		
b. Ensure the self-test mode is functional.		
9. Correct minor deficiencies.	P	F
10. Record deficiencies not corrected on DA Form 2404 and complete appropriate reports and forms.	P	F
11. Take the unit out of service if uncorrected deficiencies present any danger to patients or operator or if the machine could be damaged due to continued use.	P	F

REFERENCES:	***Required***	***Related***
	TM 8-6530-009-24&P TB 38-750-2	AR 40-61

081-874-0032

CALIBRATE A PORTABLE VENTILATOR

CONDITIONS

You have received DD Form 314 and DA Form 2404 on a portable ventilator scheduled for calibration. Necessary materials and equipment: TB 38-750-2, TM 8-6530-009-24A&P, multimeter, oscilloscope, signal generator, electronic digital counter, medical functions simulator, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled calibration is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are corrected during the calibration. The calibration is recorded on DD Form 314.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**	
1. Perform the ventilator self-test. (Refer to TM 8-6530-009-24&P, Chapter 2, Section 2-12.)	P	F
2. Perform an operator transducer calibration. (Refer to TM 8-6530-009-24&P, Chapter 2, Section 2-13.)	P	F
3. Calibrate the transducer internally. (Refer to TM 8-6530-009-24&P, Chapter 4, Section 4-25.)	P	F
4. Record the results of the calibration on the appropriate forms and records.	P	F

REFERENCES:	***Required***	***Related***
	TM 8-6530-009-24&P TB 38-750-2	AR 40-61

081-874-0033

REPAIR A PORTABLE VENTILATOR TO MODULE/BOARD LEVEL

CONDITIONS

You have received a DA Form 2407 for repair of a portable ventilator. Necessary materials and equipment: DA Form 2409, TM 8-6530-009-24&P, TB 38-750-2, TB Med 7, multimeter, current leakage tester, oscilloscope, circuit component test set, semiconductor tester, signal generator, electronic digital counter, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The malfunction is isolated to module/board level and corrected. The portable ventilator is functional in accordance with operational standards specified in TM 8-6530-009-24&P. Results are recorded on DA Forms 2407 and 2409.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**	
1. Review DA Form 2407 for the operator's description of the equipment's malfunction.	P	F
2. Determine the maintenance expenditure limits (MEL) for definite life equipment.	P	F

a. Obtain current replacement cost.

b. Calculate the percentage of useful life remaining for the item by dividing the life remaining in months by the life expectancy in months.

c. Use the chart in Figure 3-53 to determine the MEL factor. Read up vertically from the percent of useful life remaining to a point of intersection with the baseline.

d. Project a horizontal line to the MEL factor.

e. Multiply the MEL factor by the current replacement cost to determine maximum allowable repair cost.

NOTE: Under certain conditions, the MEL may be waived. (See TB Med 7.)

Performance Measures **Results**

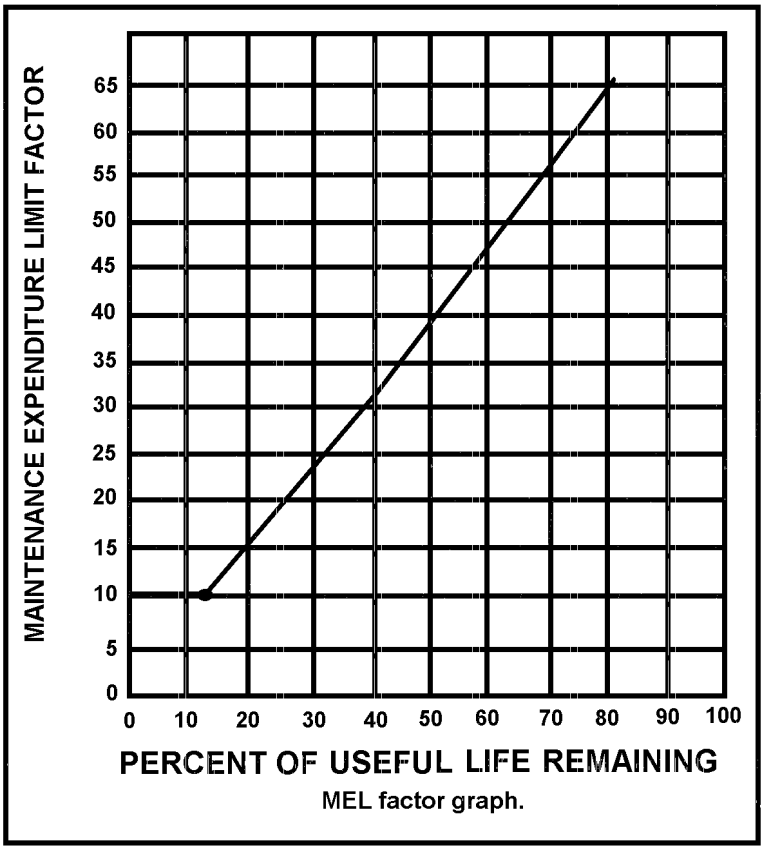

Figure 3-53

NOTE: The MEL for definite life equipment which has reached or exceeds its life expectancy is 10 percent. This MEL remains constant for as long the equipment is in use, regardless of the age.

3. Remove the cover from the unit. P F

4. Perform a visual inspection for-- P F

   a. Bare, exposed cable wires.

   b. Burned light bulbs.

5. Perform a function check to confirm symptoms listed on DA Form 2407. P F

NOTE: If the unit operates normally and no malfunctions are detected, complete DA Form 2407 and return the unit to the user. (See step 11.)

Performance Measures	Results
6. Troubleshoot and localize the malfunction to module/board level. (Refer to TM 8-6530-24&P, Chapter 4, Section 4-15.)	P F
7. Determine if the repair cost exceeds the MEL.	P F

NOTE: If the repair cost exceeds the MEL, notify the supervisor.

8. Replace the malfunctioning module/board.	P F
9. Perform a function check.	P F
10. Determine the disposition of the unit.	P F

a. Prepare to release the unit to the user if the function check is satisfactory.

b. Take the unit out of service if uncorrected deficiencies are present and they present a danger to patients or operator or if the machine could be damaged due to continued use.

c. Refer to the next higher echelon of maintenance if necessary.

11. Complete and file DA Forms 2407 and 2409 IAW TB 38-750-2.	P F

a. Obtain the hand receipt copy of DA Form 2407 from the user if the equipment was repaired in the shop.

b. Obtain the user's signature for receipt of the unit, as appropriate.

c. Release the unit to the user.

REFERENCES:	***Required***	***Related***
	TM 8-6530-009-24&P	AR 40-61
	TB 38-750-2	AR 710-2
	TB Med 7	

081-874-0035

PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) ON A SINGLE PHASE RADIOGRAPHIC UNIT (CONTINENTAL X-RAY UNIT)

CONDITIONS

You have received DD Form 314 and DA Form 2404 to perform PMCS on a single phase radiographic unit (Continental X-ray Unit). Necessary materials and equipment: TB 38-750-2, manufacturer's service literature, digital multimeter, flashlight, inspection mirror, soft cleaning rag, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The scheduled PMCS is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the PMCS. The PMCS is recorded on DD Form 314.

TRAINING/EVALUATION

Training Information Outline

NOTE: Perform steps 1 through 4 quarterly.

1. Inspect the exterior of the main control and the high voltage transformer.

    a. Inspect all the electrical cables, cords, connectors, and fittings for tightness.

    b. Inspect all cables and connectors for--

        (1) Break in the insulation.

        (2) Abrasions.

        (3) Signs of arcing or burns.

    c. Inspect the high voltage transformer for oil leaks.

    d. Inspect the exterior painted or plated surfaces for--

        (1) Scratches.

        (2) Chipping.

(3) Corrosion.

e. Ensure that all name plates and warning labels are present, legible, and securely mounted.

f. Turn the unit on.

g. Test all the front panel controls and meters for correct operation and to ensure that they light properly. Replace any burned out lamps.

h. Inspect the X-ray tube filaments.

CAUTION

Do not look directly into either tube port. Open both collimators and use an inspection mirror to ensure the filaments are lit.

i. Inspect the auxiliary box.

(1) Inspect the exterior surfaces and door hinges for--

(a) Loose or missing parts.

(b) Deterioration.

(c) Corrosion.

(2) Inspect all internal components, connectors, cables, and mounting hardware for--

(a) Damage.

(b) Deterioration.

(c) Corrosion.

(d) Loose or missing parts.

2. Inspect the table mounting hardware.

a. Inspect all the bolts, nuts, screws, rivets, and other fasteners, including table base mounts, for tightness and missing parts.

b. Inspect all electrical cables, connectors, cords, and fittings for--

(1) Tightness.

(2) Break in the insulation.

(3) Abrasions.

c. Inspect cables where electrical cabling enters housing.

d. Inspect the exterior surfaces and door hinges for--

(1) Loose or missing parts.

(2) Deterioration.

(3) Corrosion.

(4) Ensure that all nameplates and warning labels are present, legible, and securely mounted.

e. Perform a table operations check.

(1) Press and hold the longitudinal foot switch until the top reaches its limit of travel. The tabletop should move approximately 30" from the center position before stopping.

(2) Press and hold the longitudinal head switch until the tabletop reaches its limit of travel. The tabletop should move approximately 30" from the center position before stopping.

(3) Press and hold the table center switch until the tabletop stops. It should move to the center position, from either of the two longitudinal positions before stopping.

(4) Press and hold the Trendelenburg tilt switch until the table reaches its maximum tilt. The tabletop should tilt 12° down toward the head end and stop.

(5) Press and hold the vertical tilt switch until the tabletop reach the maximum tilt. The table should tilt 88° down toward the foot end before it stops.

(6) Engage all the locks and attempt to reposition the spot film device in all directions. It should take a minimum of 20 pounds of force to move a corresponding part. The locks should not make a banging sound when engaged.

CAUTION

A faulty lock can cause serious injury. A system with malfunctioning locks should be taken out of service.

3. Inspect the tubestand.

a. Inspect all exterior painted and plated surfaces for--

(1) Scratches.

(2) Rust.

(3) Corrosion.

b. Ensure that all name and warning plates are clean, securely mounted, and legible.

c. Inspect for loose or missing nuts and bolts.

d. Inspect the travel features ensuring there is smooth travel indicating each electric lock is operating properly.

e. Inspect the manual locks for proper operation.

4. Inspect the line set adjustment on the generator.

a. Set the major and minor kVp controls fully clockwise.

b. Turn on the power to the generator.

c. Use the coarse and fine line adjust controls to position the line set meter pointer directly over the reference mark at the center of the scale.

d. Select the 25S mA push button switch and adjust the major and minor kVp rotory switches for 78 kVp.

e. Select 1 second on the Radiographic Seconds dial.

f. On the Constant Current Multiplex Filament Control Circuit Board, connect the negative lead of a digital multimeter (DC scale) to the junction of the two 250 µF capacitors and the positive lead to the left side of the 10K ohm resistor indicated as test point XD1.

g. Adjust P30 for 0 volts.

h. Make a 2 second exposure while reading the front panel mAs meter readings. Adjust P12 and P22 for 25 mA, if necessary.

i. Repeat steps 4a-g for all mA stations, using the line set adjustment data listed in Table 3-1. Use 78 kVp for all settings.

mA Station	Adj. Meter with:	mA Displayed
200L	P11,21	200mA
SPOT		
25S	P12,22	25mA
50S	P13,23	50mA
100S	P14,24	100mA
100L	P15,25	100mA
150L	P16,26	100mA
200L	P17,27	200mA
300L	P18,28	300mA

Table 3-1. Line Set Adjustments

j. Select 50 kVp, 200L, 2 seconds.

k. Make an exposure while reading the front panel mAs meter. Adjust P31 for 200 mA, if necessary.

l. Repeat step 4a-g for all mA stations using line set adjustment data in Table 3-1. Use 50 kVp for all settings.

5. Inspect the counterweight cables.

NOTE: Step 5 is performed semiannually.

CAUTION

A cable failure can cause serious patient or operator injury or equipment damage. This is especially true of the spot film device vertical counterbalancing system in the tower. Worn or damaged cables cannot be repaired. The cables must be replaced immediately.

a. Remove the back cover from the tower.

b. Move the spot film device to its highest possible vertical position.

NOTE: The vertical carriage is connected to the sides of the counterweight holder by means of two cables, one on each end. (See Figure 3-54.)

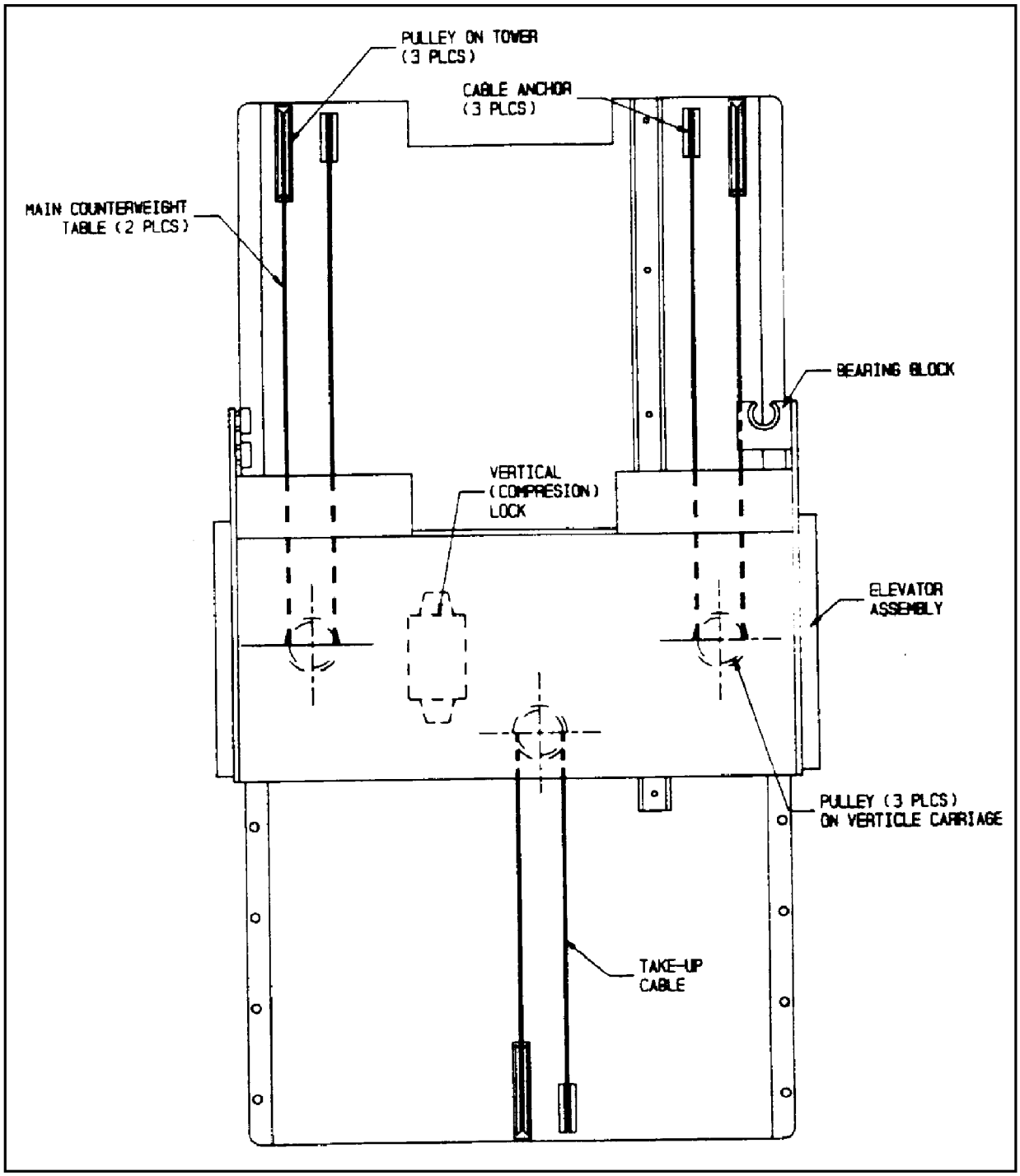

Figure 3-54

c. Visually inspect both cables for--

(1) Kinks.

(2) Separation of strands.

(3) Rust and corrosion.

NOTE: The cable must be replaced if it has been penetrated by rust or corrosion.

d. Move the spot film device to its lowest possible position to inspect a third cable attached to the counterweight holder at the center bottom. Perform the same inspection as in step 5d(1) through 5d(3).

e. Inspect the internal PCBs for--

(1) Corrosion.

(2) Loose or missing components.

f. Replace all covers after inspecting the cables.

6. Inspect the collimator.

NOTE: Step 6 is performed annually.

a. Inspect the exterior surfaces for damage, rust, and corrosion.

b. Inspect the cables and connectors for tightness and insulation breaks.

c. Inspect the carrying frame and collimator X-ray tube for missing parts, rust, and corrosion.

7. Perform a function check.

CAUTION

The procedure in this section requires the making of exposures. Take all precautions necessary to protect all personnel against unnecessary radiation.

a. Turn the power on to the generator.

b. Select the over-table X-ray tube.

(1) Set the machine at 80 kVp, 200 mA and 0.1 seconds. Make four exposures at 20 seconds intervals.

(2) Make four additional exposures at 20 second intervals, increasing the kVp by 10 kVp for each exposure. Begin the exposures at 90 kVp.

8. Record deficiencies uncorrected on DA Form 2404 and complete the appropriate reports and forms.

9. Take the unit out of service if uncorrected deficiencies present any danger to patients or operator or if the machine could be damaged due to continued use.

Evaluation Guide

Performance Measures `	**Results**	
1. Inspect the exterior of the main control and the high voltage transformer.	P	F
2. Inspect the table mounting hardware.	P	F
3. Inspect the tube stand.	P	F
4. Inspect the generator.	P	F
5. Inspect the counterweight cables.	P	F
6. Inspect the collimator.	P	F
7. Perform a function check.	P	F
8. Record deficiencies uncorrected on DA Form 2404 and complete the appropriate reports and forms.	P	F
9. Take the unit out of service as necessary.	P	F

REFERENCES:	***Required***	***Related***
	Manufacture's Service Literature TB 38-750-2	AR 40-61

081-874-0037

CALIBRATE A SINGLE PHASE RADIOGRAPHIC UNIT (CONTINENTAL X-RAY UNIT)

CONDITIONS

You have received DD Form 314 and DA Form 2404 on a single phase radiographic unit (Continental X-ray Unit) scheduled for calibration. Necessary materials and equipment: Tool kits 5180-00-611-7923 and 5180-00-611-7924, X-ray film and cassettes (8 x 10, 9 x 9, 14 x 17); Radiation Dose Monitoring Badge; Radiation Protection Vest (Lead Apron); Beam attenuator; 4 radiopaque markers, 1.5" X 0.5" X 1/32" (38 mm X 13 mm X .8 mm); jumper wire, 0.2 mm spaced metallic (stainless steel or cooper) wire mesh .2 mm diameter; measuring tape; grease pencil or masking tape; 1/2" cam adjusting open end wrench (Continental part # 4144.234.01); insulating compound, such as Dow DC-4; cleaner for high voltage cable connectors; Wedge, Step-Spin Top; calculator; CS-8952 Field Deployable X-ray System Maintenance Manual, Volume I, Chapter 3, Calibration; digital multimeter, 500 volts DC, 500 volts AC, 1000 Ma DC, + 1%; dual channel oscilloscope, calibrated DC to minimum 100 Khz, 0.1 Volts DC/cm with long persistence phosphor or storage capability DC current source with milliammeter, with at least 360 mA capacity; radiation dose rate meter, 0 to 10 R/minute (Victoreen model 06-526 or equivalent); densitometer, or 1.0 neutral density filter, for density comparison; patient phantom, or water phantom (a clean, flat-bottomed plastic bucket with a minimum diameter of 6" which can be filled with up to 12" of tap water); X-ray film processor dark room. For noninvasive calibration, the following equipment is required: kVp meter (Nuclear Associates model 07-494, or equivalent), mAs meter (Nuclear Associates model 07-472, or equivalent), X-ray timer (Nuclear Associates model 07-457, or equivalent). For invasive calibration, a dynalyzer (or Kvp measuring tank) is required.

STANDARDS

The scheduled calibration is performed and all uncorrected, unsafe conditions are identified and recorded on DA Form 2404. Minor deficiencies are recorded and corrected during the calibration. The calibration is recorded on DD Form 314.

TRAINING/EVALUATION

Training Information Outline

1. Perform precalibration checks.

   a. Check that all mechanical movements are free moving and that they do not rub or block cabling.

   b. Inspect the system for protruding screws and potential cable strains.

   c. Turn the MAINS on and verify that all magnetic locks hold securely.

   d. Tilt the table as far as it will tilt in both directions and verify that it does not come in contact with the floor or the ceiling.

e. Move the tubestand to each end of its rail and vertical to its limits.

f. Rotate the overtable in all directions.

NOTE: If mechanical parts need adjustment, see manufacturer's instructions, Chapter 2, Installation, for instructions.

2. Perform generator calibration.

CAUTION

Generator calibration requires the production of X-rays and mandates the strict observance of all safety precautions, including the use of protective devices.

NOTE: Calibration of the X-ray generator requires either a complete set of noninvasive X-ray calibration meters or a Dynalyzer (kVp measuring tank). The instructions are different for each type of calibration test equipment.

a. Conduct 50/60 Hz Conversion.

NOTE: This unit is shipped from the manufacturer in the 60 Hz configuration.

(1) Turn the MAINS off at the main control and open the main control door.

(2) Remove the four screws holding the dual-sided radiographic seconds select panel. (See Figure 3-55.)

(3) Rotate the panel until it can be removed from under the knob. (It should not be necessary to remove the knob.)

(4) Position the desired scale (50 or 60 Hz) of the panel face up and slide the panel back under the knob into the correct position. Replace the panel screws.

NOTE: Line frequency dependent components inside the cabinets are labeled with a red tag for easy identification.

NOTE: Two time select decks are located inside the control door behind the Radiographic Seconds panel.

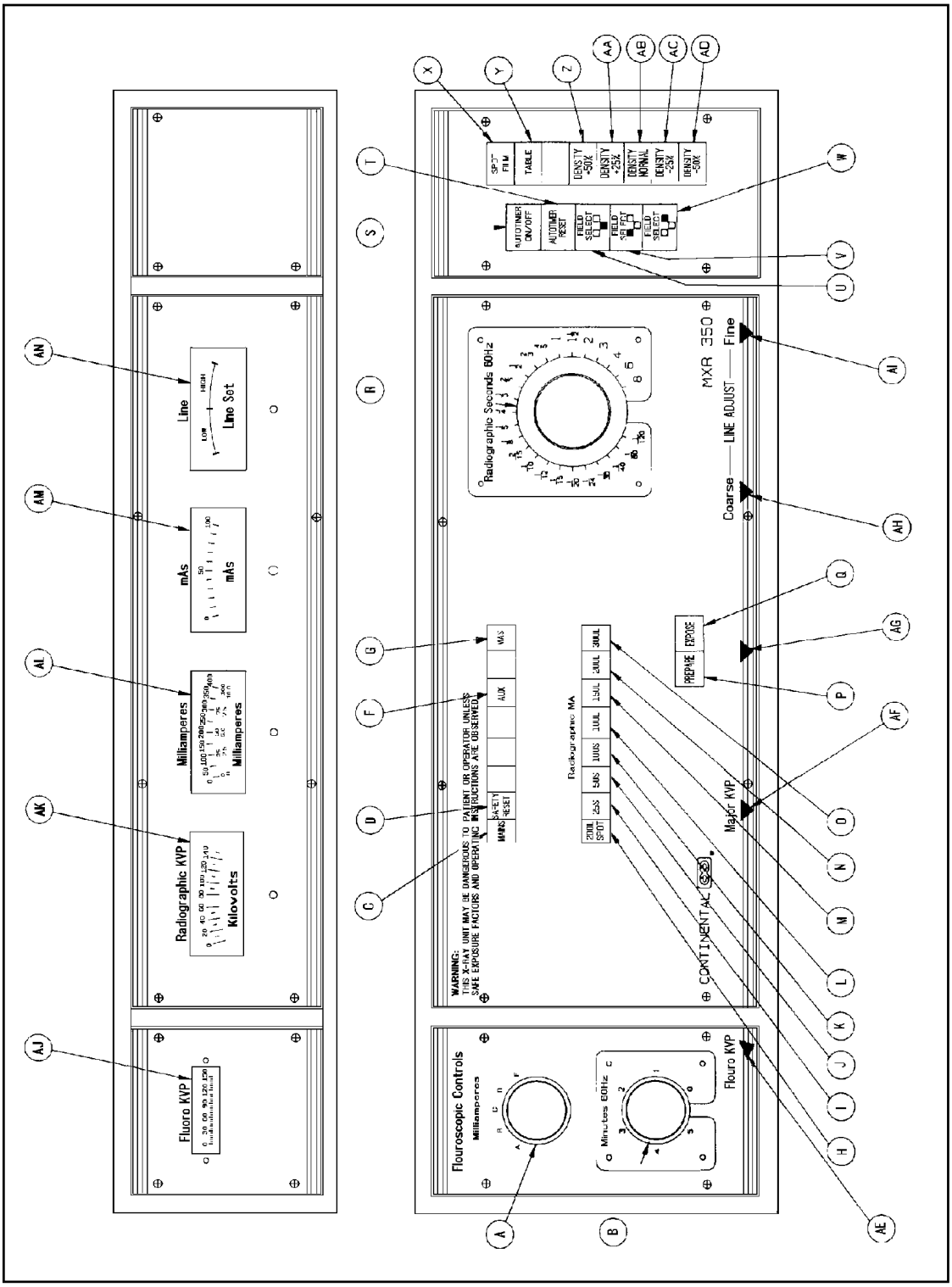
Line
Line Set
mAs
mAs
Milliamperes
Milliamperes
Radiographic KVP
Kilovolts
Fluoro KVP
Radiographic Seconds 60Hz
MXR 350
Coarse —— LINE ADJUST —— Fine
Radiographic mA
PREPARE
EXPOSE
Major KVP
CONTINENTAL
Flouroscopic Controls
Milliamperes
Minutes 60Hz
Fluoro KVP
SPOT FILM
TABLE
DENSITY +50%
DENSITY +25%
DENSITY NORMAL
DENSITY -25%
DENSITY -50%
AUTOTIMER ON/OFF
AUTOTIMER RESET
FIELD SELECT
WARNING:
THIS X-RAY UNIT MAY BE DANGEROUS TO PATIENT OR OPERATOR UNLESS
SAFE EXPOSURE FACTORS AND OPERATING INSTRUCTIONS ARE OBSERVED.
MAINS
SAFETY RESET
AUX
MAS
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
AA
AB
AC
AD
AE
AF
AG
AH
AI
AJ
AK
AL
AM
AN

Figure 3-55

(5) Install leads D2T and TRI on appropriate time select deck, (50 or 60 Hz). (See Figure 3-56.)

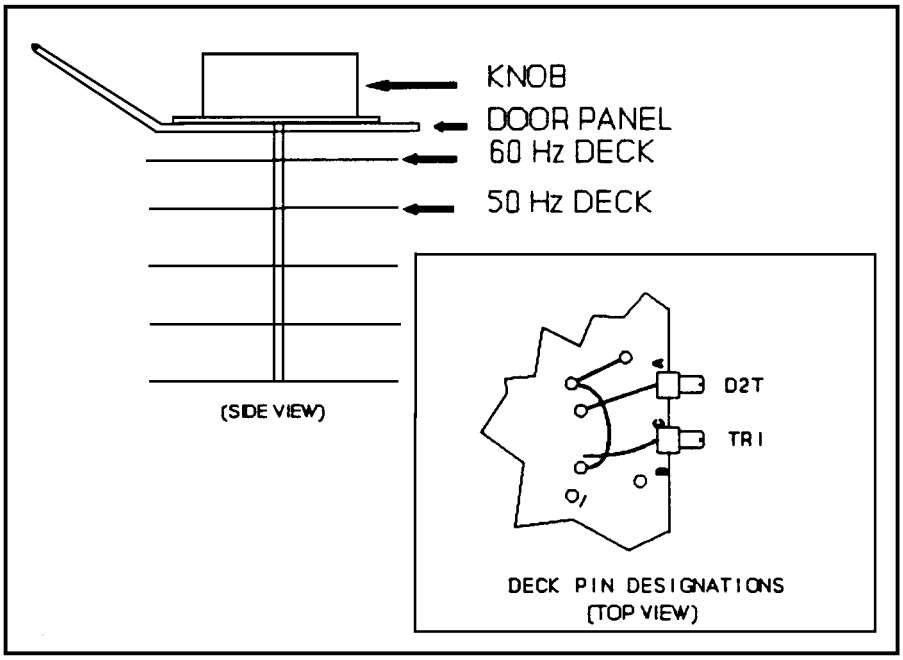

Figure 3-56

(6) Select either the 50 Hz or 60 Hz position on the constant voltage transformer selector switch. (See Figure 3-57.)

(7) Remove the four screws holding the dual-sided fluoro controls "Minutes" dial. (See Figure 3-55.)

(8) Rotate the panel until it can be removed from under the knob. Position the appropriate 50 or 60 Hz scale face up and slide it into the correct position. Replace the panel screws.

(9) Depress the internal "Minutes" switch at the <0> position.

(10) Listen carefully while slowly rotating the "Minutes" knob back and forth across the <0> mark. If a "click" is heard, the "Minutes" switch <0> cam is correctly positioned.

(11) If no "click" can be heard, use the following method to reposition the cam:

(a) Use the wrench attached to the "Minutes" (timer) assembly (Continental part # 4144.234.01).

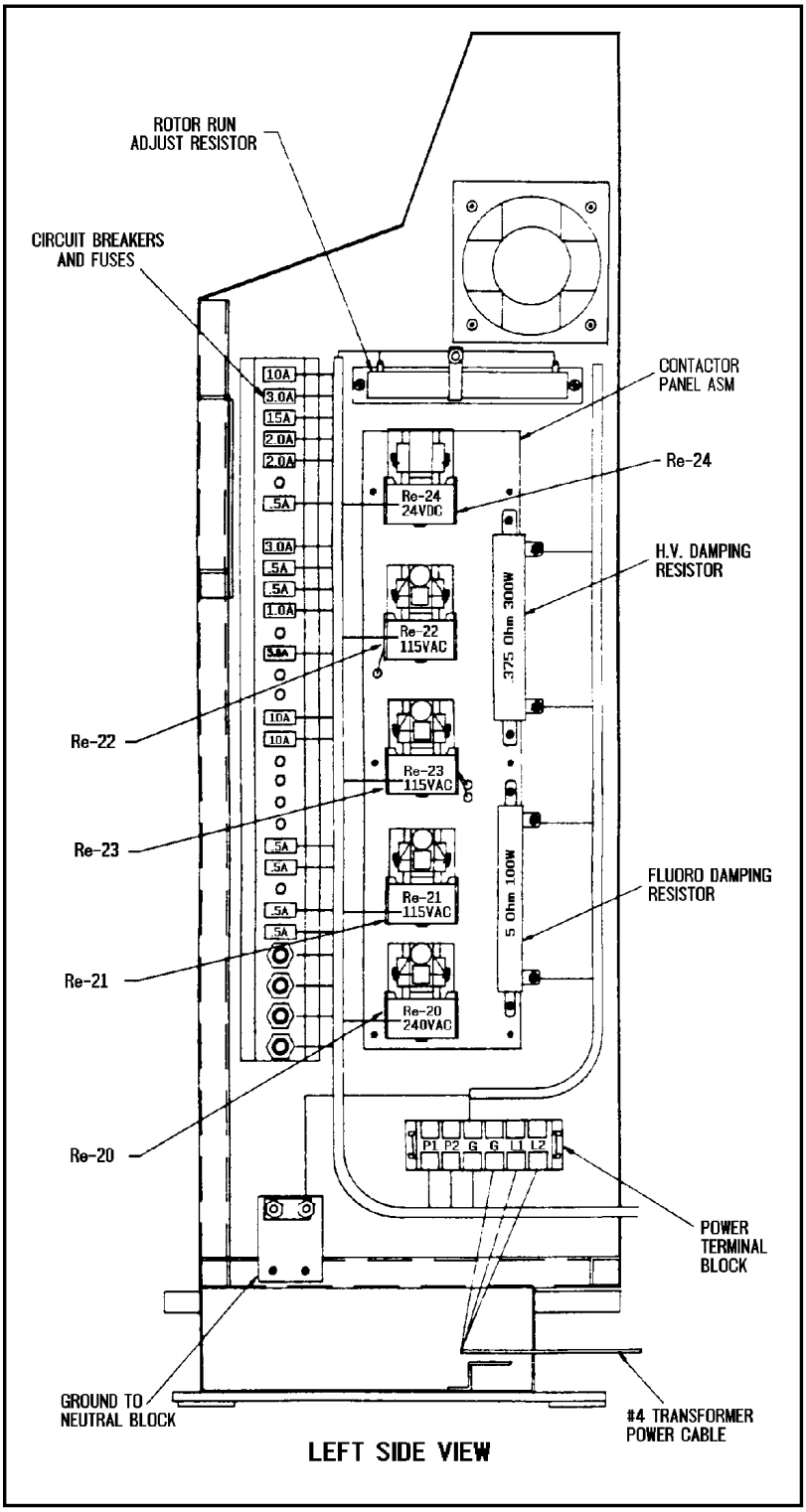
ROTOR RUN
ADJUST RESISTOR
CIRCUIT BREAKERS
AND FUSES
CONTACTOR
PANEL ASM
Re-24
H.V. DAMPING
RESISTOR
Re-22
Re-23
Re-21
Re-20
FLUORO DAMPING
RESISTOR
POWER
TERMINAL
BLOCK
GROUND TO
NEUTRAL BLOCK
#4 TRANSFORMER
POWER CABLE
10A
3.0A
1.5A
2.0A
2.0A
.5A
3.0A
.5A
.5A
1.0A
10A
10A
.5A
.5A
.5A
.5A
Re-24
24VDC
Re-22
115VAC
Re-23
115VAC
Re-21
115VAC
Re-20
240VAC
.375 Ohm 300W
5 Ohm 100W
P1 P2 G G L1 L2
LEFT SIDE VIEW

Figure 3-57

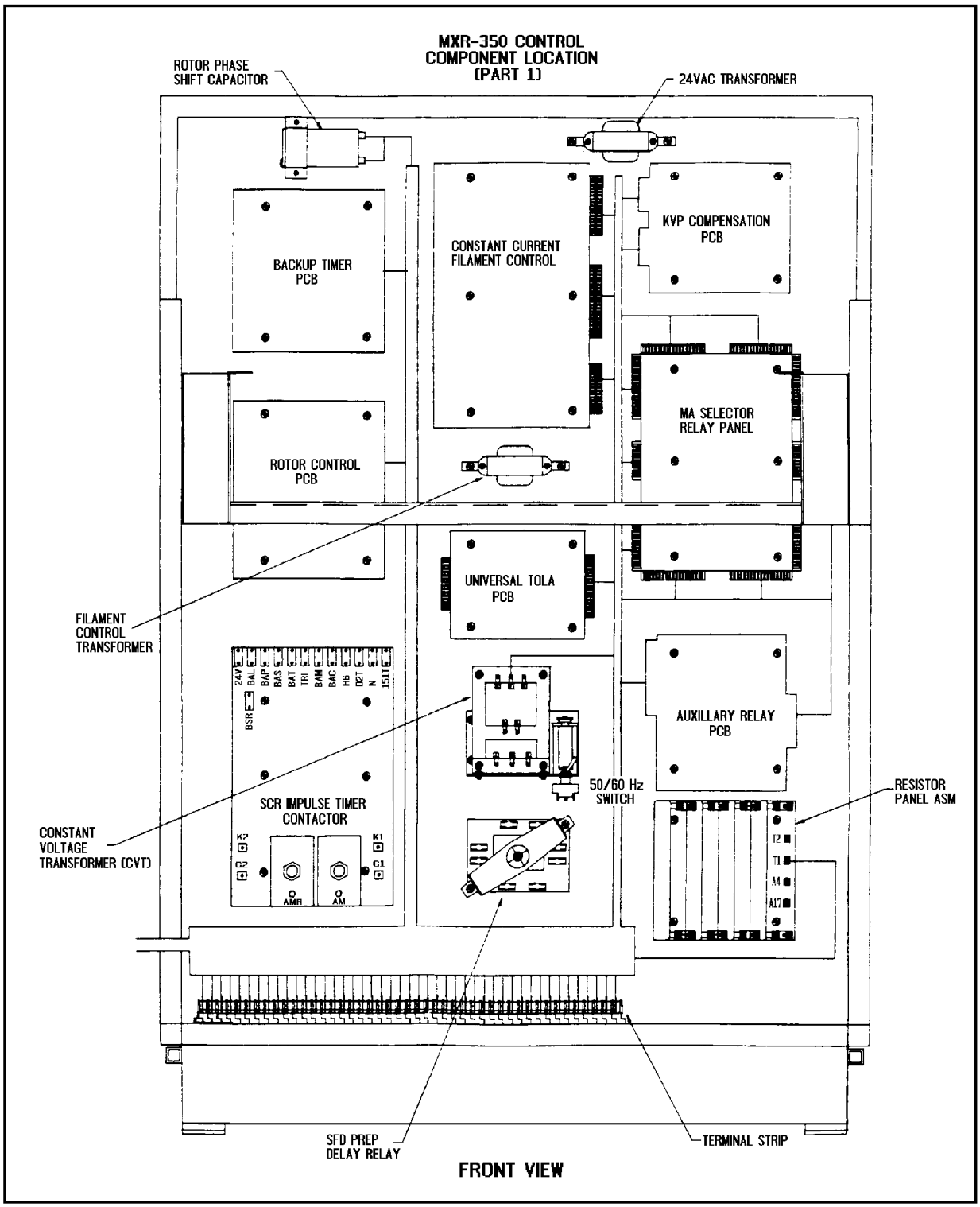

Figure 3-57 (Continued)

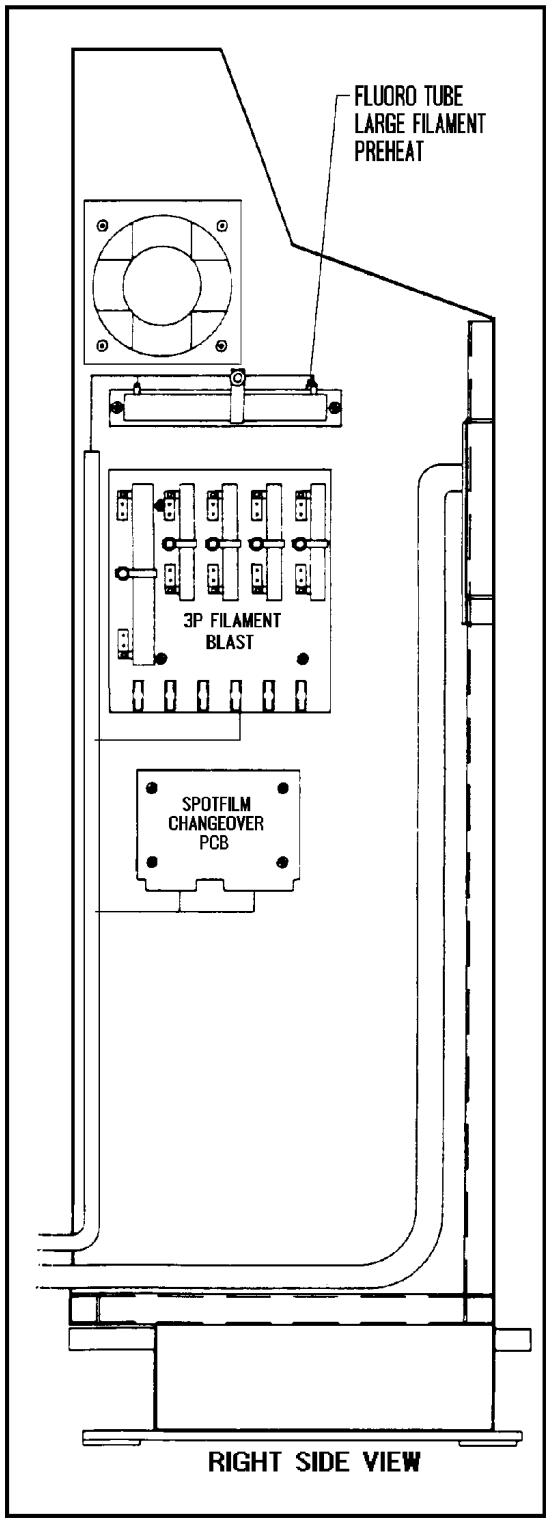

Figure 3-57 (Continued)

(b) Point the knob at <0> and hold it in place while turning the black cam with the wrench until the switch activates.

(12) Rotate the "Minutes" knob to <5>. Hold the knob and rotate the white cam with the wrench (clockwise to increase time; counterclockwise to decrease time, looking from the timer motor side) until the switch releases (makes a "click").

NOTE: This step allows the "Minutes" knob to operate at the 5 minute time set position.

NOTE: When converting from 60 Hz to 50 Hz, rotate the white cam counter- clockwise (looking from the timer motor side).

NOTE: When converting from 50 Hz to 60 Hz, rotate the white cam clockwise (looking form the timer motor side).

(13) Move the "Minutes" knob to <3> and verify the switch remains depressed.

NOTE: This completes the 50 or 60 Hz conversion.

b. Conduct tube warm-up.

CAUTION

Before calibration each X-ray tube must be warmed up. This will substantially reduce the possibility of damage to the X-ray tube anode caused by "hot spots" and uneven heating.

(1) Turn MAINS on and close the appropriate collimator blades.

(2) Select the 200L mA station, <70 kVp>, and <1/2 second>, with NO autotiming. Make three exposures at 20 second intervals.

(3) Raise to <80 kVp>. Make three exposures at 20 second intervals.

(4) Raise to <90 kVp>. Make three exposures at 20 second intervals.

(5) Raise to <100 kVp>. Make three exposures at 20 second intervals.

NOTE: This completes the warm up procedure.

c. Perform line compensation.

(1) Turn the MAINS off to the X-ray system and connect an AC volt meter between AC and AM (center taps from the major and minor kVp switches).

(2) Turn the major kVp and minor kVp controls fully clockwise and turn the MAINS on. If the volt meter does not read 288 (± 3) volts AC, adjust the Line Adjust Coarse and Fine controls until it does.

(3) Adjust P2 on the mA-kVp-Line Meter Shunt PCB (6284.234.12) to center the needle on the line meter. (See Figure 3-58.)

d. Determine line voltage drop.

NOTE: For accurate calibration it is necessary to determine the line voltage drop during an exposure. "Line drop" is expressed as a percentage of the "no load" line voltage.

(1) Turn the MAINS off and connect a voltmeter between L1 and L2 on the terminal strip inside the main control. (See Figure 3-57.) Select an AC scale that includes the incoming line voltage.

(2) Turn the system on and ensure that line compensation has been correctly set. (See step 2d.)

(3) Measure the incoming line voltage; record at step 2e(5) as "Vnl" (voltage with no load).

(4) Make an exposure with the over-table tube at 300L mA, <75 kVp>, for <1 second>, while observing the voltmeter. Record line voltage during exposure as "VI" (voltage under load).

NOTE: To calculate the line drop correctly in the following formula, note that the ratio is multiplied by 200, instead of 100. This compensates for making the exposure at 75 kVp or 50% of maximum load of the allowable kVp (150 kVp).

(5) No Load (Vnl):_____Load (VI)_____

(6) Calculate line drop using the following formula:

$$\frac{(Vnl - Vl) \times 200}{Vl} = \% \text{ line drop}$$

(7) Use the calculated percentage line drop to select the Kvp calibration table to be used during calibration of kVp compensation. (See Table 3-9.)

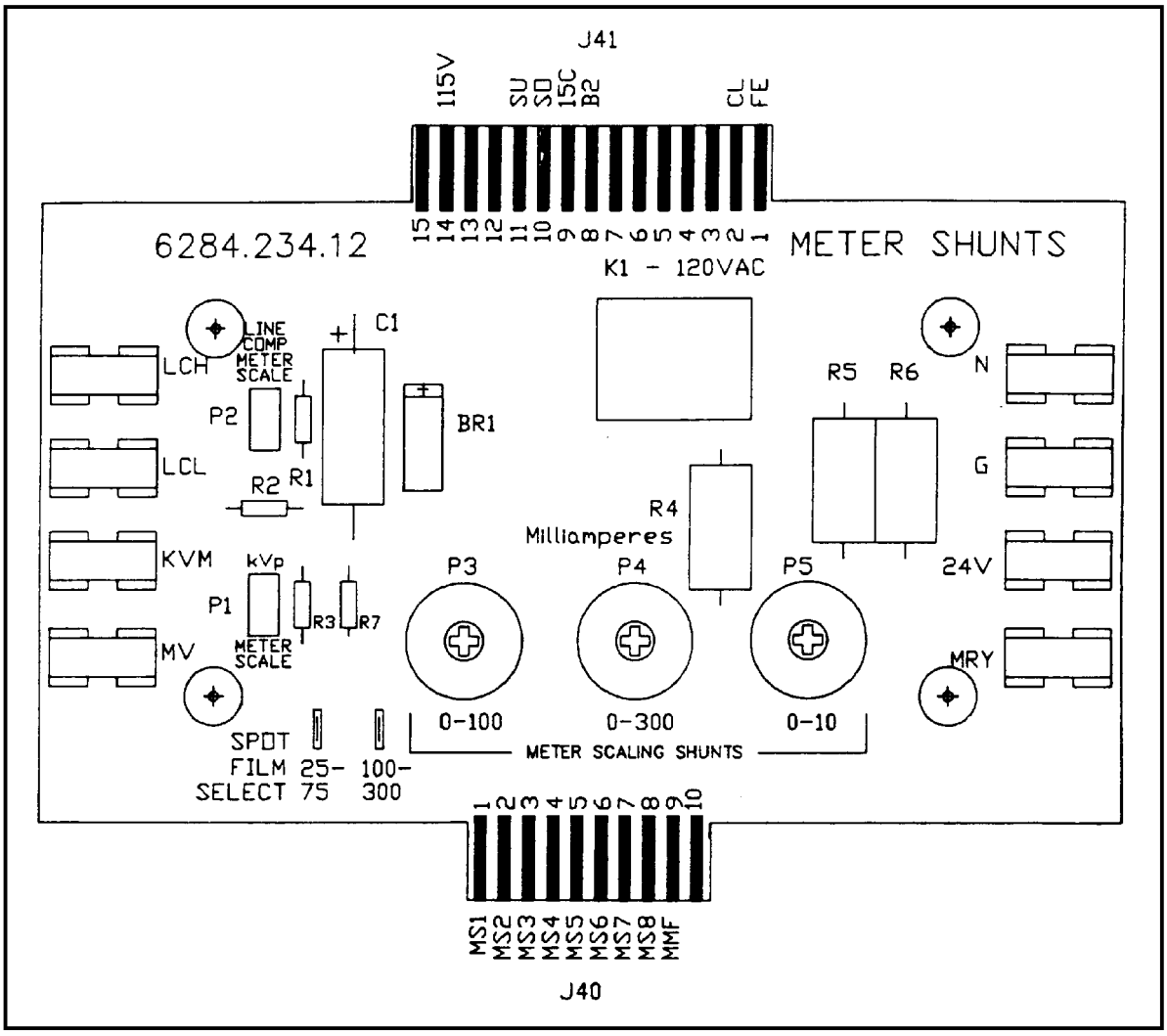

Figure 3-58

e. Perform rotor boost time adjustment.

NOTE: Refer to Figure 3-59 for location of ROTOR CONTROL PCB (6284.234.09). Its placement is shown in Figure 3-57, front view.

(1) Perform overtable tube rotor boost time adjustment.

(a) Turn the MAINS off.

(b) Connect a scope and an AC voltmeter across O7 and N on the Rotor Control PCB (6284.234.09). (See Figure 3-59.)

(c) Set the voltmeter to read at least 300 VAC.

(d) Set the oscilloscope to display 100 volts/div. at a sweep rate of 200 msec/div.

NOTE: All meter readings in this section should be within 5% tolerance to be considered acceptable.

(e) Turn the MAINS on.

(f) Select the 200L mA station, <80 kVp>, <1/10th second>.

(g) Press PREPARE. The oscilloscope should display approximately 650 VAC peak-to-peak for approximately 1.5 seconds, and then drop it to approximately 150 peak-to-peak. (See Figure 3-60.)

(h) Proceed to step 2f(2) if the requirements in step 2f(1)(g) are met. Proceed to step 2f(1)(i) if those requirements are not met.

(i) Locate pot P1 (Boost Time) on the Rotor Control PCB. Using the same technique, 200L mA, <80 kVp> and <1/10th second>, press and hold PREPARE.

(j) Adjust pot P1 on the Rotor Control PCB for a 1.5 second boost time. At the END of boost time, the green lamp inside the PREPARE push button should illuminate.

CAUTION

Turn off the MAINS before performing the following steps. Adjust the resistor with the power off. Do **NOT** turn the MAINS on to read the setting until hands are clear. Several attempts may be necessary.

(k) Using the voltmeter, adjust the 10 ohm 100 watt Rotor Run resistor, located immediately below the left side cooling fan inside the main control, for 50 (±2) VAC rotor run voltage. (See Figure 3-57.)

NOTE: There is no adjustment for rotor boost voltage.

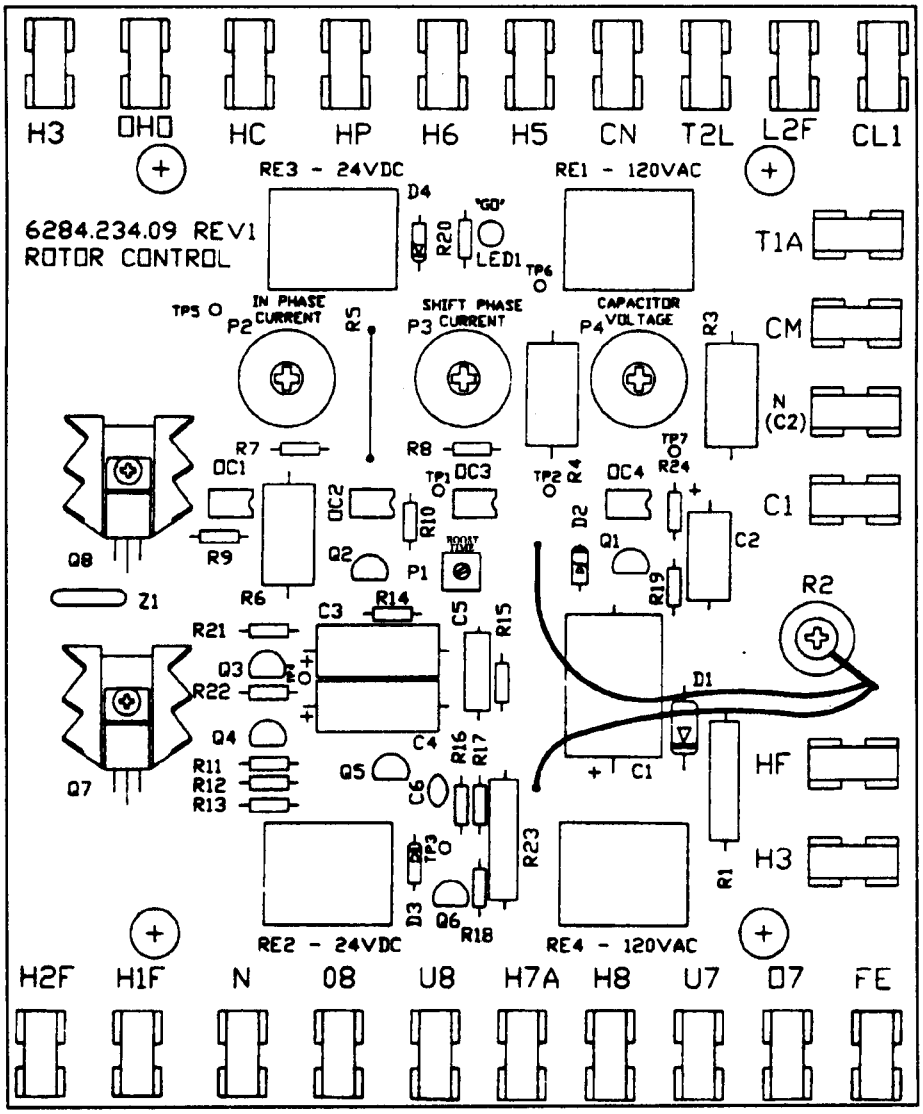
H3
OHO
HC
HP
H6
H5
CN
T2L
L2F
CL1
RE3 - 24VDC
RE1 - 120VAC
6284.234.09 REV1
ROTOR CONTROL
D4
R20
"GO"
LED1
TP6
T1A
TP5
IN PHASE CURRENT
P2
R5
SHIFT PHASE CURRENT
P3
CAPACITOR VOLTAGE
P4
R3
CM
N (C2)
R7
R8
TP7
R24
OC1
OC2
TP1
OC3
TP2
R4
OC4
C1
D2
Q1
C2
Q8
R9
Q2
R10
P1
R6
Z1
R19
R2
C3
R14
C5
R15
R21
Q3
R22
D1
C4
R16
R17
Q4
R11
R12
R13
Q5
C6
Q7
HF
+ C1
TP3
R23
R1
H3
D3
Q6
R18
RE2 - 24VDC
RE4 - 120VAC
H2F
H1F
N
08
U8
H7A
H8
U7
07
FE

Figure 3-59

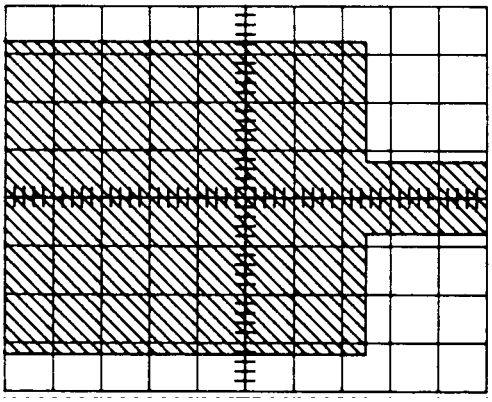

Figure 3-60

(l) With the PREPARE button depressed, adjust pot P2 (in Phase Current) on the Rotor Control PCB counterclockwise until the PREPARE lamp goes out and then back clockwise until the lamp illuminates again.

NOTE: Over adjust slightly in the ON direction--clockwise.

(m) With the PREPARE button depressed, adjust pot P3 (Shift Phase Current) on the Rotor Control PCB counterclockwise until the PREPARE lamp goes out and then back clockwise until the lamp illuminates again.

NOTE: Over adjust slightly in the ON direction--clockwise.

(n) Turn the MAINS off and install a jumper wire between H7A and H8 on the Rotor Control PCB. Turn the MAINS on and press the PREPARE push button. Verify that the PREPARE push button does not light. If PREPARE illuminates, repeat steps 2f(1)(l) through 2f(1)(n) until it does not.

(o) Turn the MAINS off. Remove the AC voltmeter and jumper wire from H7A and H8.

(2) Perform under-table tube rotor boost time adjustment.

(a) Ensure the MAINS are turned OFF.

NOTE: The oscilloscope and voltmeter should still be attached from the over the tube rotor boost time adjustment. Ensure the scope and the AC voltmeter are across O7 and N on the Rotor Control PCB (6284.234.09). (See Figure 3-59.)

(b) Set the voltmeter to read at least 300 VAC and set the oscilloscope to display 100 volts/div. at a sweeprate of 200 msec/div.

NOTE: All meter readings in this section should be within 5% tolerance to be considered acceptable.

(c) Turn the MAINS on.

(d) Select the 200L SPOT mA, <80 kVp>, <1/10th second> and ensure the green LED ("GO"-LED1) on the Rotor Control PCB (6284.234.09) is illuminated 1.5 seconds after the SPOT mA station is selected, and continuously thereafter.

(e) Ensure the voltmeter displays 230 volts AC (boost voltage) for approximately 1.5 seconds beginning when the 200L SPOT mA station is selected; then drop it to 50 volts AC (run voltage).

(f) Ensure the scope displays 650 volts AC peak-to-peak for 7.5 divisions, and then drops to 150 volts AC peak-to-peak. (See Figure 3-60).

(g) Proceed to step 2g if these readings are satisfactory; otherwise, repeat step 2f(1)(k), as necessary.

g. Adjust radiographic kVp and mA meters.

NOTE: The voltage measurement and adjustment points for the radiographic kVp meter are on the mA/kVp/Line Shunt Meter PCB (6284.234.12). (See Figure 3-57 for location of the board.)

(1) Turn the MAINS off and connect a voltmeter across MRY and MV on the mA/kvp/Line Shunt Meter PCB (6284.234.12) with the positive lead on MRY. (See Figure 3-58.) Set the voltmeter range to read at least 50 volts DC.

(2) Turn the MAINS on. Select 25S mA and <1/10 second>.

(3) Rotate the major and minor kVp selector switches until 50 volts DC (+0.3 volts) is read on the voltmeter. (See Figure 3-61.)

(4) Adjust P1 (Meter Scale) on the mA/kVp/Line Shunt Meter PCB (6284.234.12) for 150 kVp. (See Figure 3-58.) The radiographic kVp meter is now calibrated.

(5) Turn the MAINS off and disconnect the power cable and the control cable, P22 and P23 connectors, at the high voltage transformer.

(6) Disconnect M1 on the main terminal strip, on the lower inside of the control, and remove the card edge connectors from the left side of the Exposure Interlock PCB (6284.234.04). (See Figures 3-61 and 3-62.)

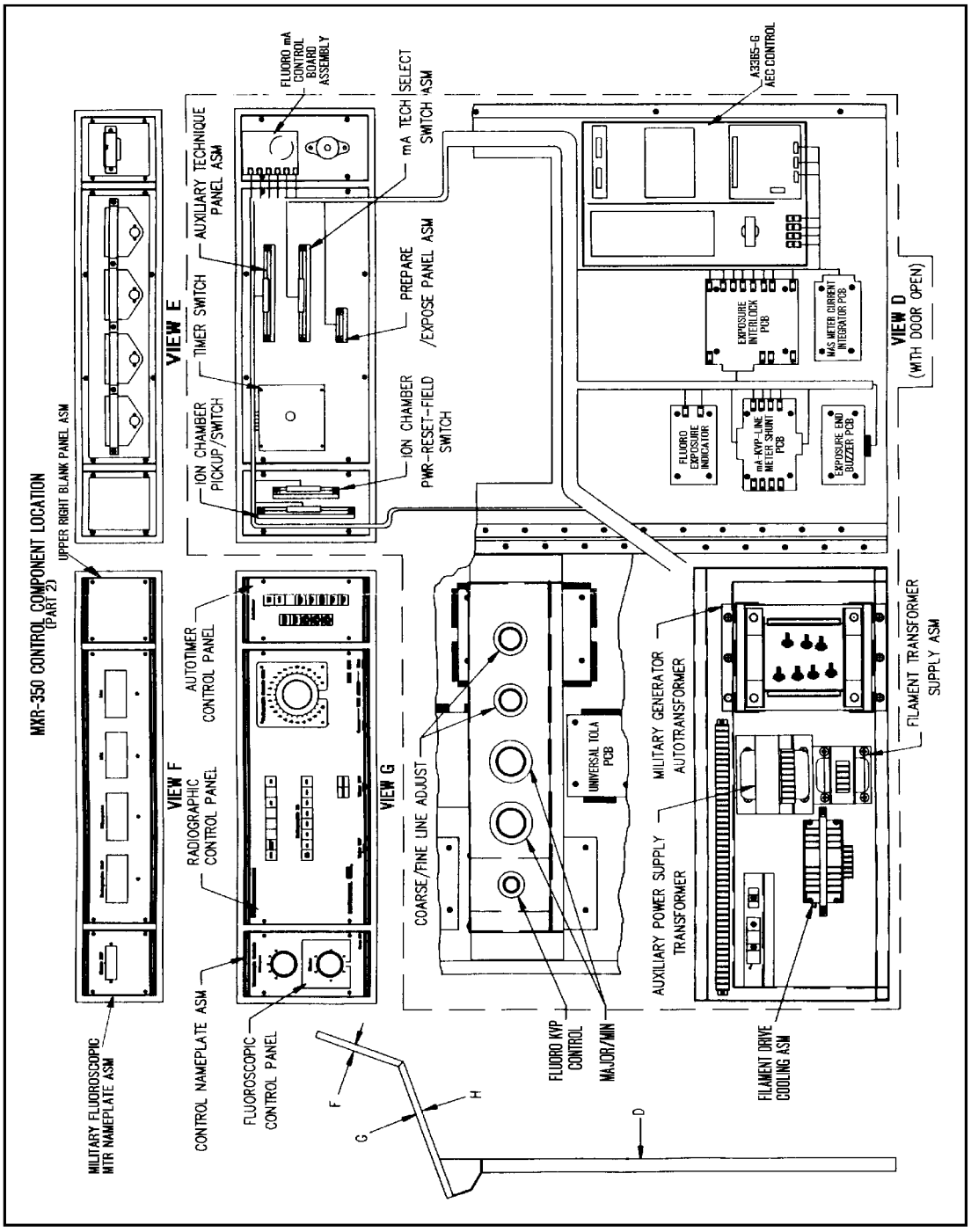
MXR-350 CONTROL COMPONENT LOCATION
(PART 2)
UPPER RIGHT BLANK PANEL ASM
VIEW E
AUXILIARY TECHNIQUE PANEL ASM
TIMER SWITCH
ION CHAMBER PICKUP/SWITCH
FLUORO mA CONTROL BOARD ASSEMBLY
mA TECH SELECT SWITCH ASM
PREPARE /EXPOSE PANEL ASM
ION CHAMBER PWR-RESET-FIELD SWITCH
A3385-G AEC CONTROL
VIEW D
(WITH DOOR OPEN)
EXPOSURE INTERLOCK PCB
mAS METER CURRENT INTEGRATOR PCB
FLUORO EXPOSURE INDICATOR
mA-KVP-LINE METER SHUNT PCB
EXPOSURE END BUZZER PCB
VIEW F
RADIOGRAPHIC CONTROL PANEL
AUTOTIMER CONTROL PANEL
VIEW G
COARSE/FINE LINE ADJUST
UNIVERSAL TOLA PCB
MILITARY GENERATOR AUTOTRANSFORMER
FILAMENT TRANSFORMER SUPPLY ASM
AUXILIARY POWER SUPPLY TRANSFORMER
MILITARY FLUOROSCOPIC MTR NAMEPLATE ASM
CONTROL NAMEPLATE ASM
FLUOROSCOPIC CONTROL PANEL
FLUORO KVP CONTROL
MA/OR/MIN
FILAMENT DRIVE COOLING ASM
F
G
H
D

Figure 3-61

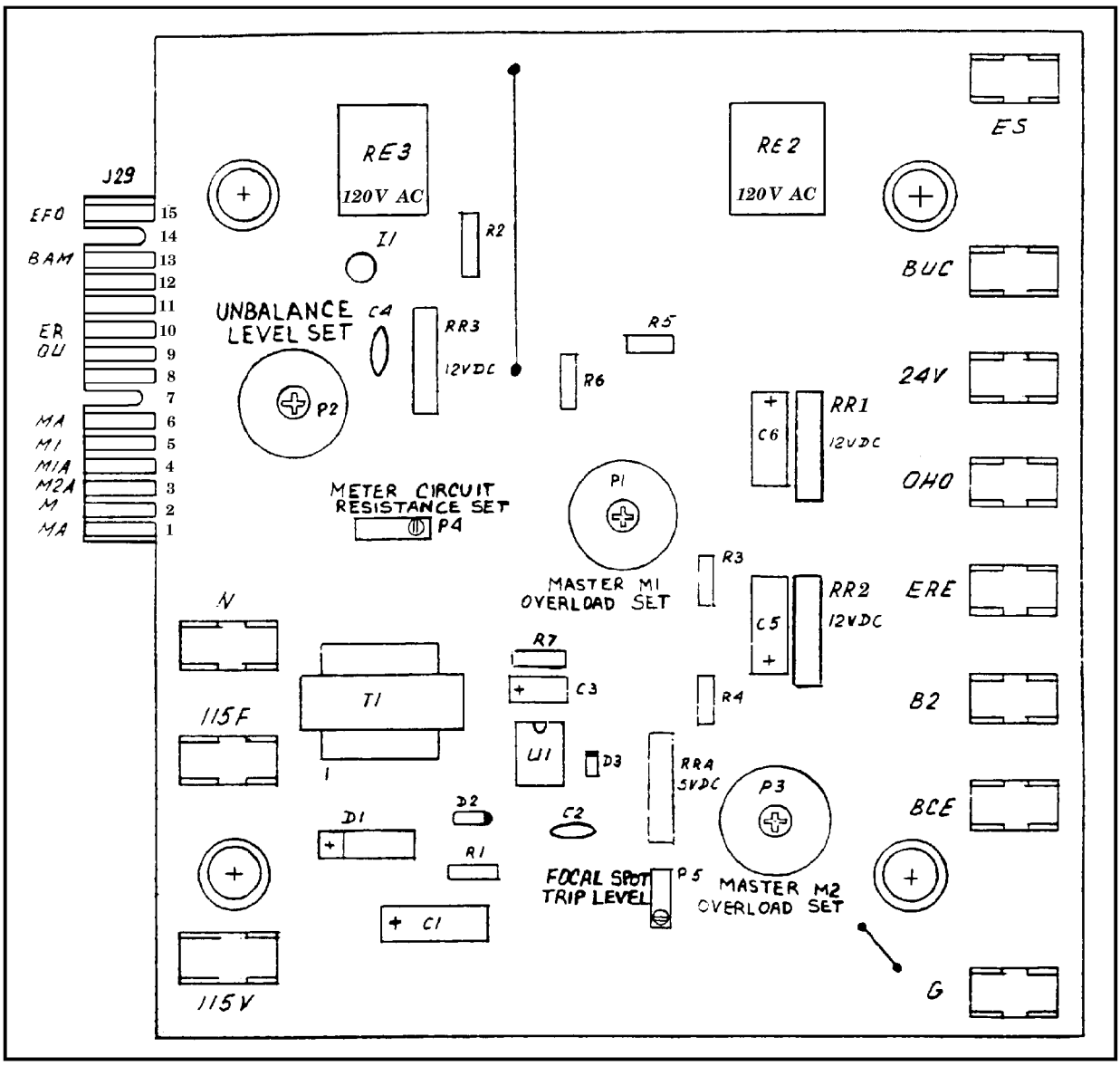

Figure 3-62

(7) Connect an ohmmeter between terminals J29-2 and J29-6 on the Exposure Interlock PCB (6824.234.04) and adjust potentiometer (pot) P4 on Exposure Interlock PCB (6824.234.04) until the ohmmeter reads 6,000 ohms resistance. Reconnect the edge connector.

(8) Connect a DC milliammeter to terminal M1 in series with the positive lead of an adjustable DC current source. Connect the negative lead of the current source to G (any convenient ground source on the terminal strip).

NOTE: Depending on the type of current source used, it may be necessary to readjust the current source after the pot adjustment.

(9) Turn the MAINS on and select 200L SPOT. Set the current source to 7.5 mA, as read on the multimeter.

(10) Read the control's mA meter on the 10 mA scale and adjust pot P5 on mA/kVp/Line Meter Shunt (6284.234.12), until it reads 7.5 mA. (See Figure 3-58.)

(11) Select 50S mA and adjust the current source to 75 mA, as read on the multimeter. Adjust pot P3, on mA/kVp/Line Meter Shunt (6284.234.12), until it reads 75 mA on the 100 mA scale of the control's mA meter.

(12) Select 300L mA and adjust the current source to 300 mA, as read on the multimeter. Adjust pot P4, on mA/kVp/Line Meter Shunt (6284.234.12), until it reads 300 mA on the 400 mA scale of the control's mA meter.

(13) Turn the MAINS off and reconnect P22 and P23 to the high voltage transformer.

g. Conduct mA overload adjustment.

NOTE: There are three separate mA overload sensing systems, the M1 overall, the M2 overall, and the focal spot overload. Each system has its own adjustments.

(1) Ensure the MAINS are off. Leave or install the current source on M1 and G on the main terminal strip. (See step 2g(8).)

(2) Connect a jumper wire on the Exposure Interlock PCB (6824.234.04), used from M1 (negative end of C6) and terminal G on the board. (See Figure 3-62.) This will bypass the focal spot overload.

(3) Turn the MAINS on and select 300L mA.

(4) Adjust the current source to 360 mA and adjust the pot P1, on the Exposure Interlock PCB (6284.234.04) until SAFETY RESET illuminates and will not illuminate for values less than 360 mA. (See Figure 3-62.)

(5) The M1 overall protection is set.

(6) Turn the MAINS off, remove the jumper wire, and reconnect it between M1 and M1A on the main terminal strip.

NOTE: This will bypass the M1 overload.

(7) Turn the MAINS on. Adjust pot P5 on the Exposure Interlock PCB (6284.234.04) until the SAFETY RESET illuminates for values above 360 mA and does not illuminate for values less than 360 mA. (See Figure 3-62.)

(8) Turn the MAINS off and remove the jumper wire.

(9) The focal spot overload is now set.

(10) Connect the negative lead of the current source to M2 and the positive lead to G on the main terminal strip located in the lower inside of the control.

(11) Turn the MAINS on and adjust the current source to 360 mA.

(12) Adjust pot P3 on the Exposure Interlock PCB (6284.234.04) until SAFETY RESET illuminates for values above 360 mA and does not illuminate for values less than 360 mA. (See Figure 3-62.)

(13) Turn the MAINS off and remove all jumper wires.

(14) The M2 overload is now set.

h. Adjust end of exposure signal.

(1) Make a radiographic exposure.

NOTE: For CDRH compliance, an audible signal must be heard to indicate an exposure has been taken.

(2) If the audible signal is too long or too short, adjust pot P1 (Duration) for a signal tone duration on the Exposure End Buzzer PCB (5184.234.2901). (See Figure 3-63.)

(3) If the audible signal is too loud or too soft, adjust pot P2 (loudness) for a signal tone duration on the Exposure End Buzzer PCB (5184.234.2901).

(4) Turn the MAINS off.

i. Perform tube overload adjustment (TOLA).

(1) Turn the MAINS on and insert the techniques shown in the TOLA Adjustment Table one at a time for all mA stations. (See Table 3-2.)

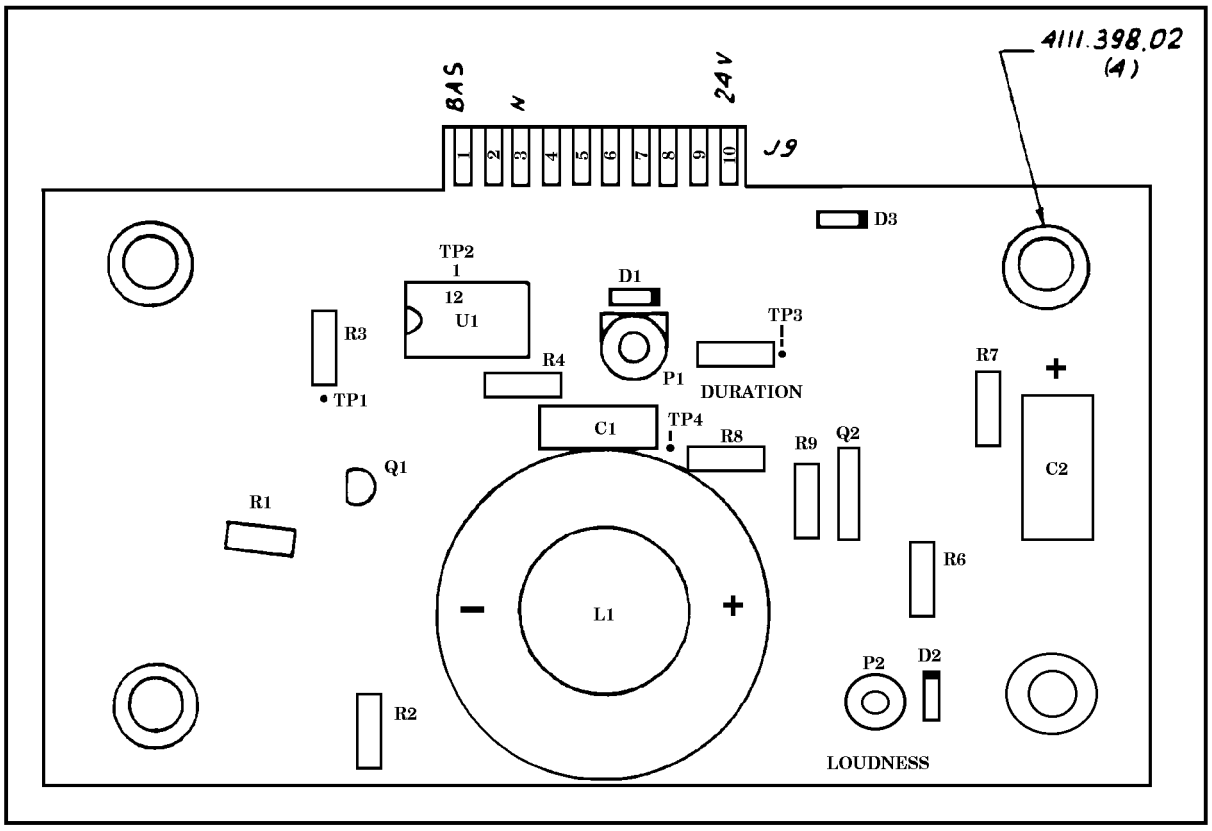

Figure 3-63

NOTE: The TOLA adjustment table is used to check the overload safety circuits at the 101% loading point.

(2) Ensure the SAFETY RESET lamp is not illuminated when exposures are made of the techniques shown in the table.

(3) If the techniques shown are increased by one mA station, three kVp, or one time station, the SAFETY RESET lamp must illuminate.

(4) If the lamp illuminates or fails to illuminate at the increased setting, adjust the potentiometer indicated on the Universal TOLA assembly PCB located in the main control. (See Figure 3-64.)

(5) Turn the MAINS off.

	MAXIMUM kVP					MAXIMUM TIME				
mA	60 Hz		50 Hz		Pot	60 Hz		50 Hz		Pot
Station	kVp	Time	kVp	Time	Adj	kVp	Time	kVp	Time	Adj
200L										
SPOT	149	2/3	142	3/5	P1	65	8.0	65	8.0	P11
25S	149	8.0	149	8.0	P2	149	8.0	149	8.0	P12
50S	149	8.0	149	6.0	P3	149	8.0	143	8.0	P13
100S	146	1½	149	1.0	P4	85	8.0	72	8.0	P14
100L	149	8.0	149	8.0	P5	149	8.0	149	8.0	P15
150L	144	3.0	143	1.0	P6	106	8.0	106	8.0	P16
200L	149	1.0	143	1.0	P7	82	8.0	77	8.0	P17
300L	149	2/15	149	2/25	P8	55	8.0	55	6.0	P18

Table 3-2. TOLA ADJUSTMENTS

j. Conduct radiographic timer (50 and 60 Hz) verification.

(1) Turn the MAINS off.

(2) Locate the Back-up Timer PCB (6284.234.0803), Figure 3-57, in the main control and disable the Back-up Timer by removing lead 3D from its terminal. (See Figure 3-65.)

(3) Turn the MAINS on.

(4) Select <85 kVp> and <150L> mA. Place the X-ray calibration timer in the center of the X-ray beam.

(5) Make an exposure at <1/120 second>. This should be precisely one pulse.

(6) Make an exposure at <1/60 second>. This should be precisely two pulses.

(7) Make an exposure at <2 seconds> (240 impulses). The X-ray calibration timer should read between 235 and 245 impulses (±2%).

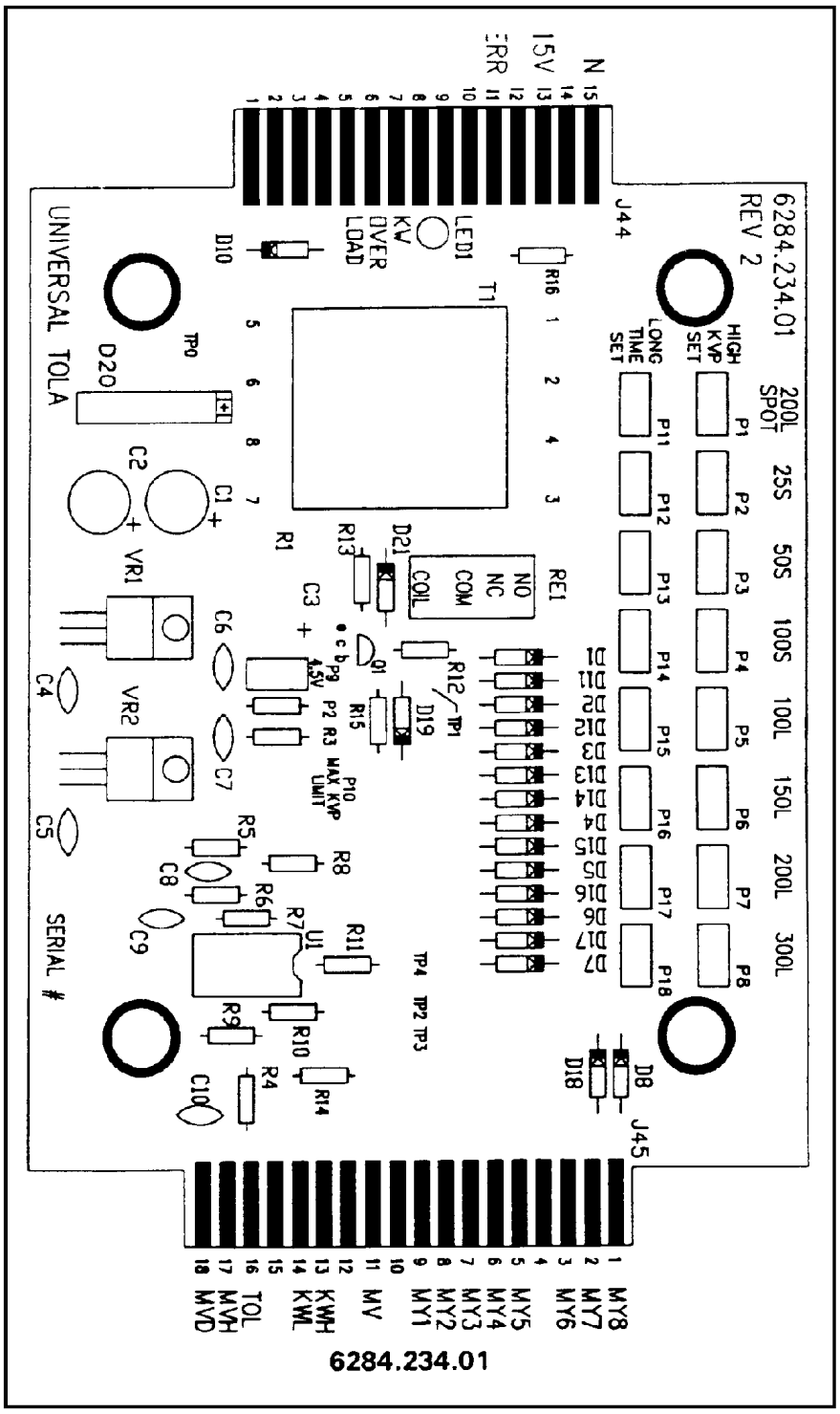
6284.234.01
REV 2
UNIVERSAL TOLA
SERIAL #
J44
J45
T1
U1
RE1
VR1
VR2
LED1
D20
D21
D19
D18
D8
Q1
TP0
TP1
TP2
TP3
TP4
P1
P2
P3
P4
P5
P6
P7
P8
P10
P11
P12
P13
P14
P15
P16
P17
P18
HIGH KVP SET
LONG TIME SET
200L SPOT
25S
50S
100S
100L
150L
200L
300L
MAX KVP LIMIT
KV OVER LOAD
15V
ERR
MY8
MY7
MY6
MY5
MY4
MY3
MY2
MY1
MV
KWH
KWL
TOL
MVH
MVD
6284.234.01

Figure 3-64

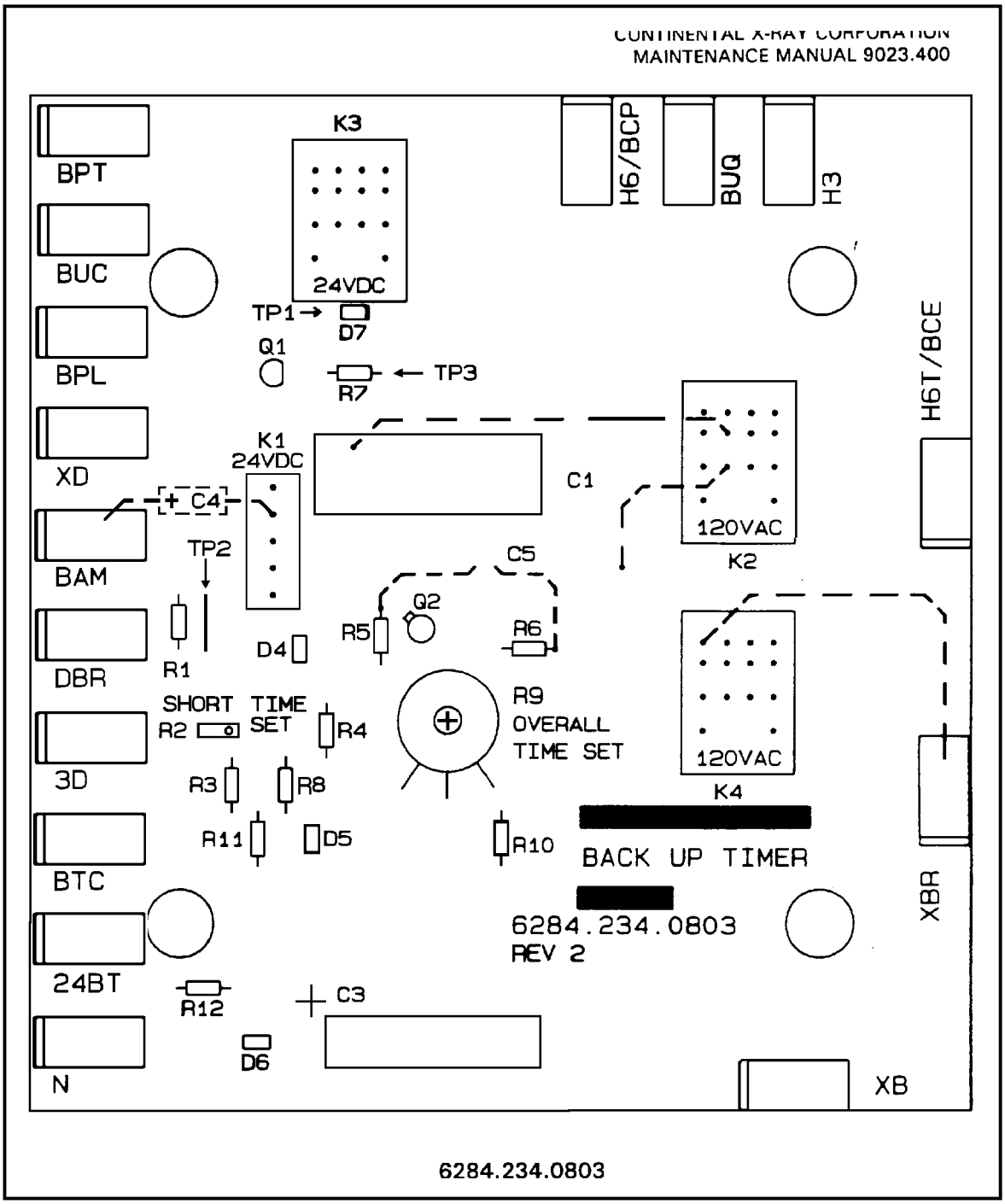
CONTINENTAL X-RAY CORPORATION
MAINTENANCE MANUAL 9023.400
K3
24VDC
H6/BCP
BUQ
H3
BPT
BUC
BPL
XD
BAM
DBR
3D
BTC
24BT
N
TP1
D7
Q1
R7
TP3
K1
24VDC
C4
TP2
R1
D4
C1
120VAC
K2
H6T/BCE
C5
Q2
R5
R6
SHORT TIME SET
R2
R4
R3
R8
R11
D5
R9
OVERALL TIME SET
R10
120VAC
K4
BACK UP TIMER
6284.234.0803
REV 2
XBR
R12
C3
D6
XB
6284.234.0803

Figure 3-65

(8) If these readings are correct, turn OFF the MAINS. Reconnect the 3D lead to its terminal on the Back-up Timer PCB (6284.234.0803) and proceed to step 2m for the 60 Hz Back-up Timer or step 2n for the 50 Hz Back-up Timer.

(9) If the readings are not correct, proceed to step 2k if the system is operating at 60 Hz or step 2l, if using 50 Hz power.

k. Conduct 60 Hz radiographic timer calibration.

NOTE: Follow this procedure only if the system is operating under 60 Hz power. If the system uses 50 Hz power, follow the instructions in step 2m below.

(1) Turn the MAINS off and locate the Back-up Timer PCB (6284.234.0803) in the main control. (See Figure 3-57.)

(2) Disable the Back-up Timer by removing lead 3D from its terminal. (See Figure 3-64.)

(3) Set the scope to 5 volts/division, vertical and 200 msec/division, horizontal, and connect the probe to M1 and the shield to G on the terminal strip.

(4) Turn the MAINS on.

(5) Select <80 kVp>, <200L> mA, and <1 second> technique. If the SAFETY RESET lamp illuminates, refer to step 2j.

(6) Press the PREPARE and EXPOSE push buttons and observe the oscilloscope display. The display should be high at the start of exposure, remain high for the duration of the exposure, and return low at the end of the exposure. (See Figure 3-66 for proper waveform appearance.)

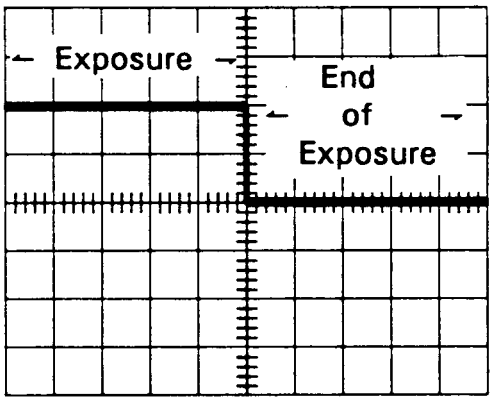

Figure 3-66

(7) The duration of the high should be 1 second, ±5%. If it is not, adjust port P1 (Overall Time) on the Single Phase Impulse Timer PCB (5184.234.12). (See Figure 3-67.)

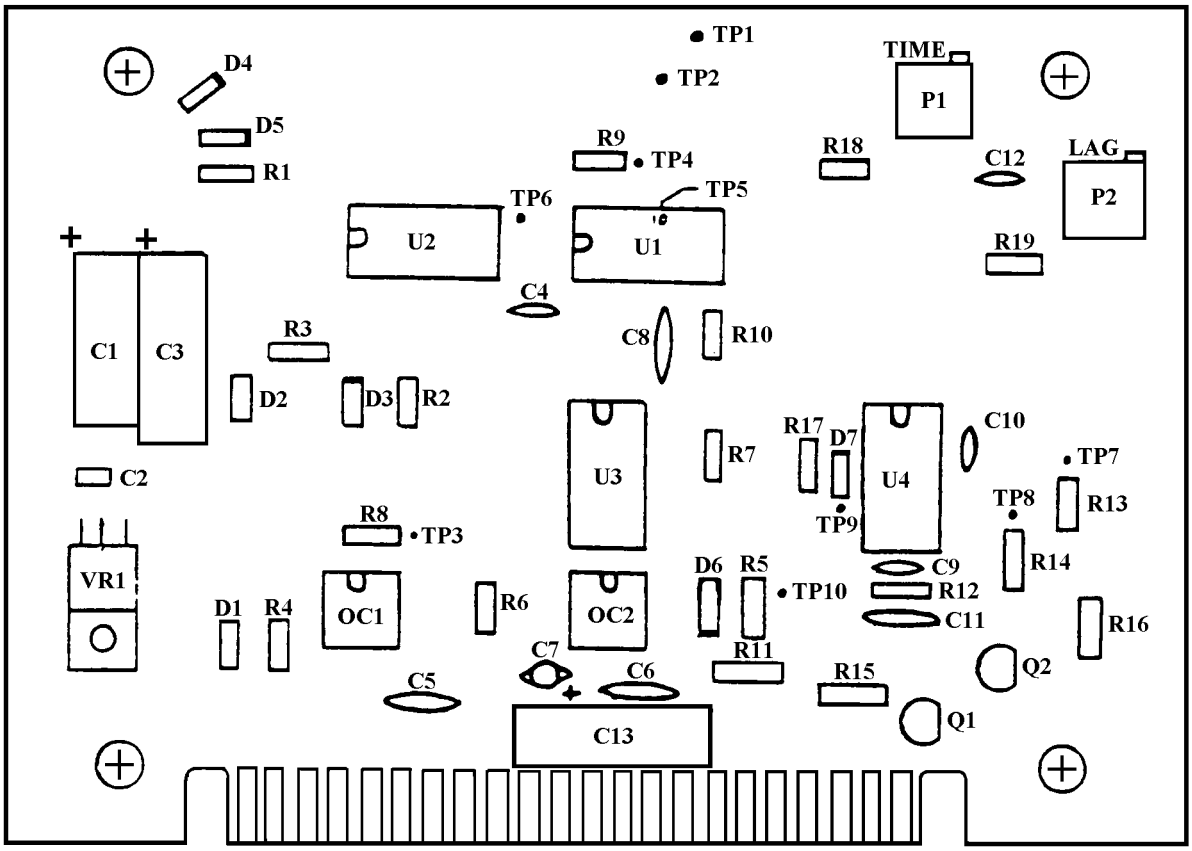

Figure 3-67

(8) Select <1/120th second> on the time select dial.

(9) If the SAFETY RESET lamp is illuminated, refer to step 2j.

(10) Set the horizontal sweep on the scope to 2 msec/division.

(11) Depress the PREPARE and EXPOSE push buttons and observe the waveform on the oscilloscope. It should be high for more than 6 mseconds (mesc) and less than 8.3 mseconds, then return to low. (See Figure 3-68.)

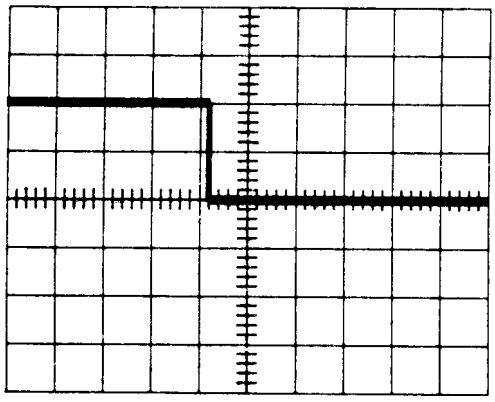

Figure 3-68

(12) If the display is not as described, adjust pot P2 (Short Time) on the same PCB for the correct display.

(13) If pot P2 (Short Time) was adjusted, repeat the procedures for verification of "overall" time. Repeat adjustments until satisfactory results are obtained for both settings.

(14) Turn the MAINS off and reconnect lead 3D to its terminal on the Back-up Timer PCB. (See Figure 3-65.)

l. Conduct the 50 Hz radiographic timer calibration.

NOTE: Follow this procedure only if the system is operating under 50 Hz power. If the system uses 60 Hz power, follow the instructions in step 2l above.

(1) Turn MAINS off and locate the Back-up Timer PCB (6284.234.0803) in the main control. (See Figure 3-57.)

(2) Disable the Back-up Timer by removing lead 3D from its terminal. (See Figure 3-65.)

(3) Set the scope to 5 volts/division, vertical and 200 msec/division, horizontal.

(4) Turn the MAINS on and select <80 kVp>, <200L> ma, and <1 second> technique.

(5) If the SAFETY RESET lamp illuminates, refer to step 2j.

(6) Press the PREPARE and EXPOSE push buttons and observe the oscilloscope display. The display should be high at the start of exposure, remain high for the duration of the exposure, and return to low at the end of the exposure. (See Figure 3-66 for proper waveform appearance.)

(7) The duration of the high should be 1 second, ±5%. If it is not, adjust pot P1 (Overall Time) on the Single Phase Impulse Timer PCB (5184.234.12). (See Figure 3-67.)

(8) Select <1/100th second> on the time select dial leaving the remaining technique factors as they are.

(9) If the SAFETY RESET lamp is illuminated, refer to step 2j.

(10) Set the horizontal sweep on the scope to 2 msec/division.

(11) Depress the PREPARE and EXPOSE push buttons and observe the waveform on the oscilloscope. It should be high for more than 10 mseconds, then return to low. (See Figure 3-69.)

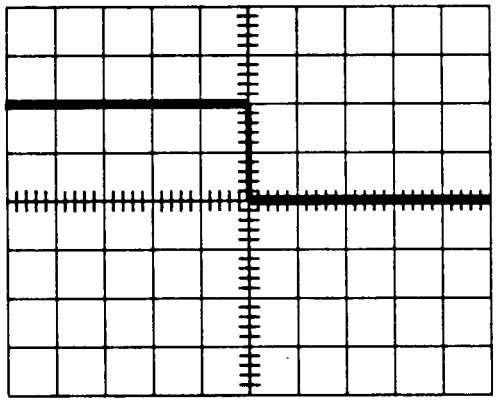

Figure 3-69

(12) If the display is not as described, adjust pot P2 (Short Time) on the same PCB (5184.234.12) for the correct display.

(13) If pot P2 (Short Time) was adjusted, repeat the procedures for verification of "overall" time. Repeat until satisfactory results are obtained for both settings.

(14) Turn the MAINS off.

m. Perform 60 Hz back-up timer calibration.

(1) Turn the MAINS off and connect channel 2 of the scope to TP1 (bar on D7 indicates cathode of D7) on the Back-up Timer PCB (6284.234.0803). (See Figure 3-65.)

(2) Connect channel 1 of the scope to TP 10 on the Single Phase Impulse Timer PCB. (See Figure 3-67.)

(3) Connect the external trigger input of the scope to terminal BAM on the SCR Impulse Timer PCB (5284.234.1102). (See Figure 3-70.)

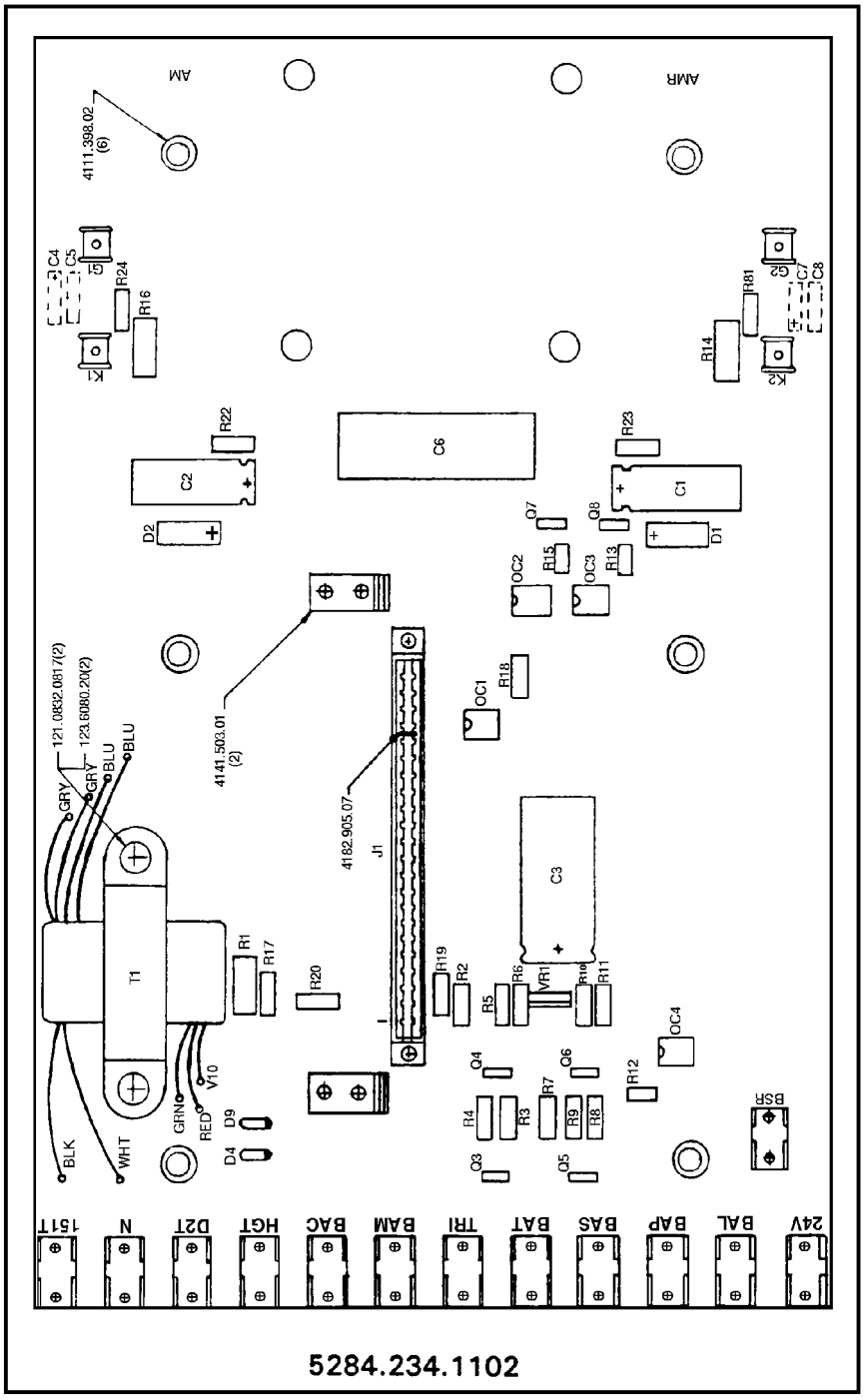
AM
AMR
4111.398.02 (6)
C4
C5
D5
R24
R16
K4
R22
C2
D2
C6
R23
C1
D1
Q7
Q8
OC2
R15
OC3
R13
K5
R14
R81
C7
C8
OC1
R18
4141.503.01 (2)
4182.905.07
J1
121.0832.0817(2)
123.6080.20(2)
GRY
GRY
BLU
BLU
T1
R1
R17
R20
R19
R2
C3
R6
VR1
R10
R11
R5
OC4
Q4
Q6
R12
R4
R3
R7
R9
R8
Q3
Q5
BSR
BLK
WHT
GRN
RED
V10
D9
D4
151T
N
D2T
HGT
BAC
BAM
TRI
BAT
BAS
BAP
BAL
24V
5284.234.1102

Figure 3-70

NOTE: This terminal is 24 VDC during exposure only.

(4) Set channel 1 of the scope to display 5 volts/division, channel 2 to 10 volts/division, and 200 msec/division, horizontal.

(5) Turn the MAINS on. Select 200L mA station, <80 kVp> and <4/5 second>.

(6) Make an exposure while observing the scope. If the display on channel 2 should end 1.5 horizontal divisions (300 ms) after the display on channel 1, proceed to step 2m(8). (See Figure 3-71 for correct scope reading.)

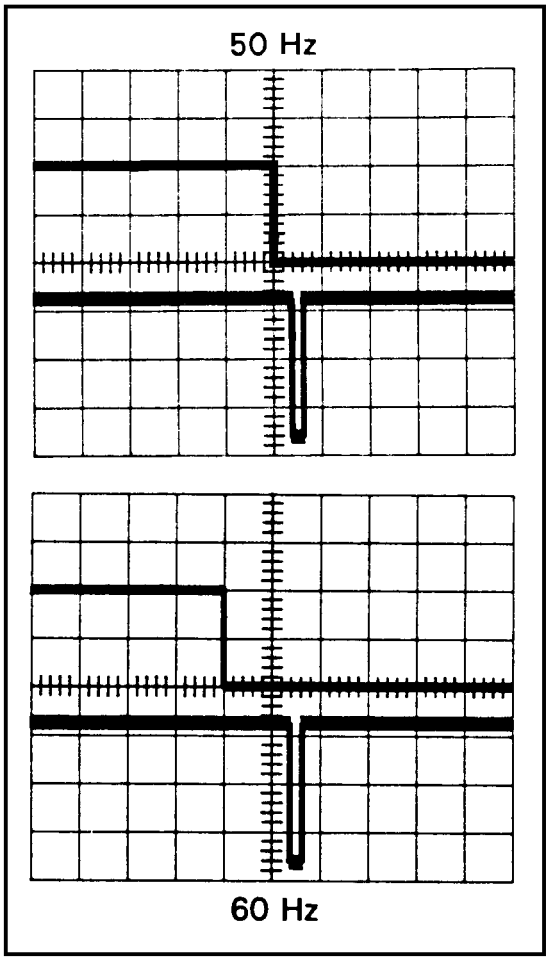

Figure 3-71

(7) If the display requirements are not met, adjust pot R9 (Overall Time Set) on the Back-up Timer PCB (6284.234.0803) and repeat step 2n(6). (See Figure 3-65.)

(8) Select <1/120th second> on the time select dial, leaving all other technique factors the same.

(9) Set the oscilloscope to display 5 msec/div., leaving the vertical display as is, and set the oscilloscope to trigger on channel 1.

(10) Depress the PREPARE and EXPOSE push buttons while observing the oscilloscope display.

(11) If the display on channel 2 should end 3 horizontal divisions (15 msec.) after the display on channel 1, proceed to step 2m(14). (Refer to Figure 3-72 for correct scope reading.)

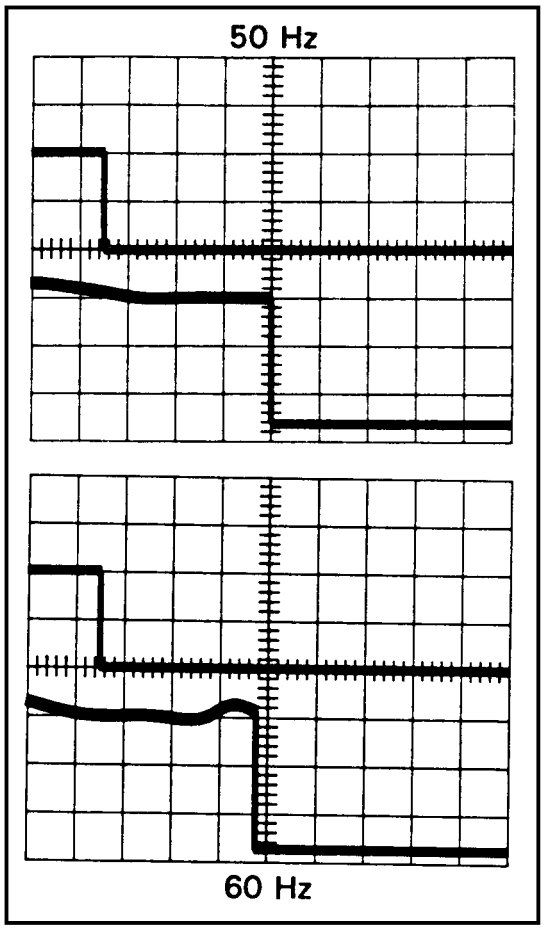

Figure 3-72

(12) If the requirements of step 2m(11) are not met, adjust pot R2 (Short Time Set) on the Back-up Timer PCB (6284.234.0803). (See Figure 3-65.)

(13) If pot R2 (Short Time Set) was adjusted, repeat the <4/5 second> procedure. Set the scope to display 200 msec/division, leaving the vertical display as is. Repeat this procedure beginning with step 2m(2).

(14) Turn the MAINS off, remove the test equipment, and reinstall J22 to the high voltage transformer.

(15) Proceed to step 3, if using noninvasive meters for calibration, or to step 4 if using a Dynalyzer.

n. Perform 50 Hz back-up timer calibration.

(1) Turn the MAINS off and connect channel 2 of the scope to TP1 (bar on D7 indicates cathode of D7) on the Back-up Timer PCB (6284.234.0803). (See Figure 3-65.)

(2) Connect channel 1 of the scope to TP 10 on the Single Phase Impulse Timer PCB (5184.234.12). (See Figure 3-67.)

(3) Connect the external trigger input of the scope to terminal BAM on the SCR Impulse Timer PCB (5284.234.1102). (See Figure 3-70.)

NOTE: This terminal is 24 VDC during exposure only.

(4) Set channel 1 of the scope to display 5 volts/division and set channel 2 of the scope to 10 volts/division and 200 msec/division, horizontal.

(5) Turn the MAINS on and select 200L mA station, <80 kVp> and <1 second>.

(6) Make an exposure while observing the scope. If the display on channel 2 should end 0.5 horizontal divisions (100 ms) after the display on channel 1, proceed to step 2n(8). (See Figure 3-71 for correct scope reading.)

(7) If the display on channel is not correct, adjust pot R9 (Overall Time Set) on the Back-up Timer PCB (6284.234.0803). (See Figure 3-65 and repeat step 6.)

(8) Select <1/100th second> on the time select dial leaving all other technique factors the same.

(9) Set the oscilloscope to display 5 msec/div leaving the vertical display as is.

(10) Set oscilloscope to trigger on channel 1.

(11) Depress the PREPARE and EXPOSE push buttons while observing the oscilloscope display.

(12) If the display on channel 2 should end 3 horizontal divisions (15 msec.) after the display on channel 1, proceed to step 2o(15). (See Figure 3-72 for correct scope reading.)

(13) If the display on channel 2 is not within requirements, adjust pot R2 (Short Time Set) on the Back-up Timer PCB (6284.234.0803). (See Figure 3-65.)

(14) If pot R2 (Short Time Set) was adjusted, repeat the 1 second procedure and set the scope to display 200 msec/division, leaving the vertical display as is. Repeat this procedure beginning with step 2n(2) until satisfactory results are achieved.

(15) Turn the MAINS off, remove the test equipment, and reinstall J22 to the high voltage transformer.

(16) At this point in the calibration procedure, it is necessary to follow the procedure for the type of test equipment used.

(a) Proceed to step 3 if using noninvasive meters for calibration.

(b) Proceed to step 4 if using a Dynalyzer.

3. Complete the calibration of the X-ray generator using noninvasive meters.

CAUTION

Each mA station must be calibrated for filament control, filament boost, space charge compensation, and kVp compensation. These adjustments are interactive and need to be performed as a set on each mA station.

NOTE: X-ray current skews at different kilovoltages, due to space charge effect. It is necessary to compensate for space charge effect by increasing the filament level at low kVps and decreasing it at high kVps. This is performed by a series of pot adjustments.

NOTE: Tables 3-4, 3-6, 3-7, and 3-8 may be photocopied to record the data required by the calibration procedures.

a. Install noninvasive meters.

NOTE: Always follow the manufacturer's instruction for installation and use of meters.

(1) Turn the MAINS off, remove wire M1 located on the terminal strip on the lower section of the inside rear of the control, and connect the meter leads of the mAs meter between the M1 terminal and the wire that was connected to M1 terminal. (See Figure 3-57.)

(2) Position the noninvasive kVp meter in the X-ray beam the indicated distance away from the X-ray tube as specified by the Focal Detector Distance (FDD) in the manufacturer's instructions.

b. Conduct over the table filament control calibration.

NOTE: Perform the following calibration steps only after verifying the radiographic timer. (See steps 2k through 2n.)

NOTE: The filament adjustments pots are located on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.) The PCB is physically located in the main control. (See Figure 3-57.)

c. Conduct space charge zero adjustment.

(1) Turn the MAINS off and connect a digital voltmeter across leads XD1 (22,J3) and XCC (7,J4) on the Constant Current Filament Control PCB, (6284.234.1009). (See Figure 3-73.)

(2) Turn the MAINS on and select 25S mA, <78 kVp>, and <2 seconds>.

(3) Adjust P30 (Space Charge Zero Adjust) on the Constant Current Filament Control PCB (6284.234.1009) until voltmeter reads (0) volts. (See Figure 3-73.)

NOTE: This is the zero space charge point. It needs to be set only once.

(4) Turn the MAINS off and remove the voltmeter.

d. Conduct exposure mAs calibration.

(1) Ensure the MAINS are turned off. Remove wire M1 located on the terminal strip on the lower section of the inside rear or the control and install the leads of Nuclear Associates mAs meter (Model 07-472) between the M1 terminal and the wire that was connected to M1 terminal in series with the M1 lead. (See Figure 3-57.)

(2) Turn the MAINS on and select 100L mA station, <80 kVp>, and <1/2 second>.

(3) Press and hold the mAs push button while making an exposure and observe the mAs meter while holding PREPARE, EXPOSE, and mAs after the exposure ends. It should read 50 mAs ±5%.

(4) If the mAs meter on the control panel drifts up or down, adjust pot P2 (Drift) accordingly on the mAs Current Integrator PCB. (See Figure 3-74 for zero indication.)

(5) Release all buttons and press mAs only. The mAs meter should read zero.

(6) Adjust pot P1 (Zero Adjustment), as necessary, on the mAs Current Integrator PCB for zero indication. (See Figure 3-74.)

(7) Compare the meter reading on the control to the digital mAs meter.

(8) Adjust pot P3, as necessary, on the mAs Current Integrator PCB (6184.234.0803) until the meter on the control panel equals that on the digital meter. (See Figure 3-74.)

(9) Make another exposure and adjust pot P3 (mAs Meter Adjustment) on the mAs Current Integrator PCB for 50 mAs ± 5%.

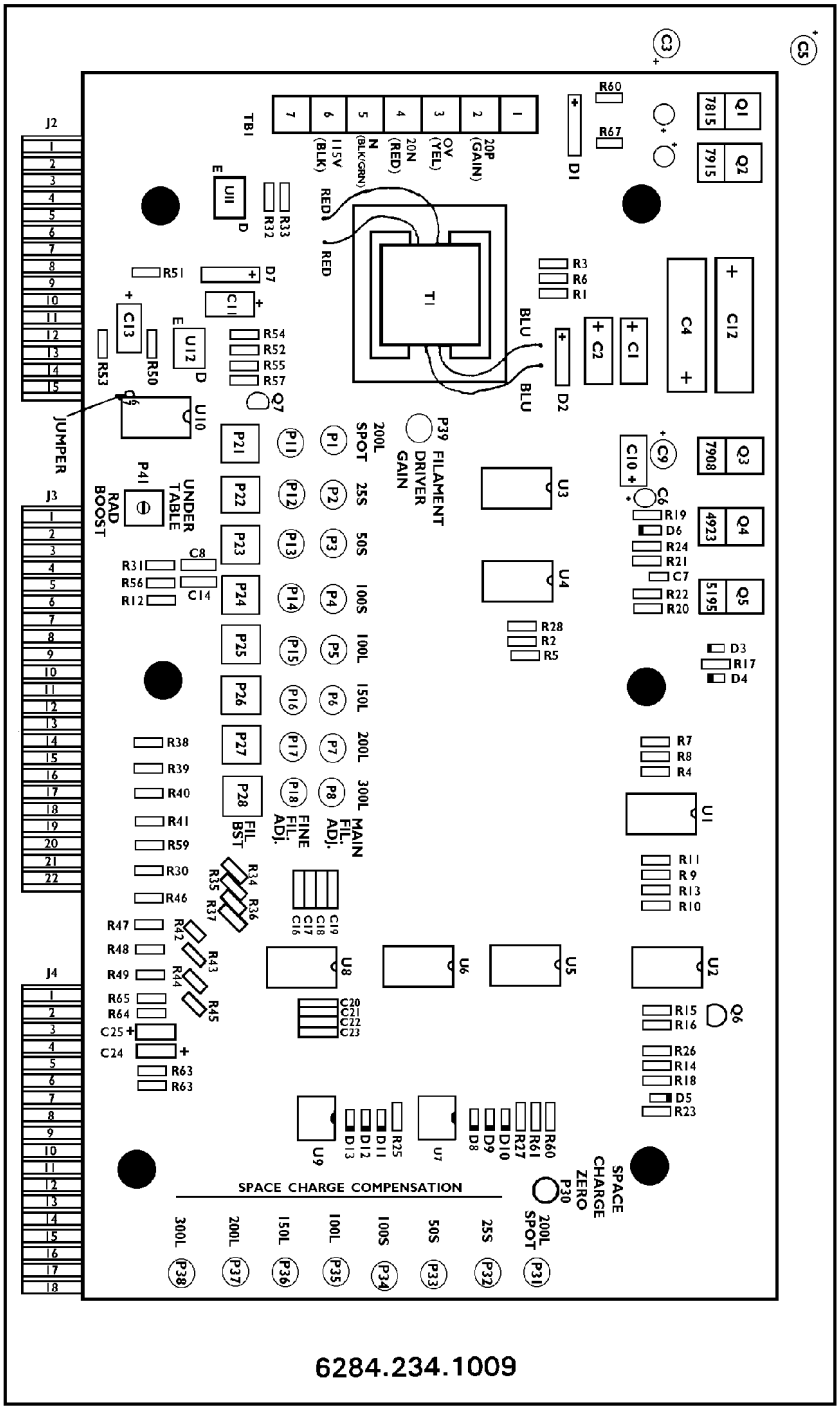
6284.234.1009
SPACE CHARGE COMPENSATION
SPACE CHARGE ZERO P30
FILAMENT DRIVER GAIN P39
UNDER TABLE RAD BOOST P41
JUMPER
FINE FIL. ADJ.
MAIN FIL. ADJ.
FIL BST
200L SPOT
25S
50S
100S
100L
150L
200L
300L
TB1
T1
J2
J3
J4

Figure 3-73

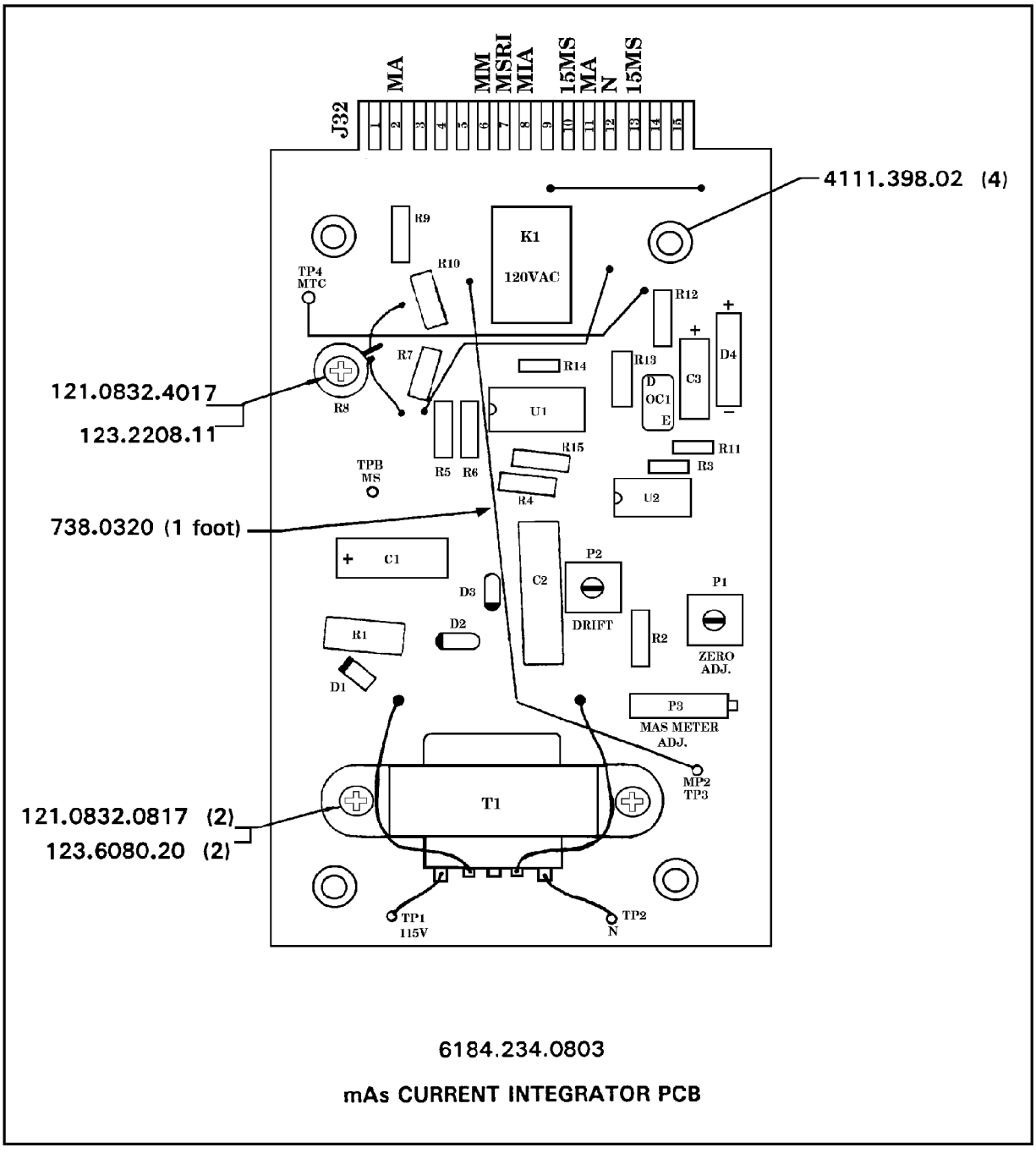
J32
MA
MM
MSRI
MIA
15MS
MA
N
15MS
4111.398.02 (4)
121.0832.4017
123.2208.11
738.0320 (1 foot)
121.0832.0817 (2)
123.6080.20 (2)
TP4
MTC
R9
R10
K1
120VAC
R12
R7
R8
R14
R13
D4
C3
D
OC1
E
U1
R5
R6
TPB
MS
R15
R4
R11
R3
U2
C1
D3
C2
P2
DRIFT
P1
ZERO
ADJ.
R1
D2
R2
D1
P3
MAS METER
ADJ.
MP2
TP3
T1
TP1
115V
TP2
N
6184.234.0803
mAs CURRENT INTEGRATOR PCB

Figure 3-74

e. Conduct filament boost adjustment.

NOTE: The following procedure allows adjustment of filament boost, using only a storage scope.

(1) Turn the MAINS off and connect channel 1 of a storage scope to M1 located on the terminal strip on the lower section of the inside rear of the control and the shield to the terminal labeled G (ground). (See Figure 3-57.)

(2) Refer to Table 3-3 for the list of scope settings and corresponding pot used in making the adjustments. Make all adjustments at <78 kVp> and <1/4 second> exposure.

(3) To adjust boost, start with 25S mA and make an exposure. Compare the output of scope with Figure 3-75 and adjust P22 on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.) Continue the adjustment until the output matches as closely as possible to the waveform labelled CORRECT.

mA Station	Scope Setting	Boost Pot
25S	1 volt/division 20 ms	P22
50S	2 volt/division 20 ms	P23
100S	2 volt/division 20 ms	P24
100L	2 volt/division 20 ms	P25
150L	2 volt/division 20 ms	P26
200L	2 volt/division 20 ms	P27
300L	5 volt/division 20 ms	P28
200L SPOT	2 volt/division 20 ms	P21

Table 3-3. FILAMENT BOOST ADJUSTMENT

(4) Using Table 3-3, continue making adjustments on all mA stations.

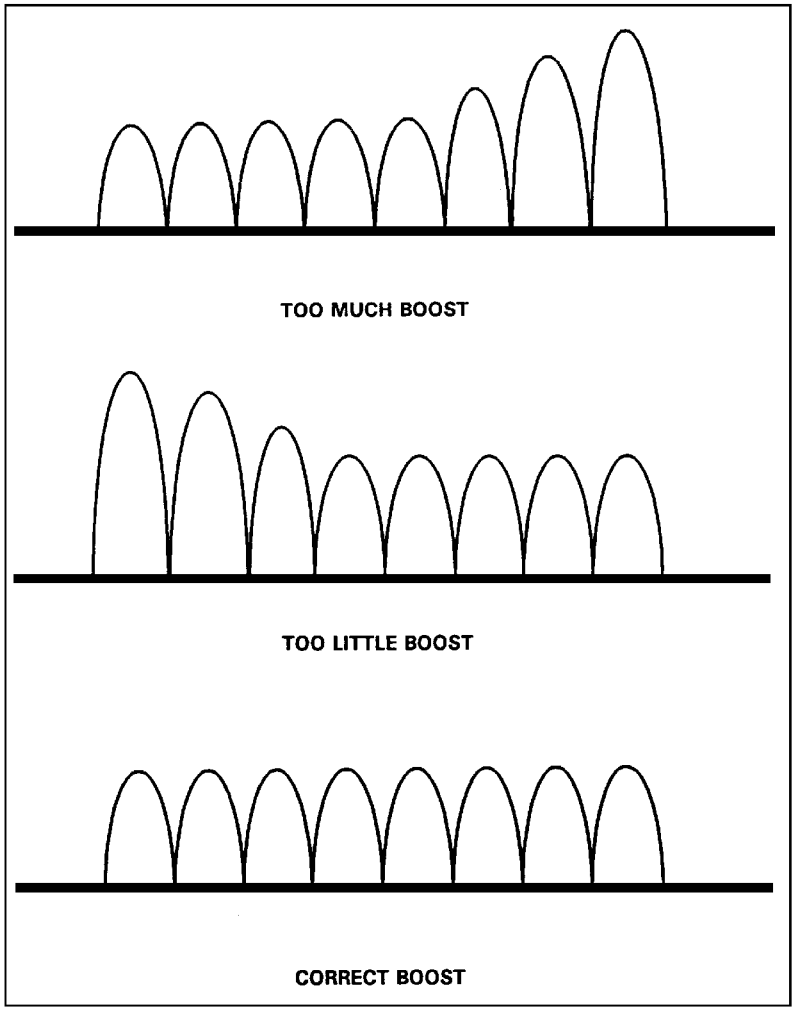

Figure 3-75

f. Conduct over-table filament calibration.

NOTE: Use Table 3-4, Filament Calibration Worksheet, for the following steps.

(1) Set the kVp to <78 kVp> for all readings. Use a 10 inch FDD to position the kVp meter for all readings in this section.

(2) Begin with 25S mA, <78 kVp>, and <2 seconds> .

NOTE: This has a calculated mAs of 50. All readings in Table 3-4 have a calculated mAs of 50.

(3) Make an exposure and record the mAs and the kVp readings.

NOTE: The mAs meter reading should be within 5% of the selected value.

(4) Adjust the pots for mA Course and mA Fine from Table 3-5, ± 5% as read on the meters.

NOTE: All mAs calculated to 50 mAs in the following table.

mA	Time	Reading	Tolerance	Pots
25S	2 sec	kVp	±4	NONE
		mAs	±2.5	P2 and P12
50S	1 sec	kVp	±4	NONE
		mAs	±2.5	P3 and P13
100S	1/2 sec	kVp	±4	NONE
		mAs	±2.5	P4 and P14
100L	1/2 sec	kVp	±4	NONE
		mAs	±2.5	P5 and P15
150L	1/3 sec	kVp	±4	NONE
		mAs	±2.5	P6 and P16
200L	1/4 sec	kVp	±4	NONE
		mAs	±2.5	P7 and P17
300L	1/6 sec	kVp	±4	NONE
		mAs	±2.5	P8 and P18

Table 3-4. FILAMENT CALIBRATION WORKSHEET

NOTE: Use 78 kVp for all settings. Use a 10" Focal Detector Distance (FDD). All pots are located on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.) Pots P2 through P8 adjust "coarse" filament current. Pots P12 through P18 adjust "fine" filament current. Pots P21 through P28 adjust filament boost.

(5) Adjust the boost pot for the waveform as shown in Figure 3-75.

(6) Repeat steps 3f(3) through 3f(5) 4 until all readings are within the specified tolerances. The pot adjustments interact, so it is necessary to adjust and recheck previously adjusted pots to keep in tolerance.

(7) Follow the same procedure for all mA stations shown on the Filament Calibration Worksheet, Table 3-4.

	ADJUSTMENT POTS			
mA Station	mA Course	mA Fine	Filament Boost	Space Charge
200L SPOT	P1	P11	P21	P31
25S	P2	P12	P22	P32
50S	P3	P13	P23	P33
100S	P4	P14	P24	P34
100L	P5	P15	P25	P35
150L	P6	P16	P26	P36
200L	P7	P17	P27	P37
300L	P8	P18	P28	P38

Table 3-5. FILAMENT ADJUSTMENT POTS

NOTE: The pots are located on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.)

g. Conduct kVp offset and space charge compensation.

NOTE: Use Table 3-6, kVp Offset & Space Charge Compensation Calibration Worksheet, for the following steps. Set the kVp to <50 kVp> for all readings. Use a 10 inch Focal Detector Distance (FDD) to position the kVp meter for all readings in the section.

(1) Begin with 25S mA, <50 kVp>, and <3 seconds> .

(2) Make an exposure and record the mAs and the kVp readings.

(3) Ensure the meter reading is within the specified tolerance of the selected values, as read in Table 3-6. Adjust the appropriate pot as indicated in the table.

(4) Repeat steps 3g(2) and 3g(3) until readings are within the specified tolerances.

NOTE: The pot adjustments interact; therefore, it is necessary to adjust and recheck previously adjusted pots to keep in tolerance.

(5) Follow the same procedure for all mA stations shown on the worksheet.

mA	Time, mAs	Reading	Tolerance	Pots
25S	3 sec	kVp	±3	P2-0
	75 mAs	mAs	±3.8	P32
50S	2 sec	kVp	±3	P3-0
	10 mAs	mAs	±5	P33
100S	1-1/2 sec	kVp	±3	P4-0
	150 mAs	mAs	±7.5	P34
100L	1-1/2 sec	kVp	±3	P5-0
	150 mAs	mAs	±7.5	P35
150L	1 sec	kVp	±3	P6-0
	150 mAs	mAs	±7.5	P36
200L	4/5 sec	kVp	±3	P7-0
	160 mAs	mAs	±8	P37
300L	1/2 sec	kVp	±4	P8-0
	150 mAs	mAs	±7.5	P38

Table 3-6. kVp OFFSET & SPACE CHARGE WORKSHEET

NOTE: Use <50 kVp> for all settings. Use a 10" Focal Detector Distance (FDD). Pots P2-0 through P8-0 ("0" for offset) are located on the kVp Compensation PCB (6284.234.03). See Figure 3-76 and adjust kVp offset compensation. Pots P32 through P38 are located on the Constant Current Filament Control PCB (6284.234.1009) and adjust space charge compensation. (See Figure 3-73.)

h. Conduct kVp slope and space charge calibration.

NOTE: Use Table 3-7, kVp Slope & Space Charge Compensation Calibration Worksheet, for the following steps. Set the kVp to <130 kVp> for all readings. Use a 36 inch Focal Detector Distance (FDD) to position the kVp meter for all readings in the section.

(1) Begin with 25S mA, <130 kVp>, and <1-1/2 seconds>.

(2) Make an exposure and record the mAs and the kVp readings. The meter reading should be within the specified tolerance of the selected values, as read in Table 3-7. Adjust the appropriate pot as indicated in the table.

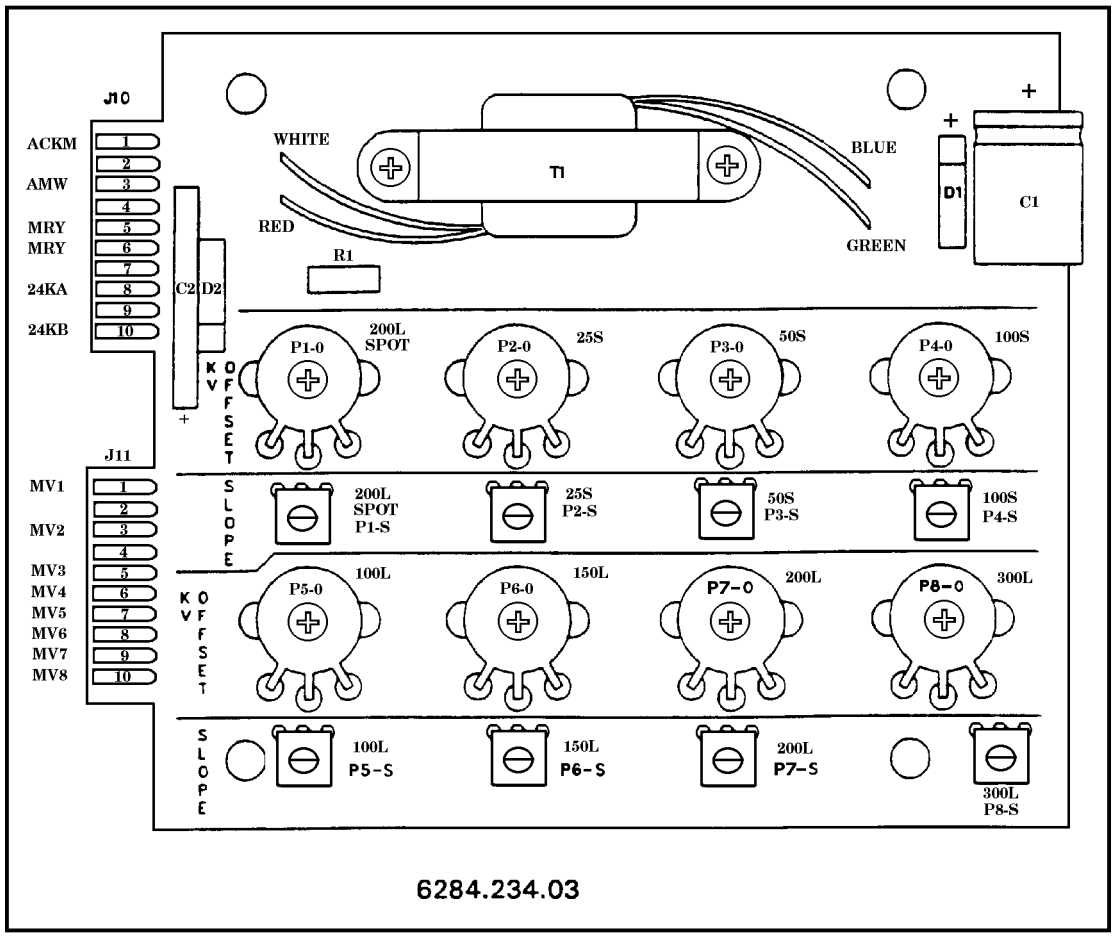

Figure 3-76

(3) Repeat step 3g(2) until the readings are within the specified tolerances. The pot adjustments interact, so it is necessary to adjust and recheck previously adjusted pots to keep in tolerance.

(4) Follow the same procedure for all mA stations shown on the Worksheet.

mA	Time, mAs	Reading	Tolerance	Pots
25S	1-1/2 sec	kVp	±6	P2-S
	37.5 mAs	mAs	±1.9	P32
50S	1 sec	kVp	±6	P3-S
	50 mAs	mAs	±2.5	P33
100S	1/2 sec	kVp	±6	P4-S
	50 mAs	mAs	±2.5	P34
100L	1/2 sec	kVp	±6	P5-S
	50 mAs	mAs	±2.5	P35
150L	1/3 sec	kVp	±6	P6-S
	50 mAs	mAs	±2.5	P36
200L	1/4 sec	kVp	±6	P7-S
	50 mAs	mAs	±2.5	P37
300L	1/6 sec	kVp	±6	P8-S
	50 mAs	mAs	±2.5	P38

Table 3-7. kVp SLOPE & SPACE CHARGE WORKSHEET

NOTE: Use <130 kVp> for all settings. Use a 36" Focal Detector Distance (FDD). Pots P2-S through P8-S ("S" for slope) are located on the kVp Compensation PCB (6284.234.03). (See Figure 3-73.) Adjust kVp slope compensation. Pots P32 through P38 are located on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.) Adjust space charge compensation.

i. Conduct under-table calibration.

NOTE: Use Table 3-8, Under-Table Calibration Worksheet, for the following steps. Set the kVp as specified and position the Focal Detector Distance (FDD) as indicated in the table to position the kVp meter.

(1) Select 200L SPOT mA, <78 kVp>, and <1/5 second>.

(2) Make an exposure and record the mAs and the kVp readings.

NOTE: The meter reading should be within the specified tolerance of the selected values, as read in Table 3-8.

(3) Repeat step 3h(2) until readings are within the specified tolerances.

NOTE: The pot adjustments interact, so it is necessary to adjust and recheck previously adjusted pots to keep in tolerance.

(4) Follow the same procedure for the other two settings shown on the worksheet.

NOTE: Use a 10 inch Focal Detector Distance (FDD) from the top surface of the under-table collimator for all settings.

a. Pots P1, P11, P21, and P31 are located on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.)
b. Pots P1 and P11 adjust filament current.
c. P21 adjusts filament boost.
d. Pots P1-O and P1-S are located on the kVp Compensation PCB (6284.234.03). (See Figure 3-76.) They adjust kVp offset and slope.

Time	kVp, mAs	Reading	Tolerance	Pots
1/5 sec	78 kVp	kVp	±4	None
	40 mAs	mAs	±2	P1,P11,P21
1-1/2 sec	60 kVp	kVp	±3	P1-0
	300 mAs	mAs	±15	P31
1/20 sec	130 kVp	kVp	±6	P1-S
	10 mAs	mAs	±5	P31

Table 3-8. 200L SPOT CALIBRATION WORKSHEET

j. Conduct fluoroscopic kVp calibration.

NOTE: The Fluoro kVp Meter PCB,5184.234.09, is located under the fluoro kVp meter on the inside of the door. (See Figure 3-61.)

NOTE: For a layout of PCB see manufacturer's instructions, Chapter 6, Generator, Figure 5-28.

(1) With the MAINS off, connect a digital AC voltmeter across leads AQF and UF on the back of the Fluoro kVp Meter PCB.

(2) Turn the MAINS on and adjust the fluoro kVp control for 200 volts AC on the digital AC voltmeter.

(3) Adjust P1 on the Fluoro kVp Meter Shunt PCB for 125 kVp reading on the fluoro kVp meter.

k. Conduct fluoroscopic mA calibration.

(1) Turn the MAINS off and connect the mA meter by removing wire, M1, from its terminal strip on the lower section of the inside rear or the control. (See Figure 3-57.) Install the leads of Nuclear Associates mAs meter (Model 07-472) between the M1 terminal and the wire that was connected to M1 terminal in series with the M1 lead.

NOTE: Adjustments in this section are performed on the Fluoro mA Control PCB, 5184.234.0501. (See Figure 3-77.)

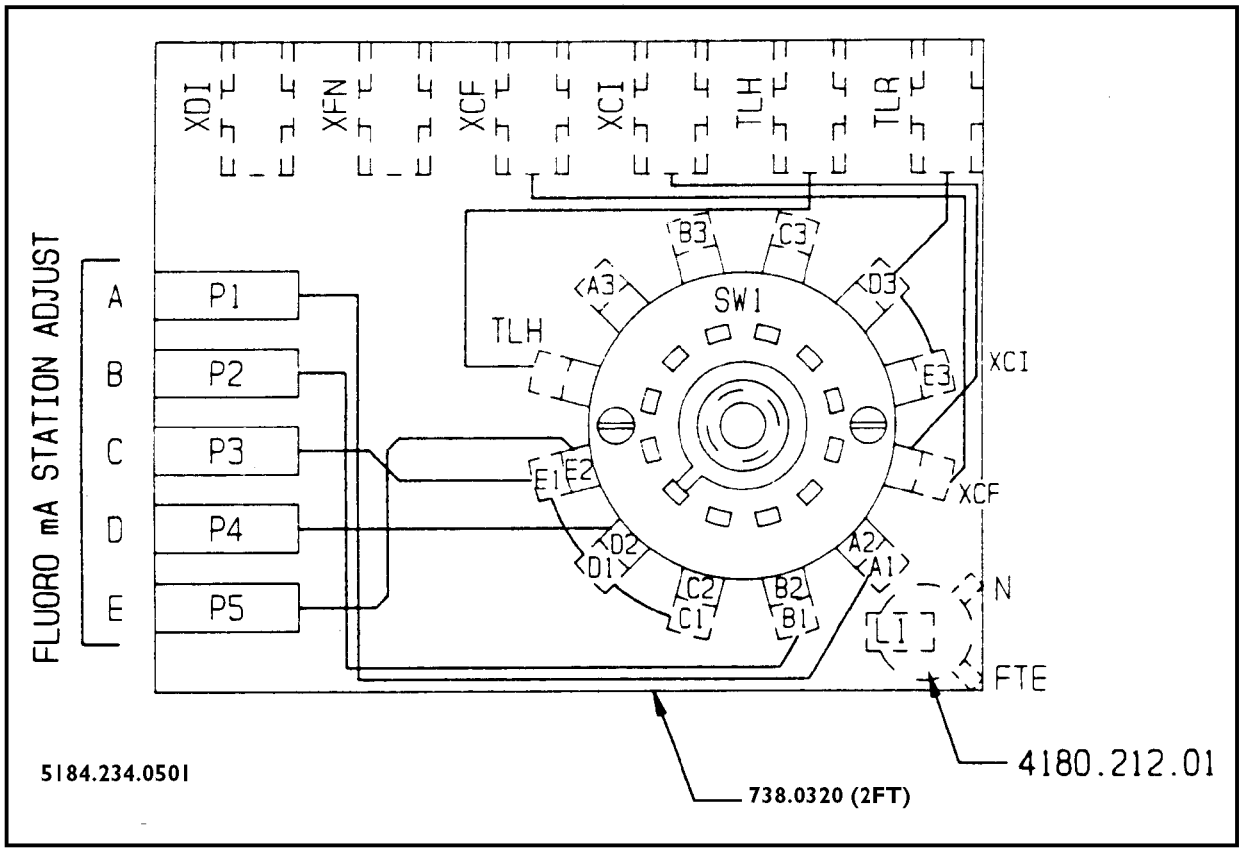

Figure 3-77

(2) Turn the MAINS on.

(3) Select Fluoro mA position A on the fluoro mA select dial. Select 125 kVp on the fluoro kVp meter. Make a fluoro exposure and adjust pot P1 on the mA Control PCB for .25 mA on the test equipment display.

(4) Select Fluoro mA position B and select 125 kVp on the fluoro kVp meter. Make a fluoro exposure and adjust pot P2 on the mA Control PCB for .5 mA on the test equipment display.

(5) Select Fluoro mA position C and select 125 kVp on the fluoro kVp meter.

(6) Make a fluoro exposure and adjust pot P2 on the mA Control PCB for 1.0 mA on the test equipment display.

(7) Select Fluoro mA position D and select 125 kVp on the fluoro kVp meter. Make a fluoro exposure.

(8) Ensure the fluoro high level buzzer sounds during the exposure.

(9) Adjust pot P4 on the mA Control PCB for 2.25 mA on the test equipment display.

(10) Select Fluoro mA position E and select 125 kVp on the fluoro kVp meter. Make a fluoro exposure.

(11) Ensure the fluoro high level buzzer sounds during the exposure.

(12) Adjust pot P5 on the mA Control PCB for 4.5 mA on the test equipment display.

(13) Turn the MAINS off.

4. Complete the calibration of the X-ray generator using a dynalyzer.

NOTE: Each mA station must be calibrated for filament control, filament boost, space charge compensation, and kVp compensation. These adjustments are interactive, and they should be performed as a set on each mA station.

NOTE: X-ray current skews at different kilovoltages, due to space charge effect. It is necessary to compensate for space charge effect by increasing the filament level at low kVps and decreasing it at high kVps. This is performed by a series of pot adjustments.

a. Install the dynalyzer.

NOTE: Always follow the manufacturer's instruction for installation and use.

b. Make all mA and kVp measurements as close to the X-ray tube as possible.

NOTE: In general, all kVp measurements are made with both anode and cathode cables connected to the high voltage divider. All mA measurements are made with only the anode cables connected to the high voltage divider, due to the loading of the filament by the high voltage divider.

NOTE: When using a scope to measure kVp, one channel reads anode kVp, and the other reads cathode kVp. One channel is inverted. Both channels are algebraically added together for total kVp.

c. Connect channel 1 of the scope to the kVp output of the Dynalyzer and connect channel 2 of the scope to the mA output of the Dynalyzer.

d. Liberally coat all high voltage cable ends with insulating compound (such as DOW DC-4) when using the test equipment.

e. Perform exposure mAs calibration.

(1) Turn the MAINS on and select 100L mA station, <80 kVp> and <1/2 second>.

(2) Press and hold the mAs push button while making an exposure. Observe the mAs meter while holding PREPARE, EXPOSE, and mAs after the exposure ends. It should read 50 mAs ± 5%.

(3) If the mAs meter on the control panel drifts up or down, adjust pot P2 (Drift) accordingly on the mAs Current Integrator PCB. (See Figure 3-74.)

(4) Release all buttons and press mAs only. The mAs meter should read zero.

(5) Adjust pot P1 (Zero Adjustment) on the mAs Current Integrator PCB for zero indication.

(6) Compare the meter reading on the control to the Dynalyzer mAs meter.

(7) Adjust pot P3, on the mAs Current Integrator PCB (6184.234.0803), until the meter on the control panel equals that on the Dynalyzer.

(8) Make another exposure and adjust pot P3 (mAs Meter Adjustment) on the mAs Current Integrator PCB for 50 mAs ± 5%.

f. Adjust kVp compensation.

NOTE: Before proceeding to this section, verify Filament Boost adjustment. (See step 3e.) A storage scope is required.

NOTE: kVp compensation calibration verification is performed using Table 3-9. If a voltmeter is not connected from the previous procedure, turn the MAINS off and connect the voltmeter across terminals AC and AM (located on the back of the major and minor kVp selector switches).

(1) Verify that for all mA stations the kVp meter readings correspond to the voltage between AC and AM. (See Figure 3-61.)

(2) Refer to Table 3-9. The first "Adjust" column is for all offset (O) pots, and the second "Adjust" column is for all slope (S) pots. Verify the kVp meter reading against the Dynalyzer. Adjust the corresponding pot for the appropriate value read by the voltmeter across terminals AC and AM.

(3) Turn the MAINS on and select all mA stations one at a time.

kVp Calibration Settings for 2% Line Drop						
mA	AC-AM	kVp	Adjust	AC-AM	kVp	Adjust
200LSPOT	118	60	P1-0	209	120	P1-S
25S	119	70	P2-0	201	120	P2-S
50S	110	60	P3-0	207	120	P3-S
100S	122	60	P4-0	219	120	P4-S
100L	122	60	P5-0	219	120	P5-S
150L	135	60	P6-0	230	120	P6-S
200L	118	60	P7-0	209	120	P7-S
300L	133	60	P8-0	219	120	P8-S

kVp Calibration Settings for 4% Line Drop						
mA	AC-AM	kVp	Adjust	AC-AM	kVp	Adjust
200LSPOT	118	60	P1-0	210	120	P1-S
25S	119	70	P2-0	201	120	P2-S
50S	110	60	P3-0	207	120	P3-S
100S	122	60	P4-0	220	120	P4-S
100L	122	60	P5-0	220	120	P5-S
150L	135	60	P6-0	232	120	P6-S
200L	118	60	P7-0	210	120	P7-S
300L	135	60	P8-0	223	120	P8-S

Table 3-9. kVp COMPENSATION

kVp Calibration Settings for 6% Line Drop						
mA	AC-AM	kVp	Adjust	AC-AM	kVp	Adjust
200LSPOT	120	60	P1-0	214	120	P1-S
25S	120	70	P2-0	203	120	P2-S
50S	111	60	P3-0	209	120	P3-S
100S	123	60	P4-0	221	120	P4-S
100L	123	60	P5-0	221	120	P5-S
150L	136	60	P6-0	233	120	P6-S
200L	120	60	P7-0	214	120	P7-S
300L	135	60	P8-0	226	120	P8-S

kVp Calibration Settings for 8% Line Drop						
mA	AC-AM	kVp	Adjust	AC-AM	kVp	Adjust
200LSPOT	121	60	P1-0	218	120	P1-S
25S	120	70	P2-0	203	120	P2-S
50S	111	60	P3-0	209	120	P3-S
100S	123	60	P4-0	222	120	P4-S
100L	123	60	P5-0	222	120	P5-S
150L	136	60	P6-0	235	120	P6-S
200L	121	60	P7-0	218	120	P7-S
300L	137	60	P8-0	231	120	P8-S

Table 3-9. kVp COMPENSATION (Continued)

(4) Verify the kVp meter reading against the Dynalyzer and that the corresponding value in Table 3-9 is reached ± 5%.

NOTE: To perform this, set time to <1/10 second> and generate an X-ray exposure. Verification must be performed at both kVp settings at each mA station. If SAFETY RESET prevents performing this procedure, refer to step 2j.

NOTE: If the mA reading is more than 10% off while performing this procedure, adjust the appropriate coarse mA pot on the Constant Current Filament PCB. (See Table 3-7). This is a preliminary adjustment.

(5) If all mA stations track within acceptable parameters, remove the voltmeter and proceed to step 4g. If the mA station does not track with acceptable parameters, proceed to NOTE below and step 4f(6).

NOTE: The remainder of the adjustments for kVp Compensation are on pots located on the kVp Compensation PCB (6284.234.03). (See Figure 3-76.) The location of the kVp Compensation Panel is shown in the front view of Figure 3-57.

(6) The offset (O) and slope (S) pots are interactive for the low and high ends. Adjust the slope for the correction at the high end and adjust the offset pot at the low end.

(7) Calibrate to 2% of the specified reading as a goal with 5% maximum as tolerance.

(8) Turn the MAINS on, select 25S mA, and set the AC-AM voltage corresponding to 70 kVp in Table 3-9.

(9) Adjust P2-O (25S) so the kVp meter reads 70 kVp. Select the AC-AM voltage corresponding to 120 kVp and adjust P2-S (25S) so the kVp meter reads 120 kVp.

(10) Confirm settings at 70 kVp and then 120 kVp, readjusting P2-O and P2-S as required.

(11) Select the 50S mA station and set the AC-AM voltage corresponding to 60 kVp in Table 3-9. Adjust P3-O (50S) so the kVp meter reads 60 kVp.

(12) Select the AC-AM voltage corresponding to 120 kVp and adjust P3-S (50S) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P3-O and P3-S, as required.

(13) Select 100S mA and set the AC-AM voltage corresponding to 100S in Table 3-9. Adjust P4-O (100S) so the kVp meter reads 60 kVp.

(14) Select the AC-AM voltage corresponding to 120 kVp and adjust P4-S (50S) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P4-O and P4-S, as required.

(15) Select 100L mA and set the AC-AM voltage corresponding to 100L in Table 3-8. Adjust P5-O (100S) so the kVp meter reads 60 kVp.

(16) Select the AC-AM voltage corresponding to 120 kVp and adjust P5-S (100L) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P5-O and P5-S, as required.

(17) Select 150L mA and set the AC-AM voltage corresponding to 150L in Table 3-9. Adjust P6-O (150L) so the kVp meter reads 60 kVp.

(18) Select the AC-AM voltage corresponding to 120 kVp and adjust P6-S (150L) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P6-O and P6-S, as required.

(19) Select 200L mA and set the AC-AM voltage corresponding to 200L in Table 3-9. Adjust P7-O (200L) so the kVp meter reads 60 kVp.

(20) Select the AC-AM voltage corresponding to 120 kVp and adjust P7-S (200L) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P7-O and P7-S, as required.

(21) Select 300L mA and set the AC-AM voltage corresponding to 300L in Table 3-9. Adjust P8-O (300L) so the kVp meter reads 60 kVp.

(22) Select the AC-AM voltage corresponding to 120 kVp and adjust P8-S (300L) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P8-O and P8-S, as required.

(23) Select 200L Spot mA and set the AC-AM voltage corresponding to 200L SPOT in Table 3-9. Adjust P1-O (200L Spot) so the kVp meter reads 60 kVp.

(24) Select the AC-AM voltage corresponding to 120 kVp and adjust P1-S (200L Spot) so the kVp meter reads 120 kVp. Confirm settings at 60 kVp and then 120 kVp, readjusting P1-O and P1-S, as required.

(25) Verify that 25S mA kVp reading in Table 3-9 are within ± 5% of the Radiographic kVp meter and Dynalyzer for the low and high ends (high end is 120 kVp and low end is 60 kVp).

(26) Verify the rest of mA station AC-AM voltages in Table 3-9 against the kVp meter and Dynalyzer for the low and high ends.

(27) Turn the MAINS off and remove test equipment.

g. Adjust mA filament (over-table X-ray tube).

(1) Select <78 kVp> and <1/2 second>. Verify all mA stations, one at a time, by making exposures and observing the mA reading on the high voltage test equipment display. The mA should be within 5% of the selected value.

(2) Verify that the mA boost waveforms match the waveforms shown in Figure 3-75. If they are correct, proceed to step 4h. If they require adjustment, proceed to step 4g(3).

(3) Turn the MAINS off.

NOTE: All filament adjustments pots for radiographic mA stations are on the Constant Current Filament Control PCB (6284.234.1009). (See Figure 3-73.) The PCB is physically located in the main control. (See Figure 3-57.) The respective adjustments pots are shown in Table 3-5.

(4) Connect a digital voltmeter across leads XD1 (22J3) and XCC (7J4) on the Constant Current Filament PCB.

(5) Turn the MAINS on and select 25S mA, <78 kVp>, and <1/4 second>.

(6) Adjust P30 (Space Charge Zero Adjust) on the Constant Current Filament Control PCB until the voltmeter reads (0) volts. This is the zero space charge point.

(7) Turn the MAINS off .

(8) Ensure the collimator blades on the X-ray tube are fully closed.

(9) Turn the MAINS on, make an exposure, and observe the mA output on the test equipment display.

(10) Use pot P2 (mA Coarse) and pot P12 (mA Fine) on the Constant Current Filament Control PCB and adjust for 25 mA on the test equipment display.

(11) Adjust pot P22 (Boost) for a mA waveform as shown in Figure 3-75.

NOTE: Adjustment of P22 will affect the mA value so readjust P2 and P12 for proper value.

(12) Select 50S mA and <78 kVp>.

(13) Make an exposure and observe the mA output on the test equipment display.

(14) Adjust pot P3 (mA Coarse) and pot P13 (mA Fine) on the Constant Current Filament Control PCB and adjust for 50 mA on the test equipment display.

(15) Adjust pot P23 (Boost) on the Constant Current Filament Control PCB for a mA waveform as shown in Figure 3-75.

NOTE: Adjustment of P23 will affect the mA value so readjust P3 and P13 for 50 mA on the test equipment display.

(16) Select 100S mA, and <78 kVp>. Make an exposure and observe the mA output on the test equipment display.

(17) Adjust pot P4 (mA Coarse) and pot P14 (mA fine) on the Constant Current Filament Control PCB and adjust for 100 mA on the test equipment display.

(18) Adjust the pot P24 (Boost) on the Constant Current Filament Control PCB for a mA waveform, as shown in Figure 3-75.

NOTE: Adjustment of P24 will affect the mA value so readjust P4 and P14 for 100 mA on the test equipment display.

(19) Select 100L mA, and <78 kVp>. Make an exposure and observe the mA output on the test equipment display.

(20) Adjust pot P5 (mA Coarse) and pot P15 (mA fine) on the Constant Current Filament Control PCB and adjust for 100 mA on the test equipment display.

(21) Adjust pot P25 (Boost) on the Constant Current Filament Control PCB for a mA waveform, as shown in Figure 3-75.

NOTE: Adjustment of P25 will affect the mA value so readjust P5 and P15 for 100 mA on the test equipment display.

(22) Select 150L mA and <78 kVp>. Make an exposure and observe the mA output on the test equipment display.

(23) Adjust pot P6 (mA Coarse) and pot P16 (mA fine) on the Constant Current Filament Control PCB; adjust for 150 mA on the test equipment display.

(24) Adjust pot P26 (Boost) on the Constant Current Filament Control PCB for a mA waveform, as shown in Figure 3-75.

NOTE: Adjustment of P26 will affect the mA value so readjust P6 and P16 for 150 mA on the test equipment display.

(25) Select 200L mA and <78 kVp>. Make an exposure and observe the mA output on the test equipment display.

(26) Adjust pot P7 (mA Coarse) and pot P17 (mA Fine) on the Constant Current Filament Control PCB and adjust for 200 mA on the test equipment display.

(27) Adjust pot P27 (Boost) on the Constant Current Filament Control PCB for a mA waveform, as shown in Figure 3-75.

NOTE: Adjustment of P27 will affect the mA value so readjust P7 and P17 for 200 mA on the test equipment display.

(28) Select 300L mA and <78 kVp>. Make an exposure and observe the mA output on the test equipment display.

(29) Adjust pot P8 (mA Coarse) and pot P18 (mA fine) on the Constant Current Filament Control PCB and adjust for 300 mA on the test equipment display.

(30) Adjust the pot P28 (Boost) on the Constant Current Filament Control PCB for a mA waveform, as shown in Figure 3-75.

NOTE: Adjustment of P28 will affect the mA value, so readjust P8 and P18 for 300 mA on the test equipment display.

h. Adjust space charge compensation

(1) Check each mA station for compensation by making exposures at 50 kVp and 110 kVp, noting the mA.

NOTE: If a difference in mA exists, the deviation from the selected mA should be equal and in the same direction at these kVps.

(2) If space charge compensation is within tolerance, proceed to step 4i.

(3) If space charge compensation is not within tolerance, proceed to step 4g(4).

NOTE: All adjustments pots for Space Charge Compensation are located on the Constant Current Filament Control PCB. (See Figure 3-73.)

(4) Make exposures at 50 kVp and 110 kVp and adjust the mA by the respective space charge pot to be as close as possible to the selected mA.

NOTE: If the mA is not exact at 50 kVp and 110 kVp, compromise between the two by adjusting the space charge pot for the least deviation at these kVps. An increase in space charge compensation will increase mA at low kVps and decrease mA at high kVps.

(5) Select 25S mA , <50 kVp>, <1/4 second>, make an exposure, and observe the output on the test equipment display.

(6) Adjust the 25S space charge pot P32 for 25 mA.

(7) Select <110 kVp>, leaving all other factors the same. Make an exposure and observe the mA output on the test equipment display.

(8) Adjust the 25S space charge pot P32 for 25 mA. If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(9) Select 50S mA], <50 kVp>, <1/4 second>.

(10) Make an exposure and observe the mA output on the test equipment display.

(11) Adjust the 50S space charge pot P33 for 50 mA.

(12) Select <110 kVp>, leaving all other factors the same. Make an exposure and observe the mA output on the test equipment display.

(13) Adjust the 50S space charge pot P33 for 50 mA. If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(14) Select 100S mA, <50 kVp>, <1/4 second>. Make an exposure and observe the output on the test equipment.

(15) Adjust the 100S space charge pot P34 for 100 mA.

(16) Select <110 kVp>, leaving all other factors the same, and make an exposure and observe the mA output on the test equipment display.

(17) Adjust the 100S space charge pot P34 for 100 mA. If a difference in the mA mAs exists between 50 kVp and 110 kVp, adjust for the least deviation.

(18) Select 100L mA, <50 kvp>, <1/4 second>. Make an exposure and observe the mAs output on the test equipment display.

(19) Adjust the 100L space charge pot P35 for 100 mA.

(20) Select 110 kVp, leaving all other factors the same, and make an exposure and observe the mA output on the test equipment display.

(21) Adjust the 100L space charge pot P35 for 100 mA. If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(22) Select 150L mA, <50 kVp>, <1/4 second>. Make an exposure and observe the mA output on the test equipment display.

(23) Adjust the 150L space charge pot P36 for 150 mA.

(24) Select <110 kVp>, leaving all other factors the same, and make an exposure and observe the mA output on the test equipment display.

(25) Adjust the 150L space charge pot P36 for 150 mA. If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(26) Select [200L] mA, <50 kVp>, <1/4 second>. Make an exposure and observe the mA output on the test equipment display.

(27) Adjust the 200L space charge pot P37 for 200 mA.

(28) Select <110 kVp>, leaving all other factors the same, and make an exposure and observe the mA output on the test equipment display.

(29) Adjust the 200L space charge pot P37 for 200 mA. If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(30) Select 300L mA, 50 kVp>, <1/4 second>. Make an exposure and observe the mA output on the test equipment display.

(31) Adjust the 300L space charge pot P38 for 300 mA.

(32) Select <110 kVp>, leaving all other factors the same. Make an exposure and observe the mA output on the test equipment display.

(33) Adjust the 300L space charge pot P38 for 300 mA.

(34) If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the least deviation.

(35) Turn the MAINS off and remove test equipment.

i. Perform under-table X-ray tube filament calibration.

(1) Ensure that the MAINS are off.

(2) Remove the equipment from over-table X-ray tube and install it on the undertable X-ray tube.

(3) Conduct warm up procedures. (See step 2c.)

(4) Turn the MAINS on and select 200L Spot mA, <78 kVp>, <1/4 second>.

(5) Make an exposure on the spot film device and read the mA on the test equipment display. The mA should be within 5% of the selected value.

(6) Verify the mA Boost waveform as in Figure 3-75. If these requirements are met, proceed to step 4j.

(7) If the requirements are not met in step 4i(6) above, proceed to step i(8).

(8) Turn the MAINS on and select 200L Spot mA, <78 kVp>, <1/4 second>.

(9) Make an exposure using the spot film device PREPARE and EXPOSE push buttons. Observe the mA output on the test equipment display.

(10) Using pot P1 (mA Coarse) and pot P11 (mA Fine) on the Constant Current Filament Control PCB (6284.234.1009), adjust for 200 mA on the test equipment display. (See Figure 3-73.)

(11) Adjust pot P21 (Boost) for an mA waveshape as shown in Figure 3-75. Readjust P1 and P11 for 200 mA.

j. Perform space charge compensation (undertable).

(1) Make exposures at <50 kVp> and <110 kVp> at <1/4 second>.

(2) Check for a difference in mA between 50 kVp and 110 kVp and if the deviation from the selected mA is opposite and equal. If it is, proceed to step 4k.

(3) Proceed to step 4j(4) if the requirements in step 4j(2) are not met.

(4) Select 200L Spot mA, <50 kVp>, <1/4 second>. Make an exposure and observe the mA output on the test equipment display.

(5) Adjust the 200L Spot space charge pot P31 for 200 mA on the Constant Current Filament PCB (6284.234.1009). (See Figure 3-73.)

(6) Select <110 kVp>, leaving all other factors the same. Make an exposure.

(7) Adjust the 200L Spot space charge pot P31 for 200 mA.

(8) If a difference in the mA exists between 50 kVp and 110 kVp, adjust for the lease deviation.

k. Conduct spot film preheat.

(1) Turn the MAINS off.

(2) Remove lead XSU from its terminal.

(3) Select <100 kVp> and <5 minutes> on the Fluoroscopic Controls section.

(4) Turn the MAINS on, make a fluoro exposure, and observe the mA readout. It should read less than 0.01 mA. Proceed to step 4l if it does.

(5) Proceed to step 4k(6) if the reading is step 4k(4) is 0.01 or greater.

(6) Select 200L Spot mA, <80 kVp>, and <1 second>.

(7) Set the fluoroscopic controls to <100 kVp> and <5 minutes>.

(8) Activate a fluoro exposure by depressing the footswitch and observe the mA readout.

(9) If a reading of higher than 0.01 mA is indicated, adjust the Preheat Resistor, Drawing 5285.234.05, for an indication of .01 mA or less. (See Figure 3-57.)

(10) Turn the MAINS off. Reconnect lead XSU and turn the MAINS on.

l. Perform fluoroscopic kVp calibration.

(1) Select <100 kVp>, fluoro position A. Make an exposure and observe the kVp output on the test equipment display. It should agree with the fluoro kVp meter within 2 kVp. Proceed to step 4m if it does.

(2) If the requirements in step 4l(1) above are not met, proceed to step 4l(3).

(3) Ensure the MAINS are turned off.

(4) Connect a digital AC voltmeter across leads AQF and UF on the back of the fluoro kVp meter. (See Figure 3-61.)

(5) Turn the MAINS on. Adjust the fluoro kVp control for 200 VAC on the digital AC voltmeter.

(6) Adjust pot P1 on the Fluoro kVp Meter Shunt PCB for 125 kVp reading on the fluoro kVp meter. (See Figure 3-61.)

(7) Make a fluoro exposure and observe the actual kVp on the test equipment display. If necessary, readjust pot P1 on the Fluoro kVp Meter Shunt PCB to match the fluoro kVp meter with the test equipment.

m. Perform fluoroscopic mA calibration.

(1) Select <125 kVp> fluoro. Fluoro mA positions A and E should be 0.5 mA and 4.5 mA respectively on the mA readout when a fluoro exposure is made.

NOTE: A radiation meter capable of reading 0 to 10 R/Minute is needed to verify fluoro mA positions B, C, and D.

(2) Place the paddle of the R meter in the X-ray beam. Make fluoro exposures using these positions.

(3) Positions B, C, and D should read 2.25 R/Minute, 4.5 R/Minute, and 7.5 respectively. All readings should be within 5% of these values. If they are, calibration of the X-ray generator is complete. Proceed to step 5.

(4) If the readings do not meet the requirements in step m(3) above, proceed to step 4m(5).

(5) Adjust fluoro mA stations A and E to a predetermined mA factor and stations B, C, and D for a table top radiation (R) level .

(6) Select fluoro mA position A and <125 kVp>.

(7) Make a fluoro exposure and adjust pot P1 on the Fluoro mA Control PCB, 5184.234.0501 for 0.5 mA on the test equipment display. (See Figure 3-77.)

(8) Place paddle of a radiation meter in the radiation beam. Select fluoro position B and <125 kVp> and make a fluoro exposure.

(9) Adjust pot P2 on the Fluoro mA Control PCB for a table top R reading of 2.25 R/Minute.

(10) Select fluoro position C and <125 kVp>. Make a fluoro exposure.

(11) Adjust pot P3 on the Fluoro mA Control PCB for a table top R reading of 4.5 R/Minute.

(12) Select fluoro position D and <125 kVp> and make a fluoro exposure.

(13) Ensure the fluoro high level buzzer sounds during exposure.

(14) Adjust pot P4 on the Fluoro mA Control PCB for a table top R reading of 7.5 R/Minute.

(15) Select fluoro position E and <125 kVp> and make a fluoro exposure.

(16) Ensure the fluoro high level buzzer sounds during exposure.

(17) Adjust pot P5 on the Fluoro mA Control PCB for 4.5 mA reading on the test equipment display.

(18) Turn the MAINS off and remove all test equipment.

5. Perform undertable collimator calibration.

a. Conduct voltage checks. Perform the following voltage checks on Undertable Logic PCB, 70-08084, using the negative probe of the DVM to TP1 (G). (See Figure 3-78.)

(1)	TP-3	+5.00 VDC ± 0.01	Adjust R8, if necessary.
(2)	TP-6	+10.00 VDC + 0.05	With switch 3 set to position 8, adjust R46, if necessary.
(3)	TP-6	+10.18 VDC ± 0.05	With switch 3 set to position 9, adjust R60, if necessary.

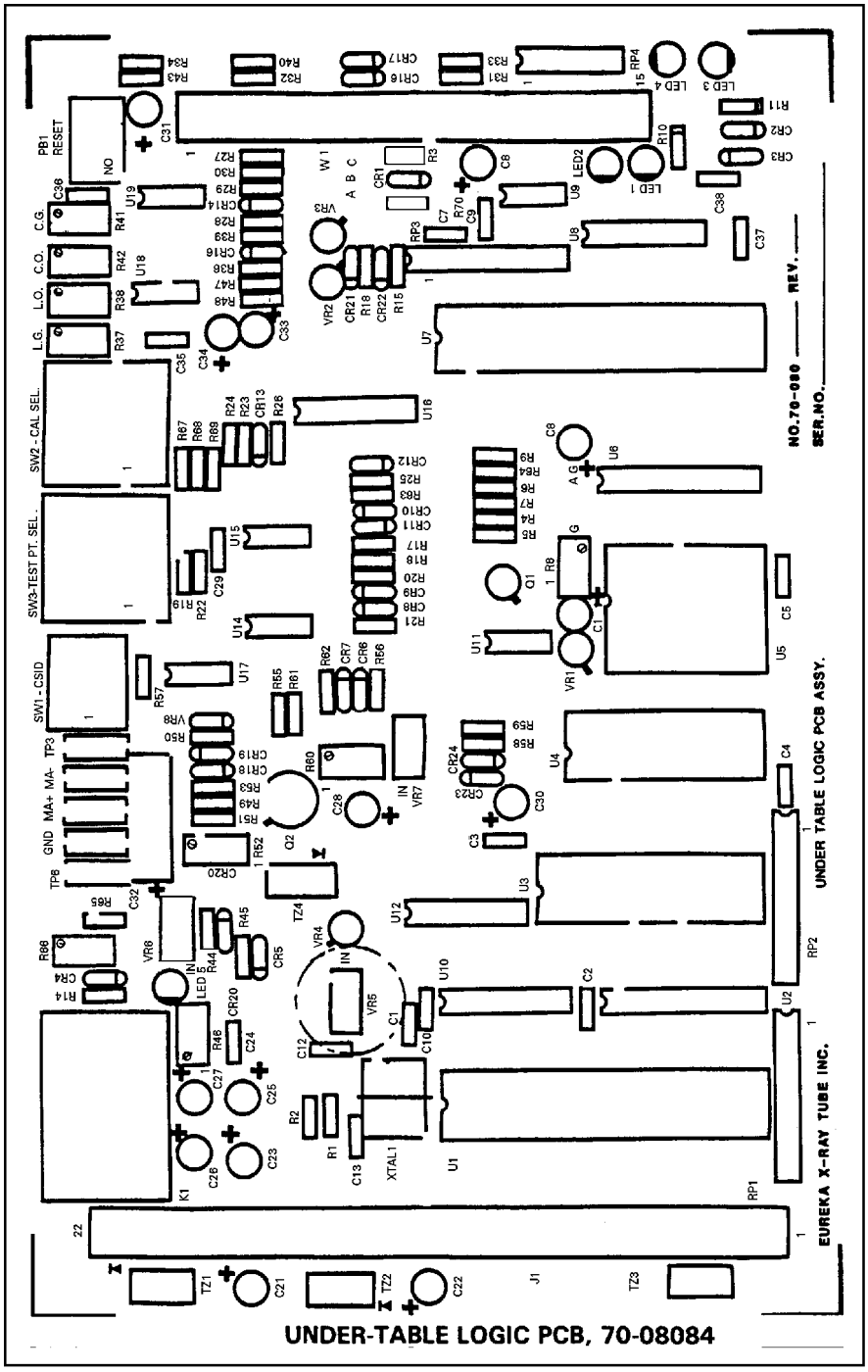
UNDER-TABLE LOGIC PCB, 70-08084
EUREKA X-RAY TUBE INC.
UNDER TABLE LOGIC PCB ASSY.
NO.70-080 ____ REV. ____
SER.NO. ____
SW2 - CAL SEL.
SW3-TEST PT. SEL.
SW1 - CSID
PB1 RESET
C.G.
C.O.
L.O.
L.G.
GND MA+ MA- TP3
TP8
LED 1
LED 2
LED 3
LED 4
J1
K1
XTAL1

Figure 3-78

b. Center the collimator using fluoroscope.

NOTE: To perform this adjustment, the table top must be removed. Refer to the installation chapter of manufacturer's instructions for the table top removal.

(1) Activate a very low fluoro exposure such as 0.5 mA at 50 kVp and adjust the shutter control to display only the four shutter blades on the fluoro image.

(2) If the collimator blades are evenly centered, proceed to step 5c. (See Figure 3-79.)

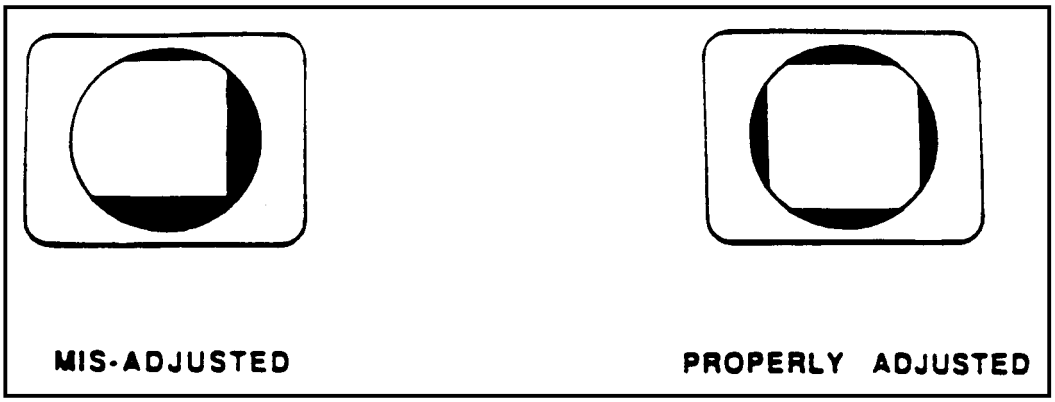

Figure 3-79

(3) If the collimator blades are not evenly centered, determine the direction of movement required.

(a) Loosen the four collimator mounting screws and shift the collimator (without X-ray) to center all four shutters on the image.

(b) Tighten the four mounting screws.

c. Perform a continuous SID adjustment.

NOTE: Prior to adjustment, remove any mechanical stops (e.g., myelographic) which would prevent the spot-film device from travelling its full vertical movement.

(1) Lower the SFD to its minimum SID.

(2) Connect a DC amp meter to TP4 (mA+) and TP5 (mA-) on the Under-Table Logic PCB, 70-08084. (See Figure 3-78.)

(3) Ensure the MAINS are on. Place the mA CAL switch (SW1-1), on the Under-Table logic PCB to the open, OFF, position.

(4) Adjust R52 (CSID slope) for 7.21 mA.

(5) Place the mA CAL switch to the closed, ON, position, and remove the DC amp meter leads.

(6) Set the CAL/mode switch SW2 to Position 9.

(7) Ensure the word CALO followed by the word SID is displayed.

(8) Determine minimum SID by the following method:

(a) Move the spot film device to the rear of the table and to its lowest position.

(b) Position a film cassette so that it protrudes one inch out of the spot film device.

(c) Record the table top-to-image receptor distance (TID).

NOTE: TID is obtained by measuring from the table top to the middle (thickness) of the extended film cassette.

(d) Calculate and record SID using the following formula.

TID + 17" =_____(SID) min

(9) Adjust R66 (VSID Base ADJ) on the Under-Table Logic PCB until the value on the display corresponds to the calculated SID.

(10) Raise the spot-film device to its maximum position and recalculate the SID. See step as in step 5c(8).

TID + 17" =_____(SID) max;

(11) The value obtained should correspond to the value indicated on the alphanumeric display. If it is not within ±0.3 inch of the measured value, make a slight readjustment to R52 (SID Current) and R66 (VSID Base Adjust).

(12) Repeat steps 5c(9) and 5c(10) until proper tracking at maximum and minimum SID is obtained.

d. Perform shutter offset adjustment.

NOTE: To perform this adjustment, the table top must be removed. (Refer to the Installation Chapter of the manufacturer's instructions for table top removal.)

CAUTION

In this procedure the collimators blades are opened and closed manually. Move very carefully to prevent damage to prevent damage to the collimator blades.

(1) Move the spot film device to 36" SID.

(2) Select <1 on 1> format with the AUTO shutter ON.

(3) Make a radiographic exposure.

(4) Select <9 on 1> format with the AUTO shutter ON.

(5) Make a radiographic exposure.

(6) Develop and measure the films.

(7) If the <1 on 1> exposure measures 9-1/8" (± 1/8") in both directions and If the <9 on 1> exposure measures 2-1/4" (± 1/4") in both directions, proceed to step 5f.

(8) If the measurements in step 5d(7) do not meet specifications, proceed to step 5d(9).

(9) Remove the aluminum filter cover from the under-table collimator.

(10) Set CAL/MODE switch, SW2, to position 7.

(11) Ensure the word CALO followed by the word VXFC is displayed.

(12) Ensure that after two seconds the value of the voltage in A/D units proportional to the position of the cross shutter is displayed.

(13) Place fingers on each side of the cross shutter (farthest from the X-ray tube). Slowly, and without excessive force, close the shutters together.

(14) Observe the value on the calibration display. Adjust cross offset pot (Cross Offset) R42 on the Under-Table Logic PCB, 70-08084. (See Figure 3-78.) Adjust the pot for a reading as close to zero as possible with a realistic reading of about 1 or 2.

(15) Set the CAL/MODE switch SW2 to position 6.

(16) Ensure the word VXFL is displayed followed by the value of the voltage in A/D units proportional to the position of the longitudinal shutter.

(17) Slowly close the longitudinal (closest to the X-ray tube) shutters together.

(18) Adjust the longitudinal offset pot, R38 for a value as close to zero as possible with a realistic reading of about 1 or 2.

e. Perform a shutter gain adjustment.

NOTE: For the procedures in this section, longitudinal and cross (transverse) measurements of X-ray film must be defined.

CAUTION

The collimator blades must be opened and closed manually. To prevent damage to the collimator blades, move very carefully.

(1) With the Under-Table Logic PCB (70-08084) still in CAL MODE (SW2-C), adjust the longitudinal and transverse shutters to a 2 inch opening position manually. (See Figure 3-78.)

(2) Set the spot device to an SID of 36 ".

(3) Adjust pot R37 (Longitudinal Gain) for 530 ± 2, and pot R41 (C.G.) for 530 ± 2 on the calibration display.

(4) Insert an unexposed film cassette into the spot device.

(5) Set switch 2 to position 0 (RUN).

(6) Select a <1-on-1> format and make a radiographic exposure.

(7) Develop the film and use a ruler to measure the image.

(8) If the exposure is 9-1/8" (±1/8") in both directions, the shutters are calibrated. Proceed to step 5f.

(9) If neither measurement meets this criteria, both the longitudinal and cross pots must be adjusted. Proceed to step 5e(10).

(10) If only the longitudinal shutter measurement is not within specification, proceed to steps 5e(12), 5e(13), 5e(16), and 5e(17).

(11) If only the cross shutter measurement is not within specifications, proceed to steps 5e(14) through 5e(17).

(12) While pressing and holding the PREP switch, set CAL/MOD switch, SW2, to position 6 and release the PREP switch.

(13) Adjust, R37 the longitudinal gain pot, for a display exposure of 9-1/8" (± 1/8"). The following will help in the adjustment:

(a) An increase in the value shown on the display reflects a decrease in the exposure size. Six A/D units equals approximately 0.1 inches.

(b) A decrease in the value shown on the display reflects an increase in the exposure size. Six A/D units equals approximately 0.1 inches.

(14) While pressing and holding the PREP switch, set CAL/MOD switch, SW2, to position 7 and release the PREP switch.

(15) Adjust R41 (Cross Gain), for a display exposure of 9-1/8" (± 1/8"). The following will help in the adjustment:

(a) An increase in the value shown on the display reflects a decrease in the exposure size. Six A/D units equals approximately 0.1 inches.

(b) A decrease in the value shown on the display reflects an increase in the exposure size. Six A/D units equals approximately 0.1 inches.

(16) Place the CAL/MODE switch, SW2, to position O. The word RUN should be displayed.

(17) Make a radiographic exposure, develop the film, repeat steps 4e(7) through 4e(16) until the exposure is 9-1/8" (± 1/8) in both directions.

(18) Select <9 On 1> format.

(19) Press PREP and move SW2 to position 7.

(20) If the calibration display reads approximately 130 A/D units, proceed to step 5e(21).

(21) Adjust pot R17 (1/9) on the Z80 Interface PCB (70-08077) clockwise to decrease the value and counterclockwise to increase the value. (See Figure 3-80.)

(22) Move SW2 to O (Run) position, then while pressing the PREP push button, move SW2 to position 7.

(23) If calibration display reads approximately 130 A/D units, proceed to step 5e(24). If this criteria is not met, repeat steps 5e(21) and 5e(22).

(24) Make a radiographic exposure in the <9 On 1> format.

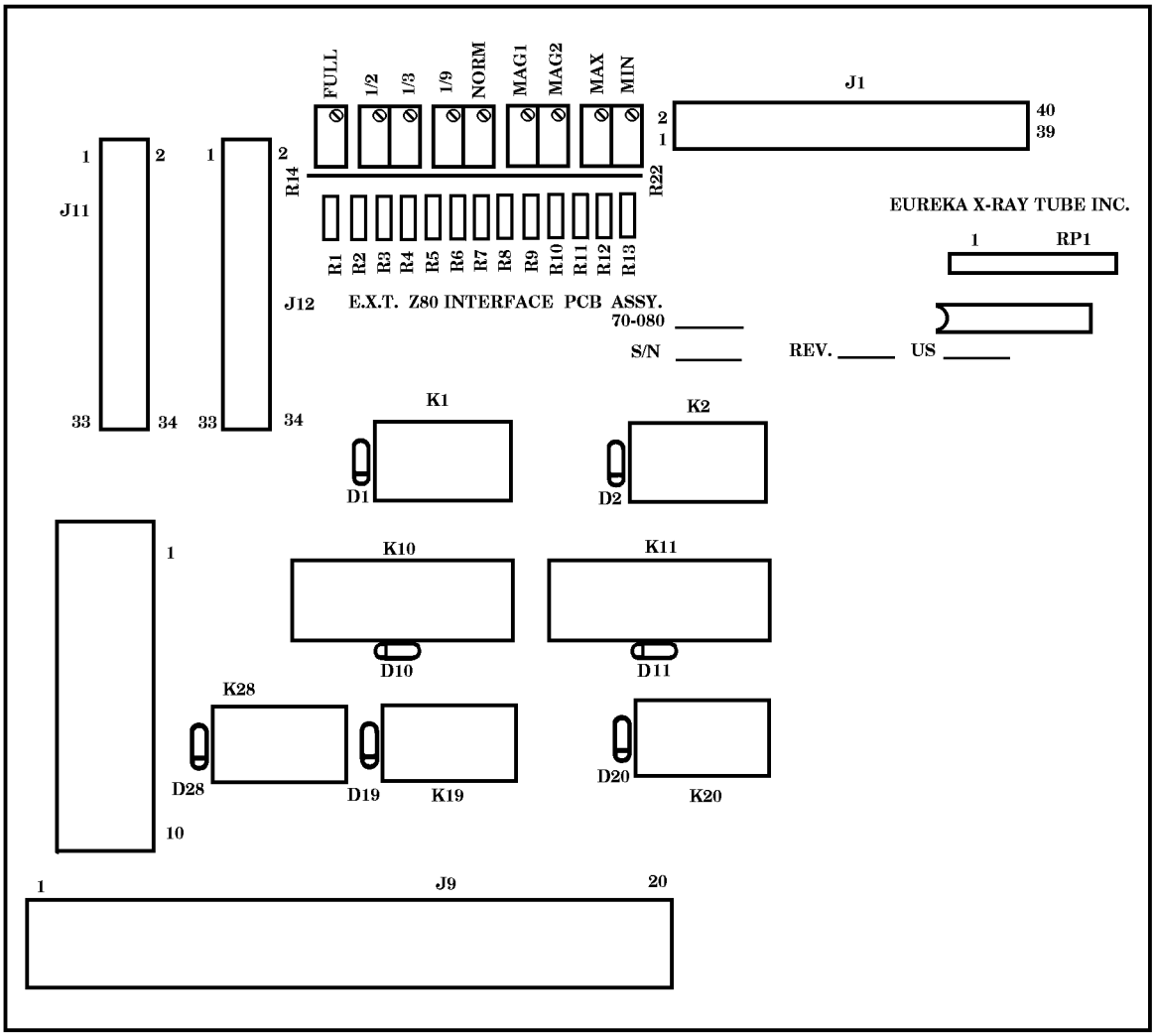

Figure 3-80

(25) Develop the film and measure the image.

(26) If the image measures 2-1/4" (± 0.20) in each direction, proceed to step 5e.

(27) Set SW2 to correspond to the larger of the two dimensions and manually close those shutters very carefully.

(a) Use position 7 for cross dimension.

(b) Use position 6 for longitudinal dimension.

(28) Adjust the appropriate offset pot to slightly increase the value of the calibration display (approximately 10 A/D units).

(a) Use pot R42 for cross direction (increasing the Offset value decreasing the image size).

(b) Use pot R38 for longitudinal direction (increasing the Offset value decreasing the image size).

(29) If one of the offset pots is adjusted, repeat step 5e(4) through 5e(25) until a good square is achieved in both <1 On 1> and <9 On 1> formats.

(30) Reattach the aluminum filter cover on the under-table collimator. Fasten securely the four (4) knurled screws. Return the tabletop to its proper position.

f. Perform fluoroscopic image size adjustment.

(1) Select the fluoro mode on the generator and open the collimator shutter blades to their maximum using the shutter controls on the SFD.

(2) Lower the SIS to its minimum SID.

(3) Depress the X-ray switch on the SFD and observe the fluoroscopic image.

NOTE: The collimator blades should be evenly visible at the edges of the display. If they are not, adjust NORM potentiometer, R18, on the SFD Interface Board until they are.

NOTE: If unable to obtain a square image on the image tube, go to step 5e.

(4) Vary the SID of the SFD while observing the fluoroscopic image.

(5) Verify that the image size remains the same as in 5f(3) and that all collimator blades are visible.

(6) Close the collimator shutter blades to their minimum using the shutter controls on the SFD.

(7) Verify that a small square or slightly rectangular image is displayed (less than 2 inches in any dimension). If it is not, adjust COLL MIN potentiometer, R22, on the Z80 Interface Board until the desired image is obtained.

g. Perform <1 On 1> (FULL) radiographic film adjustment.

(1) Lower the SFD to its minimum SID.

(2) Select the radiographic mode on the generator.

(3) Load an unexposed cassette into the SFD and place the film in the PARK position.

(4) Open the shutter blades to their maximum open position and select the <1-On-1> format.

(5) Select AUTO shutter mode to be ON.

(6) Make a radiographic exposure and develop the film.

(7) Measure the exposed area and verify that it is between 9-1/8" square (+ 1/8").

(a) If it is not, adjust FULL potentiometer, R14, on the Z80 Interface Board to increase or decrease the exposed area as required. For an increase in area, decrease A/D units; for a decrease in area, increase A/D units. A change of 6 A/D units equals approximately 0.1 inches.

(b) Repeat this procedure until the exposed area is within the limits described.

h. Perform <4-On-1> radiographic film adjustment.

(1) With the SFD at minimum SID and the radiographic mode selected at the generator, insert an unexposed film cassette and advance to the PARK position.

(2) The collimator blades should be set to their maximum open position.

(3) Select the <4-On-1> format, AUTO shutter mode to be ON, and make four radiographic exposures.

(4) Develop the film and measure the exposed areas.

(a) If the dimension of each exposed area is between 4-9/16" square (± 1/16") with no more that 3/16" gap or overlap between the images, proceed to step 5i.

(b) If necessary, adjust (HALF) pot, R1, on the Z80 Interface PCB, a small amount to increase or decrease the size of the image.

(c) If adjustments were made, repeat steps 5h(3) and 5h(4) until the exposed areas are within specifications.

i. Perform <6-On-1> radiographic film adjustment.

(1) With the SFD at minimum SID and the radiographic mode selected at the generator, insert an unexposed film cassette and advance to the PARK position.

(2) Ensure the collimator blades are set to their maximum open position.

(3) Select the <6-On-1> format, AUTO shutter mode to ON, and make six radiographic exposures.

(4) Develop the film and measure the exposed areas.

(a) The dimension of each exposed area should be 4-9/16" square (± 1/16") with no more that 3/16" gap or overlap between the images. Proceed to step 5j if these requirements are met.

(b) If necessary, adjust (HALF) pots, R15 and R16 (1/3), on the Z80 Interface PCB, a small amount to increase or decrease the size of the image.

(c) If adjustments were made, repeat steps 5i(3) through 5i(4)(c) until the exposed areas are within specifications.

j. Perform 9-ON-1 radiographic film adjustment.

(1) With the SFD at minimum SID, select the radiographic mode on the generator.

(2) Insert an unexposed film cassette and advance to the PARK position.

(3) Ensure the collimator blades are set to their maximum open position.

(4) Select the <9-On-1> format, AUTO shutter mode ON, and make nine radiographic exposures.

(5) Develop the film and measure the exposed areas.

(a) The dimension of each exposed area should be 2-1/4" square (± 1/8") with no more than 3/16" gap or overlap between the images. Proceed to step 5k if these requirements are met.

(b) If necessary, adjust pot, R17 (1/9), on the Z80 Interface PCB, a small amount to increase or decrease the size of the image.

(c) If adjustments were made, repeat steps 5j(4) and 5j(5) until the exposed areas are within specifications.

k. Perform SID tracking verification.

(1) Raise the SFD to its maximum SID.

(2) Repeat steps 5g through 5j and verify that the film sizes are within the limits specified for each format.

NOTE: If they are not, it may be necessary to recalibrate the SID tracking system. Refer to step 5c for adjustment.

6. Perform over-table collimator checks.

NOTE: The following procedures form a key troubleshooting aid by using internal SID an IR signals to check for correct Logic PCB and collimator response, followed by use of external signals to check the wiring. Although some signals are internally simulated, external wiring or component defects can prevent proper operation by producing false input signals. An external short circuit to ground, for example, on the 40" SID switch will prevent the 40" indicator from coming ON. During any of the following tests, an incorrect indication or operation must be identified and corrected before continuing with the tests.

CAUTION

The following procedures are written in a specific sequence; do not alter.

a. Conduct collimator tilt switch check.

(1) Remove the collimator cover.

(2) Set the switches on the logic PCB shown in Figure 3-81 as follows:

SW2-1	OFF	SW3-1	OFF
SW2-2	OFF	SW3-2	OFF
SW2-3	OFF	SW3-3	OFF
SW2-4	OFF	SW3-4	OFF
SW2-5	OFF	SW3-5	OFF

(3) Position the tilt switch at 0° horizontal. Angulate the collimator to a 0° beamdown position. Slowly angulate the collimator +20° toward a beam-left position and back to -20° toward a bean-right position.

NOTE: LED-4 must be on at 0° and remain on for +11° and -11° angulations. (See Figure 3-81.)

(4) Angulate the collimator to a +90° beam-left position and slowly angulate it to 20° down below horizontal (+70° from vertical).

NOTE: LED-1 must be on at +90° and remain on for 11° below horizontal (+79°).

(5) Angulate the collimator to a -90° beam-right position and slowly angulate it to 20° down below horizontal (-70° from vertical).

NOTE: LED-5 must be on at -90° and remain on for 11° below horizontal (-79°).

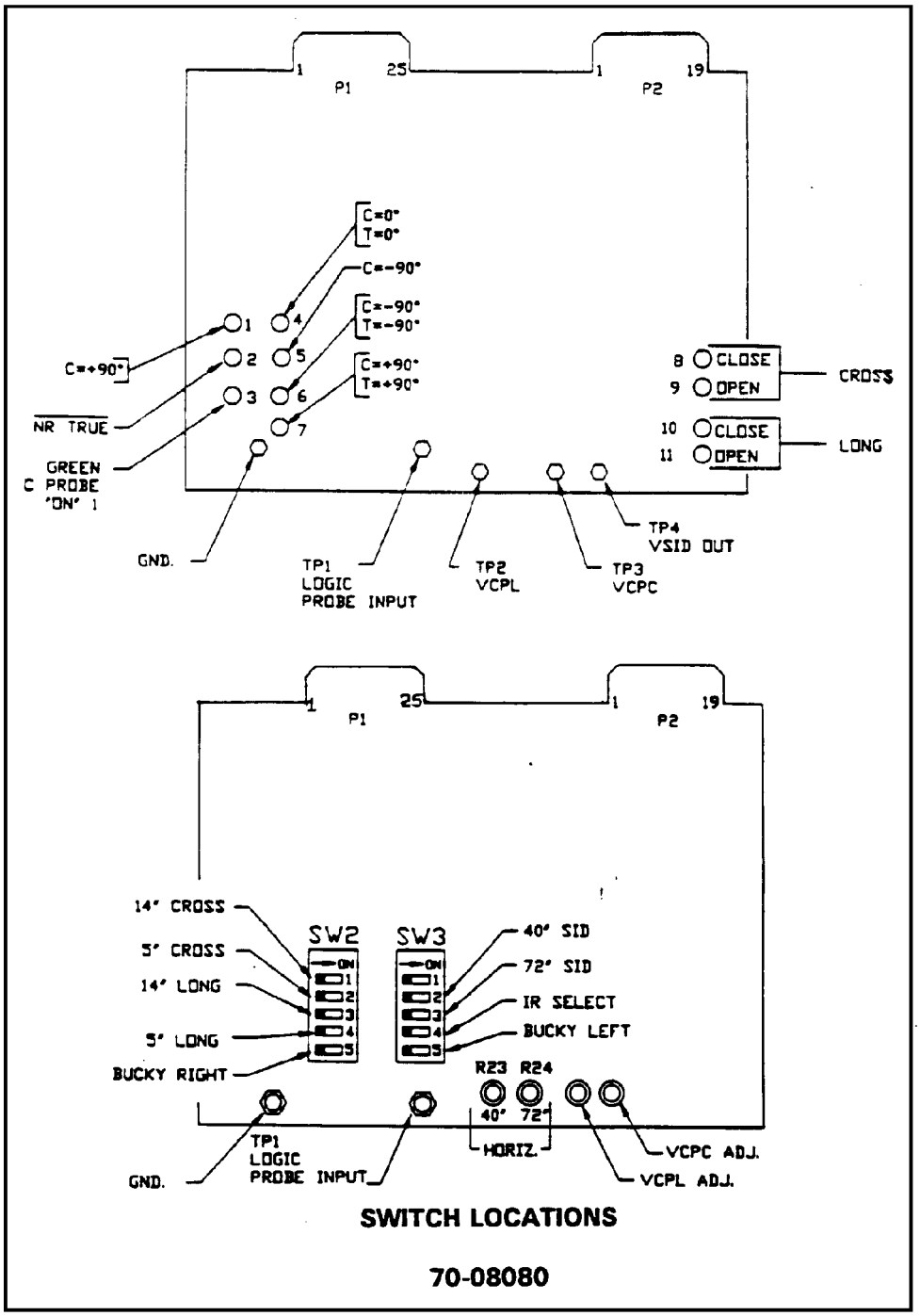
P1
P2
1
25
19
C=0°
T=0°
C=-90°
C=-90°
T=-90°
C=+90°
T=+90°
C=+90°
NR TRUE
GREEN
C PROBE
'ON' 1
CLOSE
OPEN
CROSS
CLOSE
OPEN
LONG
GND.
TP1
LOGIC
PROBE INPUT
TP2
VCPL
TP3
VCPC
TP4
VSID OUT
14° CROSS
5° CROSS
14° LONG
5° LONG
BUCKY RIGHT
SW2
SW3
40° SID
72° SID
IR SELECT
BUCKY LEFT
R23
R24
40°
72°
HORIZ.
VCPC ADJ.
VCPL ADJ.
GND.
TP1
LOGIC
PROBE INPUT
SWITCH LOCATIONS
70-08080

Figure 3-81

b. Conduct table tilt switch check.

(1) Verify that there is no jumper between TS2-5 and TS2-10 on the Logic PCB. Angulate the collimator to 0° beam-down. Angulate the table to 0° horizontal and slowly tilt it to +20° and then -20°.

NOTE: LED-4 must be on with the table at 0° and remain on for +11° and -11° from horizontal. (See Figure 3-81.)

(2) Position the table at +90° upright (usually about an actual +85°) and angulate the collimator to a +90° (LED-1 ON) beam-left position. Slowly tilt the table 20° down from the maximum upright position (+70°).

NOTE: LED-7 must be ON at a maximum upright and remain ON until the table is angulated down to +79°. (See Figure 3-81.) LED-1 will also be ON.

c. Perform logic and collimator operation checkout.

NOTE: The cassette tray must be removed for the following procedures.

(1) SW2-1 through 4 and SW3-1 through 4 of the Logic PCB must be OFF. (See Figure 3-81.)

(2) Angulate the table to 0° horizontal and the collimator to 0° beam-down position.

NOTE: LED-4 on the Logic PCB must be ON.

(3) Measure the distance from the center of the plastic exit window to the center of the light field on the table top. Set this distance to 30-5/8" ±1/16" in order to achieve 40" focal spot to table top distance.

NOTE: The ON and MANUAL indicators on the collimator front panel should be ON and LED-2 on the Logic PCB should also be ON. (See Figure 3-81.)

(4) Set SW2-1 and SW2-3 ON to simulate a 14" x 14" cassette. Set SW3-4 ON to simulate the insertion of a cassette in the cassette tray.

NOTE: LED-2 should switch OFF, the MANUAL indicator should switch OFF, and the HOLD indicator should switch ON.

(5) Set SW3-2 ON to simulate 40" SID switch closure. Move the front panel sliding SID scale knob to the 40" detented position.

(a) The 40" indicator should switch ON.

(b) The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

(c) The HOLD indicator should switch OFF.

(d) The READY indicators should switch ON.

(e) The light field size on the table top (40") should be about 14" x 14" on the table top. (Refer to manufacturer's instructions, FIGURE 5-3, for the test pattern and tape it into position.)

(6) Set SW3-2 OFF (to simulate the opening of 40" SID switch).

(a) The 40" indicators should switch OFF.

(b) The READY indicators should switch OFF.

(c) The HOLD indicator should switch ON.

d. Perform external SID signal check (horizontal).

(1) Angulate the collimator to 90 degrees with the X-ray beam at the wall mounted cassette holder. Angulate the table to 0 degrees horizontal.

NOTE: If the cassette holder is on the wall adjacent to the head end of the table, the collimator must be at +90 degrees beam-left.

(2) Check the LEDs and switches on the Logic PCB as shown in Figure 3-81.

(a) LED-1 should be ON.

(b) Set SW3-5 to the ON position and SW2-5 to the OFF position to select left-wall operation.

(3) Move the collimator horizontally to a 40" SID and slowly move the collimator to a greater and then lesser SID.

(4) Ensure the 40" indicator on the collimator is ON at a measured 40" SID and switches OFF at a maximum of 40.40" and at a minimum of 39.60" SID.

e. Perform table receptor SID signal check.

NOTE: The LEDs and switches are located on the Logic PCB as shown in Figure 3-81.

(1) Angulate the table to a full upright position. Angulate the collimator beam left to aim the X-ray beam at the upright table cassette tray. LED-7 on the logic PCB must be ON .

(2) Move the collimator horizontally to a 40" SID and slowly move the collimator to a greater and then to a lesser SID.

(3) Ensure the 40" indicator on 40" SID, switches OFF at a maximum of 40.40" and OFF again at a minimum of 39.60" SID.

f. Perform external IR signals check.

NOTE: The LEDs and switches are located on the Logic PCB as shown in Figure 3-81.

(1) Set the switches as follows:

(a)	SW3-1	OFF	SW4-1	OFF
(b)	SW3-2	OFF	SW4-2	OFF
(c)	SW3-3	OFF	SW4-3	OFF
(d)	SW3-4	OFF	SW4-4	OFF
(e)	SW2-5	OFF	SW3-5	ON

(2) Angulate the collimator 0 degrees beam-down direction with a measured SID of 40" measured to the bucky. Angulate the table to 0° horizontal.

(a) Ensure the MANUAL indicator is ON.

(b) Ensure LED-2 on the Logic PCB is ON.

(c) Ensure the 40" indicator is ON.

(3) Locate a cassette in the table cassette holder and fully insert the tray into the bucky.

(a) Ensure the MANUAL indicator switches OFF.

(b) Ensure the HOLD indicator switches ON.

(c) Ensure LED-2 switches OFF.

(d) Ensure the collimator field size indicator (front panel) rapidly adjusts and stops.

(e) Ensure the HOLD indicator switches OFF.

(f) Ensure the READY indicators switch ON.

NOTE: The light field size on the table-top should be about the same size as the cassette inserted into the cassette tray. Do not remove the cassette at this time.

(4) Tilt the table to full upright at +79° without a cassette in the table bucky. Check for the following to occur:

(a) LED-2 on the Logic PCB switches ON.

(b) The READY indicator switches OFF.

(c) The MANUAL indicator switches ON.

(5) Angulate the collimator to +90° beam-left position. Insert a cassette into the cassette tray and fully insert the tray into the table bucky and ensure--

(a) LED-2 on the Logic PCB switches OFF.

(b) The HOLD indicator switches ON.

(c) The MANUAL indicator switches OFF.

(6) Move the collimator to each of the available SIDs to the tilted table (i.e. 40" or 72") and ensure--

(a) A SID indicator switches ON.

(b) The collimator field size indicators (front panel) rapidly adjust and stop.

(c) The HOLD indicator switches OFF.

(d) The READY indicator switches ON.

NOTE: The light field size should be about the same size as the cassette inserted into the table cassette tray.

g. Conduct final test switch settings test.

(1) Locate the LEDs and switches on the Logic PCB as shown in Figure 3-81.

(2) At the end of this test procedure, set the test switches as follows:

(a)	SW2-1	OFF	SW3-1	OFF
(b)	SW2-2	OFF	SW3-2	OFF
(c)	SW2-3	OFF	SW3-3	OFF
(d)	SW2-4	OFF	SW3-4	OFF

(e) SW2-5 OFF SW3-5 ON

h. Perform adjustment procedures.

(1) The following adjustment procedures are performed with the collimator located in a single fixed position above a test pattern located on the table top.

(2) The adjustments are made while observing the light field edges. It is necessary to confirm that the light field accurately represents the X-ray field. By establishing a defined light field and exposing a film to produce a density of 1.0, the X-ray field (image) can be compared to the light field.

(3) The Performance Standards 1020.30 (b)(22) and (45) define the edges of the light field as the locus of points at which the illumination is one-fourth of the maximum and the edges of the X-ray field as the focus of points at which the exposure rate is one-fourth of the maximum.

(4) Determine the X-ray field by exposing a film to a density of 1.0 on the developed image. Observe the points at which the density is just visibly increased above the base fog background of the film.

(5) In a similar manner determine the light field edges by observing the light field on a white background.

(6) Observe the points at which the light field is just visibly increased over the background illumination and compare this to the X-ray field (and to the tolerance marks on the pattern). Make the required adjustments.

i. Perform VCPL (R25) and VCPC (R26) verification.

NOTE: The over-table collimator has been tested and calibrated during manufacturing. The following procedure will confirm its performance and readjust the SID voltage to match the collimator and the IR (cassette tray) after installation.

CAUTION

Do not alter FACTORY SET adjustments. They are R25 (VCPL) and R26 (VCPC), both on the Logic PCB (70-08002).

NOTE: The R25 and R26 pots set the voltages to the collimator feedback pots. The voltages control the "Tracking" of the collimator, closed to open, and are extremely critical. If, in the unlikely event that they require adjustment, you can measure VCPL at TP-2 and VCPC at TP-3. The factory set values are recorded on the label inside the bottom cover.

NOTE: R26 controls the voltage to the CROSS feedback potentiometer and is used to balance CROSS to LONG after the correct X-ray field size has been set.

(1) Connect a DVM from logic ground to TP-2 (VCPL). Verify that the voltage reading on the DVM is the same as that recorded on the label inside the bottom cover of the collimator.

(2) If the voltage reading is not correct, adjust R25 to produce the voltage reading that has been recorded inside the bottom cover of the collimator.

(3) Connect the DVM from logic ground to TP-3 (VCPC). Verify that the voltage reading on the DVM is the same as that recorded on the label inside the bottom cover of the collimator.

(4) If the voltage reading is not correct, adjust R26 to produce the voltage reading that has been recorded inside the bottom cover of the collimator.

j. Conduct light field/X-ray congruence test.

(1) Place the X-ray source-to-table distance at 40" SID and lock it in place.

(2) Locate a cassette on the table top and accurately center the cassette to the light field. Mark the position of the cassette on the table top.

(3) Manually reduce the size of the X-ray field to the next smaller film size.

(4) Identify the light-field edges and carefully mark the edges by placing metal markers as illustrated below. (See Figure 3-82.)

(5) Expose the film to a density of 1.0 and develop it.

(6) Carefully identify the X-ray field edges and measure the difference between the X-ray field edges and the light field edges.

(a) The sum of long axis difference (X1 + X2) shall not exceed 2% of the SID, and the sum of the cross axis difference shall not exceed 2% of the SID. (See Figure 3-82.)

(b) If adjustment is required, proceed to steps 6j(7) through 6j(11). If no adjustment is necessary, proceed to step 6k.

(7) Remove the lamp cover and bottom cover of the collimator.

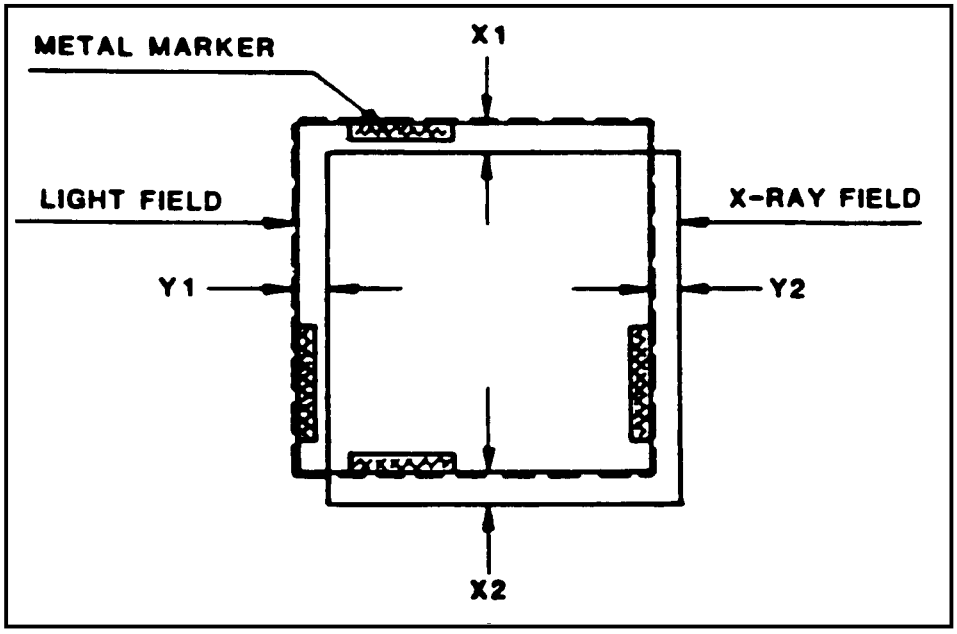

Figure 3-82

CAUTIONS

1. The lamp and heat deflectors may be hot enough to cause severe burns. Do not touch any object in the lamp with your bare skin.

2. The intensity of the light source is sufficient enough to cause temporary vision impairment if it is looked at directly.

3. Maintain a position that does not allow the filament to be seen when the light source is off.

(8) If the developed X-ray image is soft-centered in the longitudinal direction, loosen the screws securing the lamp bracket.

(9) Use a pair of long-nose pliers to move the bracket slightly until the light field has shifted to a position that is centered to the developed X-ray image in the longitudinal direction. Tighten the two screws securing the lamp bracket.

(10) If the developed X-ray image is in error in the cross-table, adjust the angle of the mirror using the knurled nuts until the light field has shifted to a position that is centered to the developed X-ray image. (See Figure 3-83.)

(11) Repeat steps 6j(3) through 6j(6(b) to confirm the results of the above adjustments.

(12) Tighten the lamp bracket screws and replace the lamp housing cover.

k. Perform 40" SID adjustment.

NOTE: The switches are located on the Logic PCB as shown in Figure 3-81.

(1) Angulate the collimator to a 0° beam-down position and the table top to 0° horizontal.

(2) Place the TEST PATTERN on the table top and tape it into position at the corners.

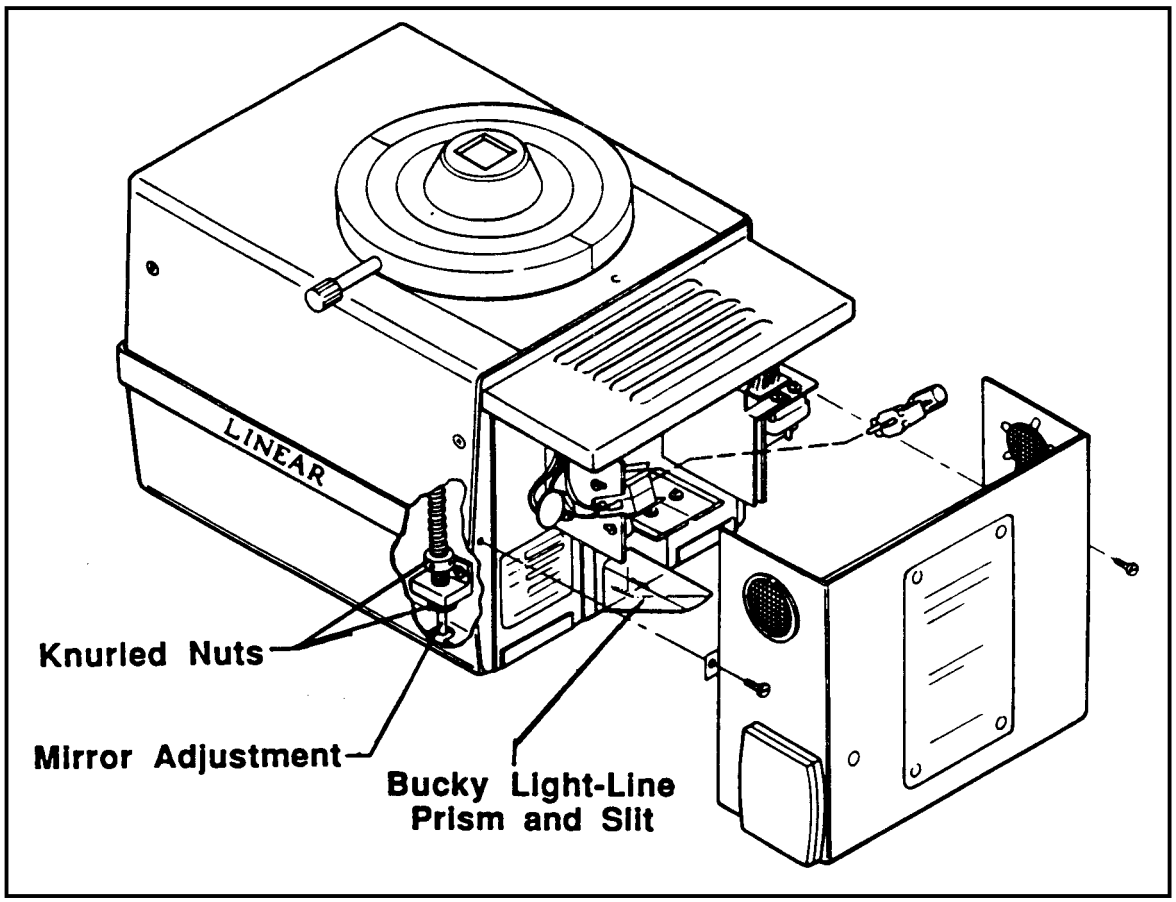

Figure 3-83

(3) Position the collimator at a focal spot distance of 40" ± 1/16" by measuring from the center of the exit window to the center of the light field on the table top; this distance should be 30-5/8" ± 1/16".

(4) If necessary, remove the bottom collimator cover to gain access to the program switches on the Logic PCB.

NOTE: Ensure there is no cassette in the bucky.

(5) Set SW3-2 "ON" to simulate 40" HSID.

(6) Set SW2-1 and SW2-3 "ON" to simulate a 14" x 14" cassette.

(7) Set SW3-4 "ON" to simulate the insertion of the 14" x 14" cassette.

NOTE: The light field edges should now be inside the 14" x 14" at 40" SID tolerance marks on TEST PATTERN.

(8) If the light field edges are not within the 14" x 14" cassette at 40" SID tolerance marks, adjust the 40" SID pot R23 a small amount (7.0 VDC nominal on TP-4, IC3-pin 1, Logic PCB or TS3-4, power supply). Manually turn the collimator knobs to a larger size and release them. The shutters will reset to the new size by adjusting R23.

(9) Repeat the steps above until the light field edges are within the 14" x 14" x 40" SID tolerance marks.

l. Conduct collimator feedback linearity test.

NOTE: The following test will quickly confirm the correct factory settings of the shutter feedback potentiometers by simulating a 14" x 14" cassette, then stimulating a 5" x 5" cassette. The "errors" of each of these field sizes must be the same.

(1) EXAMPLE 1.

Field size, Step 3.14.1 = 14.5" x 14.5" = +0.5" error
Field size, Step 3.14.5 = 5.5" x 5.5" = +0.5" error

CONCLUSION: Errors are consistent, collimator passes linearity test, proceed with Step 3.14.7

(2) EXAMPLE 2.

Field size, Step 3.14.1 = 13.7" x 13.7" = -0.3" error
Field size, Step 3.14.5 = 5.4" x 5.4" = +0.4" error

CONCLUSION: Errors are inconsistent, collimator fails linearity test, replace the collimator head (PN 6685.402).

(3) EXAMPLE 3.

Field size, Step 3.14.1 = 13" x 14" = (Testing Stopped)

CONCLUSION: Errors in only one field size test inconsistent, resulting in a "rectangular" X-ray field size, collimator fails test. Replace the collimator head (PN 6685.402).

(4) Measure the light field in the CROSS direction and the LONG direction and record. The CROSS size must match the LONG size within 0.20". The switches are located on the Logic PCB. (See Figure 3-81.)

(a) Set SW3-4 OFF (Cassette removal).

(b) Set SW2-1 and SW2-3 OFF, then Set SW2-2 and SW2-4 ON (exchanging 14" x 14" IR with a 5" x 5" IR).

(c) Set SW3-4 ON to simulate the insertion of the 5" x 5" cassette in the cassette tray. Allow the system to readjust until both READY lights come on.

(5) Measure the light field in the CROSS direction and the LONG direction and record. The CROSS size must match the LONG size within 0.20".

NOTE: If they do not match, replace the collimator head.

(6) Set SW3-4 ON (insertion of cassette).

(7) Reset the test switches as follows:

(a)	SW2-1	OFF	SW3-1	OFF
(b)	SW2-2	OFF	SW3-2	OFF
(c)	SW2-3	OFF	SW3-3	OFF
(d)	SW2-4	OFF	SW3-4	OFF
(e)	SW2-5	OFF	SW3-5	ON

m. Perform cassette tray adjustment.

NOTE: The collimator has been calibrated for a cassette tray that is calibrated at 500 ohms for an 11" (12-1/8" outside) cassette. The 11" dimension represents exactly one-half of the 1K ohm cassette tray potentiometer.

(1) Refer to the tray manufacturer's manual for adjustment procedures.

(2) Refer to Figure 3-84 for the cassette size and corresponding resistance values.

Cassette Size	Pins	Ohms between 1-5 and 4-8
5"		60 Ohms
7		207
8		280
10		427
11		500
12		573
14		720
17		940

(3) Make adjustments as necessary.

n. Perform cross-hair window adjustment.

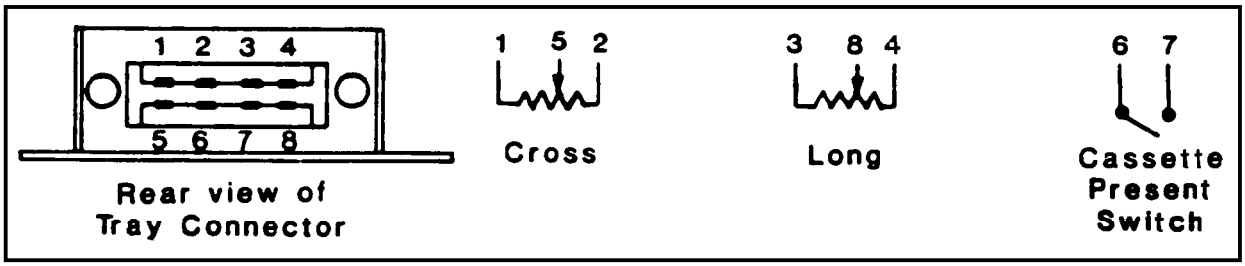

Figure 3-84

(1) Check cross-hair shadow to determine if it is centered in the light field. If centered, proceed to step 6(o). If it is not centered, proceed to step 6n(2).

(2) Remove the accessories track and the lower half of the collimator case. (See Figure 3-80.)

(3) Loosen the screws securing the plastic window.

(4) Move the plastic window to align and center the cross hair pattern to the light-field (center lines on the test pattern).

(5) Tighten the screws and reassemble the collimator cover.

o. Make bucky centering line-light adjustment.

NOTE: These procedures are to be performed if the centering light-line is not centered to the correctly adjusted light field.

(1) Remove the lamp housing cover.

CAUTIONS

1. The lamp and heat deflections may be hot enough to cause severe burns. Do not touch any object in the lamp area with your bare skin.

2. The intensity of light output is sufficient to temporarily impair your vision if allowed to enter the eyes directly.

3. Maintain a position that does not allow the filament to be seen when the light source is off.

(2) If the centering light-line is off-center to the correctly centered light field or exhibits a rainbow of colors along one edge, loosen the two screws securing the prism/slit bracket. (See Figure 3-82.)

(3) Use a pair of long-nose pliers to move the bracket as required to center the light-line with the light field and mark on the handle of the cassette tray.

NOTE: In order to avoid a rainbow of color along the edges or to eliminate these colors, maintain the prism in a position that is centered to the bright light-line observed on the bracket at the base of the prism while adjusting the bracket.

(4) Tighten the screws and replace the lamp housing cover.

7. Perform automatic exposure control calibration.

a. The following calibration instructions must be completed.

NOTE: This procedure provides instructions on matching the automatic exposure control (AEC) exactly to the generator and to the X-ray absorption characteristics of the screen-film combination to be used with that generator.

(1) The kVp level adjustment (step 7c) matches the AEC kVp measuring circuitry to the generator kVp range.

(2) The input amplifier gain adjustment (step7e) matches the AEC to the screen-film combination near the midpoint of the kVp range.

(3) Complete the kVp compensation procedure (step 7f), then complete the matching of the AEC to the screen-film combination by fine tuning four additional kVp set points on the kVp compensation curve.

(4) The fine tuning is accomplished by making an X-ray exposure, measuring the resultant optical density of the film, adjusting (if necessary) each kVp set point according to a simple formula, and then rechecking with another exposure.

b. Calibration/test set up.

(1) The collimation and location of the X-ray tube/arm must remain unchanged throughout the entire calibration procedure.

(2) The X-ray tube/arm must be centered precisely on the center line of the focused grid.

(3) The SID must remain unchanged throughout the entire calibration procedure and must be within the range of the focused grid.

(4) The phantom must be homogeneous and must completely cover all three fields of the ion chamber. The phantom must sit on the table top. Both the table top and phantom must be level.

(5) The X-ray beam must be collimated to completely cover all three fields of the ion chamber, but the X-ray beam must not be allowed to pass outside of the phantom even near its base.

NOTE: If during calibration it is necessary to make an adjustment on the preamplifier board of the three field ion chamber, the calibration/test set up must be maintained as above. To do this, position the X-ray tube/arm and film cassette at the foot (right) end of the table. Reposition the table top so that it will still support the phantom in the proper location but will also allow access to the preamplifier board.

(6) Calibrate the AEC for a particular screen/film combination. A change in the screen/film combination will require the recalibration of the system.

(7) Ensure the film processor is in stable operating condition before calibrating the AEC.

NOTE: A change in the film processor (i.e., a change in the operating temperature, replenishment of the processing chemicals, or even a change from one processor to another) during the calibration of the AEC could give results that appear to be inconsistencies in the operation of the AEC. (See Table 3-10 for information on the necessary schematics and assembly drawings for printed circuit boards requiring adjustment. The drawings are located in Chapter 13, Section 7 of manufacturer's literature.)

c. Perform kVp level adjustment.

NOTE: This procedure matches the AEC kVp selection circuitry to the actual kVp output levels of the generator. (See Figure 3-85 for adjustment component locations.)

(1) Turn the generator on.

(2) Turn the AEC on.

(3) Select normal density.

(4) Switch on 60907 SW3 to light LED (kVp level indicators).

(5) Select 100 kVp.

(6) Adjust 60907 R97 so that LED 60907 L3 just goes out and LED 60907 L4 just comes on.

PCB PART NUMBER	SCHEMATIC FIGURE	ASSEMBLY FIGURE	PARTS LIST TABLE
60899B	7-1	7-9	7-1
60900F	7-2	7-10	7-2
60907F	7-3	7-11	7-3
60916C	7-4	7-12	7-4
60917C	7-7	7-13	7-6
60932C	-	7-16	-
60940D	7-8	7-14	7-7
60905D	-	7-17	-
61017C	7-5	7-15	7-5
61061A	-	7-18	-
74074A	-	7-19	-

Table 3-10. PCB DRAWING REFERENCE

(7) Select 125 kVp.

(8) Adjust 60907 R95 so that LED 60907 L4 just goes out and LED 60907 L5 only comes on.

(9) Select 50 kVp.

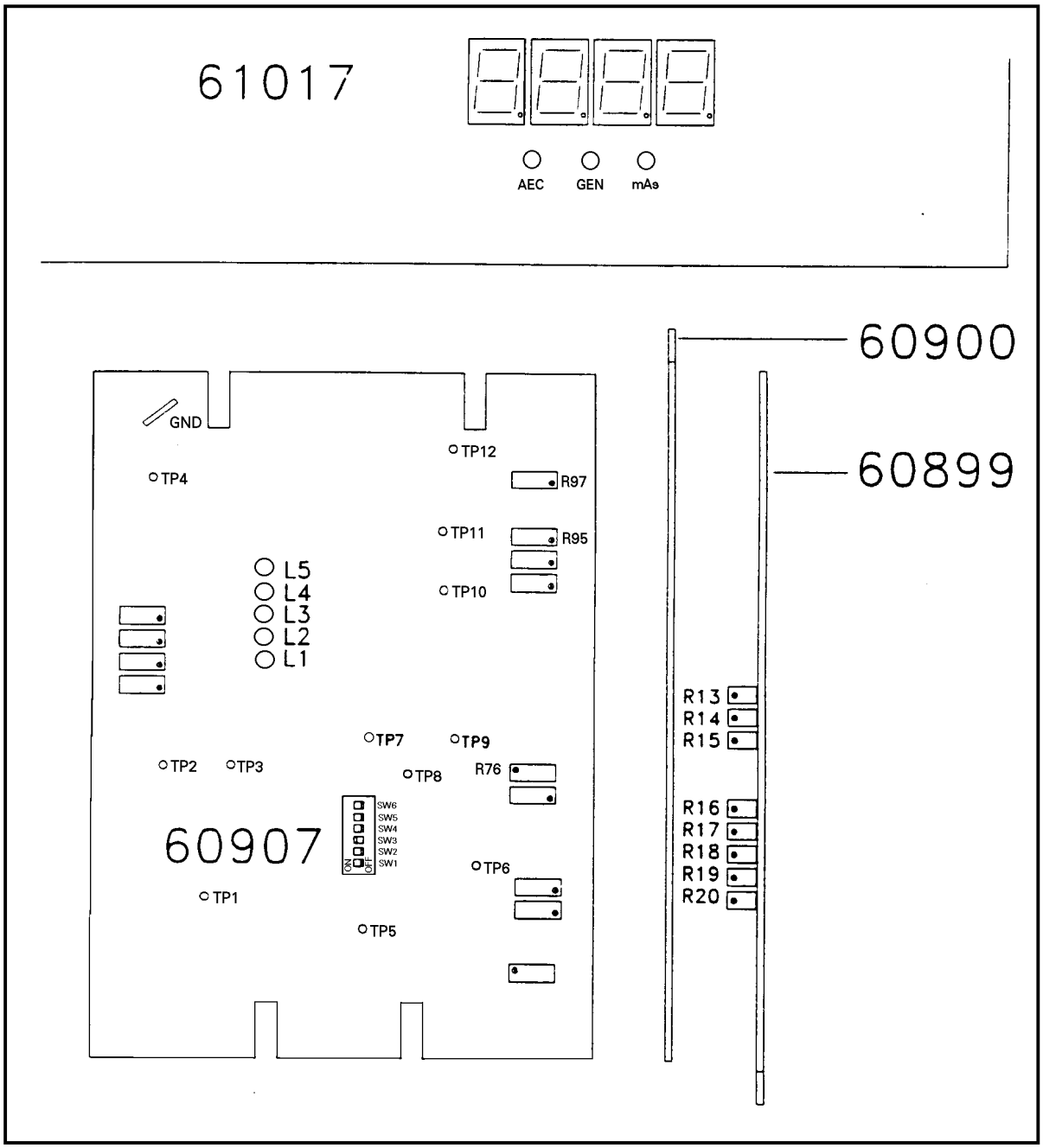

Figure 3-85

(10) Adjust 60907 R76 so that LED 60907 L1 just goes out and LED 60907 L2 only comes on.

(11) Turn OFF 60907 SW3.

d. Perform field matching.

NOTE: The output of the individual fields of a three-field ion chamber is calibrated at the factory. This adjustment may require fine tuning in the field.

NOTE: Field matching is based on the optical density (OD) of actual exposures rather than on mAs readings because of the effects of grids, anode-heel effects and back scatter. Therefore, it will be necessary to make exposures, process films, and measure optical densities in order to precisely match the three fields.

NOTE: Refer to Figure 3-86 for preamplifier field gain adjustment locations. Set the X-ray generator at 100 kVp, 100 mA large focal spot, and 5 second backup. Select density N (normal). Select center field alone.

(1) Position the phantom (10 inches of water or equivalent) as described in step 7b.

(2) Place a cassette loaded with an unexposed sheet of film in the cassette holder. Make an X-ray exposure. Record the mAs reading on the AEC 61017 display board.

(3) Develop the film. Measure and record the average OD near the center of the exposure. Mark this film CENTER.

(4) Select Left Field alone and repeat steps 7d(3) and 7d(4). Mark this film LEFT.

(5) Select Right Field alone and repeat steps 7d(3) and 7d(4). Mark this film RIGHT.

(6) Compare the optical densities of the films for the three fields.

(a) If the optical densities of the three films are within 10% of each other, proceed to step 7e.

(b) If the optical densities of the three films are not within 10% of each other, make adjustments to the appropriate field gain adjustment on the 60917 Preamplifier board and repeat steps 7d(2) through 7d(6), as needed.

e. Perform input amplifier gain adjustment.

(1) Refer to step 7b for calibration/test set-up and Figure 3-85 for input amplifier gain adjustment location.

(2) Set the X-ray generator at 100 kVp, 100 mA large focal spot, and 5 second backup.

(a) Select Density N (Normal).

(b) Select Center Field alone.

(3) Position the phantom (10 inches of water or equivalent) as described in step 7b.

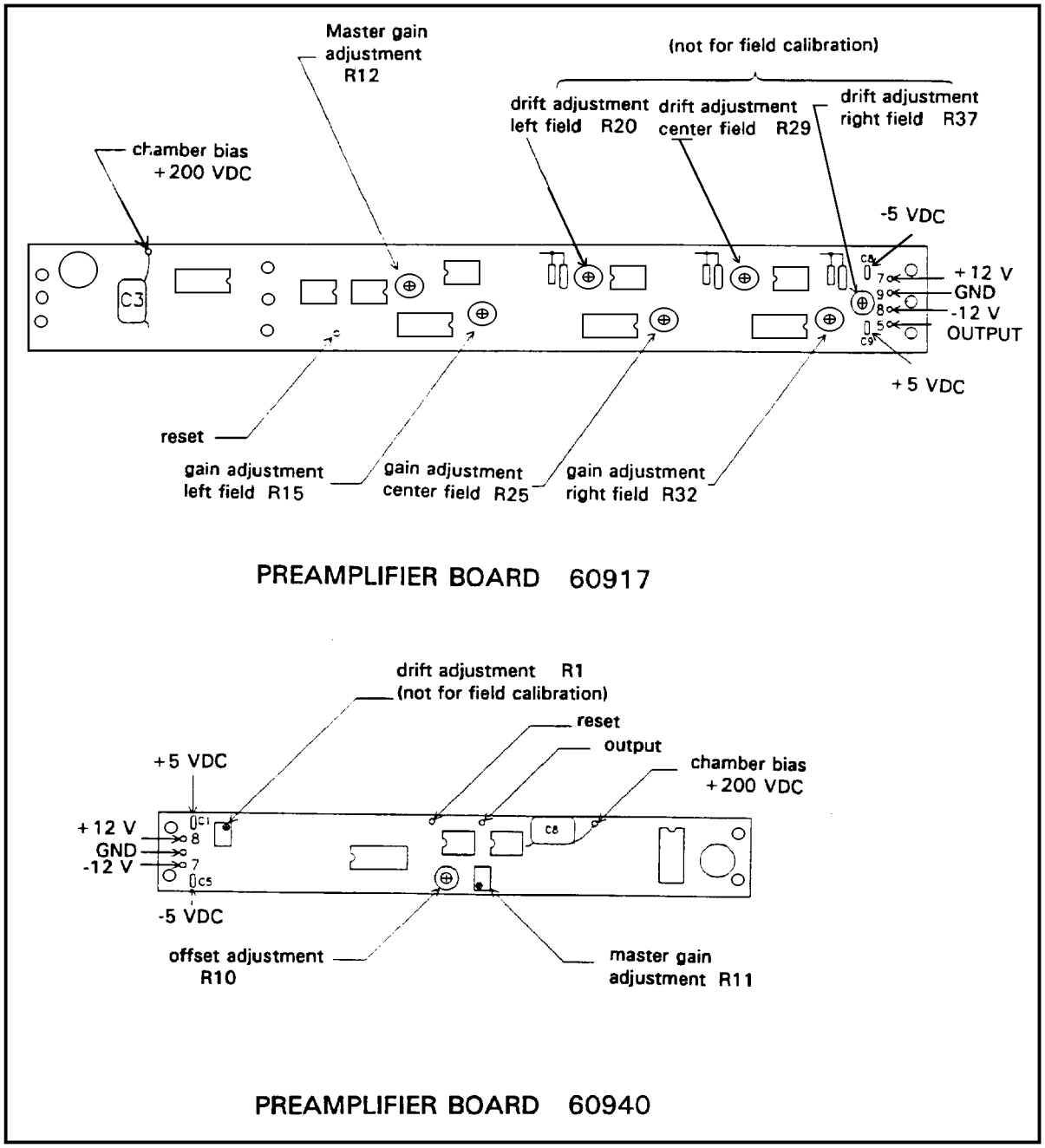

Figure 3-86

(4) Place a cassette loaded with an unexposed sheet of film in the cassette holder. Make an X-ray exposure. Record the mAs reading on the AEC 61017 display board.

(5) Develop the film. Measure and record the average OD near the center of the exposure.

(a) If the optical density is 1.20 ± 0.15, proceed to step 7f.

(b) If the optical density is not 1.20 ± 0.15, proceed to step 7e(6).

(6) Determine an approximate value of mAs to correspond to OD = 1.20 by using the following equation:

$$\text{New mAs} = \frac{1.2 \times \text{Old mAs (from step 7e(3))}}{\text{OD (from step 7e(4))}}$$

(7) Repeatedly make exposures with the loaded film cassette until adjustment of the preamplifier gain 60899 R14 produces the mAs reading calculated in step 7e(6). Repeat steps 7e(3) through 7e(5).

NOTE: If there is insufficient gain adjustment at 60899 R14, it may be necessary to adjust the preamplifier master gain and repeat steps 7e(3) through 7e(5). Refer to Figure 3-86 for preamplifier master gain adjustment location.

f. Perform kVp compensation.

NOTE: This procedure requires the prior calibration of chamber gain.

(1) Select Density N (Normal).

(2) Select Center Field alone.

(3) Set the generator at 100 mA large focal spot and 5 second backup.

(4) Select one of the generator kVp settings and a corresponding phantom thickness from Table 3-11.

Generator kV Setting	Phantom Thickness in Inches	CRV Adjustment Potentiometer on PCB 60899	Final CRV Settings 60907 TP1
125	12	R19	
150	12	R20	
75	7	R17	
50	5	R16	

Table 3-11. kVp COMPENSATION SETTINGS

(5) Place a film cassette in the cassette holder.

(6) Measure the Compensation Reference Voltage (CRV) for the selected kVp at 60907 TP1.

(7) Make an X-ray exposure at the selected kVp with a loaded film cassette.

(8) Develop the film and measure the average Optical Density (OD) near the center of the exposure.

(a) If the OD is 1.20 ± 0.15, record the CRV in Table 3-11 for future reference and proceed to step 7g.

(b) If the OD is not 1.20 ± 0.15, proceed to step 7f(9).

(9) Use the following equation to calculate a new CRV setting to obtain the appropriate desired OD.

$$\text{New CRV} = \frac{1.20}{\text{OD (from Step 7f(8)}} \times \text{Old CRV (from step 7f(8))}$$

NOTE: If the exposure required to reach the desired OD exceeds the mAs limit of the AEC or X-ray generator, then the phantom thickness must be adjusted to allow the proper exposure.

(10) Adjust the CRV at 60907 TP1 for the selected kVp using the pot on PCB 60899 as indicated in Table 3-10, to give the new CRV which was calculated in step 7f(9). Repeat steps 7f(7) and 7f(8).

(11) Repeat steps 7f(4) through 7f(8) for all kVp settings listed in Table 3-10 to obtain films with optical densities of 1.20 ± 0.15

g. Check spot film chamber.

(1) Refer to step 7b for calibration/test set-up.

(2) See Figure 3-86 for preamplifier gain adjustment location.

(3) Set the X-ray generator at 100 kVp, 200 mA large focal spot, and 5 second backup.

(a) Select Density N (Normal).

(b) Select the spot field ion chamber.

(4) Position the phantom (10 inches of water or equivalent). (See step 7b.)

(5) Place a cassette loaded with an unexposed sheet of film in the cassette holder. Select <1-On-1> format, with AUTO SHUTTER ON. Make an X-ray exposure. Record the mAs reading on the AEC 61017 display board.

(6) Develop the film. Measure and record the average OD near the center of the exposure.

(a) If the optical density is 1.20 ± 0.15, proceed to step 7g.

(b) If the optical density is not 1.20 ± 0.15, proceed to step 7g(7).

(7) Determine an approximate value of mAs to correspond to OD = 1.20 by using the following equation:

$$\text{New mAs} = \frac{1.2}{\text{OD (from step 7g(6))}} \times \text{Old mAs (from step 7g(5))}$$

(8) Repeatedly make exposures with the loaded film cassette until adjustment of the preamplifier gain produces the mAs reading calculated in step 7g(7).

(9) Repeat steps 7g(5) and 7g(6).

(10) See Figure 3-86 for preamplifier master gain adjustment location.

8. Perform image intensifier calibration-image tube focus.

CAUTION

The screwdriver used to adjust P2 must have an insulating shaft and handle. The potentiometer slider is at 3800 V with respect to ground, and the insulation value between the slider and the potentiometer shaft is only 1000 V.

a. Locate the potentiometers for focus adjustment of the Intensifier Tube on the left side of the power supply. They are labeled.

b. Remove the outer cover of the power supply to access these potentiometers.

c. For the adjustment procedure, it is necessary to use a 0.2-mm spaced metallic (stainless steel or copper) wire mesh of 2/10 mm diameter that can be attached, with masking tape, to the Spot Film Device directly beneath the Intensifier Tube. This screen will provide an adequate image to ensure proper focusing.

d. With the screen in place, initiate a Fluoroscopic exposure, and begin adjusting. (Refer to manufacturer's instructions, System Operation Section, Chapter 5, for taking a Fluoroscopic exposure.)

e. To obtain a correct image--

(1) First check output voltages V4 (+2.5 to 3.0 KVDC) and V5 (+27 ± 0.15 KVDC).

(2) Adjust g1 electrode voltage, V1, by means of potentiometer P8, clockwise from the extreme counterclockwise position until the size of the image goes through a maximum. Stop just beyond the maximum size.

(3) Adjust g2 electrode, V2, by means of potentiometer P5 until optimum focusing is obtained. Slightly readjust g1 electrode voltage, P8, in both directions to determine optimum focus position.

(4) Discontinue the exposure and replace the power supply's out cover once the image is satisfactorily adjusted.

9. Record the results of the calibration on the appropriate forms and records.

Evaluation Guide

Performance Measures	**Results**	
1. Perform precalibration checks.	P	F
2. Perform generator calibration.	P	F
3. Complete the calibration of the X-ray generator using noninvasive meters.	P	F
4. Complete the calibration of the X-ray generator using a dynalyzer.	P	F
5. Perform under-table collimator calibration.	P	F
6. Perform over-table collimator calibration.	P	F
7. Perform automatic exposure control calibration.	P	F
8. Perform image intensifier calibration.	P	F
9. Record the results of the calibraton.	P	F

REFERENCES:	***Required***	***Related***
	CS-8952 Field Deployable X-ray System Maintenance Manual, Volume I.	AR 40-61

081-874-0038

REPAIR A SINGLE PHASE RADIOGRAPHIC UNIT TO MODULE/BOARD LEVEL (CONTINENTAL X-RAY UNIT)

CONDITIONS

You have received DA Form 2407 requesting repair of a single phase X-ray unit. Necessary materials and equipment: manufacturer's service literature, DA Form 2409, TB Med 7, TB 38-750-2, tool kit (medical equipment organizational maintenance), and individual tool box.

STANDARDS

The malfunction is isolated to module/board level and corrected. The unit is functional in accordance with operational standards specified in the manufacturer's service literature. Results are recorded on DA Forms 2407 and 2409.

TRAINING/EVALUATION

Evaluation Guide

Performance Measures	**Results**	
1. Review DA Form 2407.	P	F
2. Determine maintenance expenditure limits (MEL) for definite life equipment.	P	F

a. Obtain the current replacement cost.

b. Calculate the percentage of useful life remaining for the item by dividing the life remaining in months by the life expectancy in months.

c. Use the chart at Figure 3-87 to determine the MEL factor. Read up vertically from the percent of useful life remaining to a point of intersection with the base line.

d. Project a horizontal line to the MEL factor.

e. Multiply the MEL factor by the current replacement cost to determine maximum allowable repair cost.

NOTE: Under certain conditions, the MEL may be waived. (See TB Med 7.)

NOTE: The MEL for definite life equipment which has reached or exceeded its life expectancy is 10 percent. This MEL remains constant for as long as the equipment is in use, regardless of age.

Performance Measures **Results**

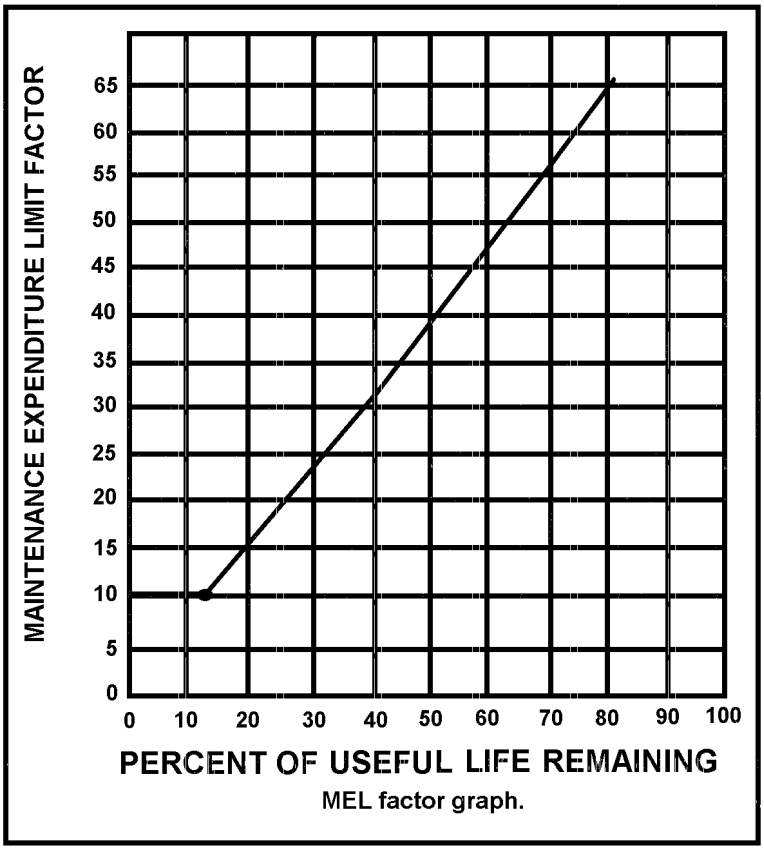

Figure 3-87

3. Perform a visual inspection. P F

a. Examine all cables for signs of damage.

b. Examine all connectors for signs of corrosion or damage.

c. Seat all connectors firmly in their sockets.

d. Check the X-ray generator, collimator, and remote hand control for signs of damage from a blow, dropping, or exposure to heat or moisture.

e. Inspect controls for maladjustment that may prevent normal operation.

4. Troubleshoot and isolate the malfunction to modular level. (Refer to the TROUBLESHOOTING section of the manufacturer's service literature.) P F

Performance Measures	Results
5. Replace the faulty module(s)/board(s).	P F
6. Perform function check.	P F
7. Determine the disposition of the unit.	P F
a. Prepare to release the unit to the user if the function check is satisfactory.	
b. Take the unit out of service if uncorrected deficiencies are present and they present a danger to patients or operator if the machine could be damaged due to continued use.	
c. Refer to the next higher echelon of maintenance, if necessary.	
8. Complete and file DA Forms 2407 and 2409 IAW TB 38-750-2.	P F
a. Obtain the hand receipt copy of DA Form 2407 from the user if the equipment was repaired in the shop.	
b. Obtain the user's signature for receipt of the unit, as appropriate.	
c. Release the unit to the user.	

REFERENCES:	*Required*	*Related*
	Manufacturer's Service Literature TB 38-750-2 TB Med 7	AR 40-61 AR 710-2