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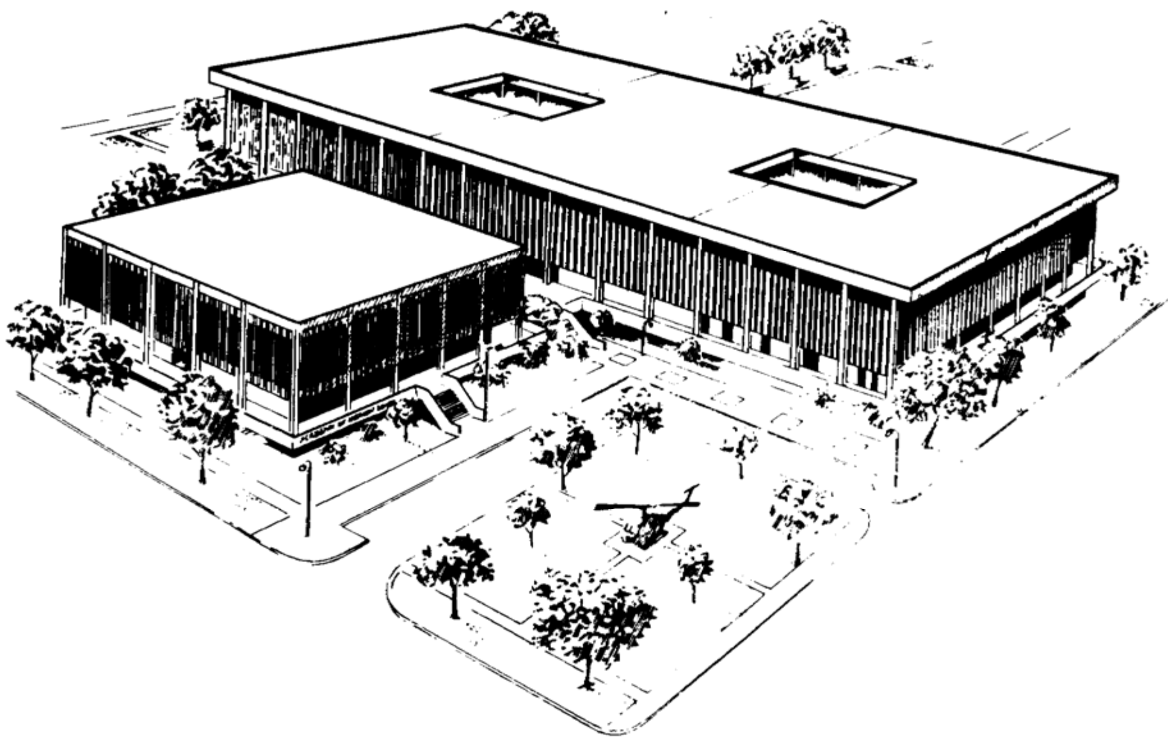

RADIOGRAPHIC X-RAY

SUBCOURSE MD0351 EDITION 100

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CORRESPONDENCE COURSE OF
THE U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0351

RADIOGRAPHIC X-RAY

INTRODUCTION

This lesson provides the medical equipment repairer with complete maintenance information for the CS-8952 Field Deployable Radiographic/Fluoroscopic X-ray System. The CS-8952 is designed to military standards for use by the Armed Forces in hard-wall shelters and other field environments. Although the CS-8952 is a mobile system, it is equally adaptable to a hospital or clinic situation if that is the preferred use.

The system is a complete radiographic/fluoroscopic system capable of performing conventional fluoroscopic/spot film procedures with the table at any angle and radiographic procedures including vertical radiography to cassette tray, table top, or floor; horizontal radiography to a mobile cassette holder; and cross-table radiography. By utilizing separate under-table and over-table X-ray tube positioning systems, procedures types may be intermixed, yet rapidly performed because procedure setup time is minimized.

The system includes a radiographic/fluoroscopic tilt table, an overhead tube support with a full range of motions, an electronically controlled spot film device, a six-inch image intensifier with mirror viewer, and a single phase x-ray power unit. Baseplates for the hard-wall shelter installation and equipment handling devices are also supplied. The table and overhead tube support are provided with leveling screws for installation on uneven surfaces. The X-ray is suitable for installation on any reasonably level hard surface. It will provide full capabilities either in a field or hospital setting.

The single phase power unit is adaptable to a wide range of incoming power sources, 50 Hz or 60 Hz, both single and three phase since single phase can be derived from three phase power systems. The system is capable of being unpacked and installed by four personnel in less than eight hours with standard tools and test equipment. The system also includes a full set of accessories, including footstep, leg supports, mobile cassette holder, cross-table cassette holder, shoulder supports, compression band, head clamp, and detachable hand grips.

Subcourse Components:

This subcourse consists of four lessons as follow:

- Lesson 1, Preventive Maintenance Checks and Services.
- Lesson 2, Isolate Malfunctions to Module Level.
- Lesson 3, Remove and Replace Defective Modules.
- Lesson 4, Prepare and Process a Food and Drug Admininstration (FDA) Form 2579.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 8 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

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LESSON ASSIGNMENT

LESSON 1 Preventive Maintenance Checks and Services.

TEXT ASSIGNMENT Paragraphs 1-1 through 1-10.

LESSON OBJECTIVES After completing this lesson, you should be able to:

1-1. Perform preventive maintenance checks and services on the CS-8952 field-deployable X-ray unit.

1-2. Identify the major components of the CS-8952 field-deployable X-ray unit.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1-1. GENERAL

As a medical equipment repairer you are responsible for keeping the CS-8952 Field Deployable X-ray System functioning at highest efficiency levels. To perform preventive maintenance checks and services (PMCS) on this mobile X-ray unit you need the following materials and equipment: the manufacturer's service literature, a digital multimeter, a flashlight, and inspection mirror, a soft cleaning rag, a medical equipment organizational maintenance tool kit, and your individual tool box. Report any uncorrectable conditions on a DA Form 2404. This lesson covers general maintenance of the entire mobile X-ray unit and preventive maintenance procedures for the major individual components of the CS-8952 system.

1-2. UNIT MAINTENANCE

NOTE: Steps "a" through "d" are performed quarterly.

a. **Inspect Main Control Cabinet Exterior and High-Voltage Transformer.**

(1) Inspect all the electrical cables, cords, connectors, and fittings for tightness.

(2) Inspect all cables and connectors for the following.

(a) Breaks in the insulation.

(b) Abrasions.

(c) Signs of arcing or burns.

(3) Inspect the high-voltage transformer for oil leaks.

(4) Inspect the exterior painted or plated surfaces for the following conditions.

(a) Scratches.

(b) Chipping.

(c) Corrosion.

(5) Ensure all name plates and warning labels are present, legible, and securely mounted.

(6) Turn on the unit.

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

(8) 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.

(9) Inspect the auxiliary box.

(a) Inspect the exterior surfaces and door hinges for the following.

1 Loose or missing parts.

2 Deterioration.

3 Corrosion.

(b) Inspect all internal components, connectors, cables, and mounting hardware for the following conditions.

1 Damage.

2 Deterioration.

3 Corrosion.

4 Loose or missing parts.

b. **Inspect Table-Mounting Hardware.**

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

(2) Inspect all electrical cables, connectors, cords, and fittings for the following.

(a) Tightness.

(b) Breaks in the insulation.

(3) Inspect cables where electrical cabling enters a housing or where they may be subject to stress from mechanical motions.

(4) Inspect the exterior surfaces and door hinges for the following conditions.

(a) Loose or missing parts.

(b) Deterioration.

(c) Corrosion.

(d) Ensure all name plates and warning labels are present, legible and securely mounted.

(5) Perform a table operations check.

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

(b) Press and hold the longitudinal head switch until the table top reaches its limit of travel. The table top should move approximately 30 inches from the center position before stopping.

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

(d) Press and hold the Trendelenburg tilt switch until the table reaches its maximum tilt. The table top should tilt 12 degrees down toward the head end and stop.

(e) Press and hold the vertical tilt switch until the table top reaches the maximum tilt. The table should tilt 88 degrees down toward the foot end before it stops.

(f) 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.

c. **Inspect Tubestand.**

(1) Inspect all exterior painted and plated surfaces for the following conditions.

(a) Scratches.

(b) Rust or any type of corrosion.

(2) Ensure all name and warning plates are clean, securely mounted, and legible.

(3) Inspect for loose or missing nuts and bolts.

(4) Inspect the travel features for smooth travel indicating each electric lock is operating properly.

(5) Inspect the manual locks for proper operation.

d. **Inspect Line-Set Adjustment on Generator.**

(1) Set the major and minor kvp controls fully clockwise.

(2) Turn on the power to the generator.

(3) 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.

(4) Select the 25S-ma push-button switch and adjust the major and minor kvp rotary switches for 78kvp.

(5) Select one second on the radiographic-seconds dial.

(6) 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-microfarad capacitors and the positive lead to the left side of the 10k-ohm resistor indicated as test point XD1.

(7) Adjust P30 for 0 volts.

(8) Select two seconds and make an exposure while reading the front panel ma meter readings. Adjust P12 and P22 for 25ma if necessary.

(9) Repeat the above step 1-2d(8) for all ma stations, using the line-set adjustment data listed in figure 1-1. Use 78kvp for all settings.

ma Station	Adjust 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	150ma
200L	P17, 27	200ma
300L	P18, 28	300ma

Figure 1-1. Line-set adjustments.

(10) Select 50kvp, 200L, and two seconds.

(11) Make an exposure while reading the front panel ma meter. Adjust P31 for 200ma if necessary.

(12) Repeat step 1-2d (8) for all ma stations using the line-set adjustment data shown in figure 1-1. Use 50kvp for all settings.

e. **Inspect Counterweight Cables.**

NOTE: This step is performed semi-annually.

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.

(1) Remove the back cover from the tower.

(2) 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.

(3) Visually inspect both cables for the following.

(a) Kinks.

(b) Separation of strands.

(c) Rust and corrosion.

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

(4) Move the spot-film device to its lowest possible position to inspect a third cable attached to the counterweight holder at the center bottom. Inspect for kinks, strand separation, rust, and corrosion as above.

(5) Inspect the internal printed-circuit boards (PCBs) for the following.

(a) Corrosion.

(b) Loose or missing components.

(c) Damage.

(6) Replace all covers after inspecting the cables.

f. **Inspect the Collimator.**

NOTE: This step is performed annually.

(1) Inspect the exterior surfaces for damage, rust, and corrosion.

(2) Inspect the cables and connectors for tightness and insulation breaks.

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

g. **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.

(1) Turn on the power to the generator.

(2) Select the over-table X-ray tube.

(a) Set the machine at 80kvp, 200ma and 0.1 seconds. Make four exposures at 20-second intervals.

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

h. **Prepare Reports.** Each time PMCS is scheduled on an X-ray system you will receive a DD Form 314 (Preventive Maintenance Schedule and Record), DA Form 2409 (Equipment Maintenance Log), and, if your unit is automated, a report from either The Army Maintenance Management Information System (TAMMIS) or the Army Medical Department Property Accounting System (AMEDDPAS).

(1) Check the performance history of the X-ray system for any recurrent problems. Check DA Form 2404 or the automated print-out as necessary.

(2) Be alert for any systematic problems you find in your review.

(3) If you are on a manual system, record all uncorrected conditions on DA Form 2404 as you perform PMCS.

(4) The following are the forms you use to record PMCS.

(a) <u>DD Form 314</u>. Update after completing PMCS.

(b) <u>DD Form 2164 (X-ray Verification/ Certification Worksheet</u>. Complete and attach a list of test equipment used during PMCS procedures.

(c) <u>DA Form 2404</u>. Update after completing PMCS.

(d) <u>DD Form 2163 (Medical Equipment Verification/Certification Label</u>. Complete and attach to the X-ray unit.

(5) Complete a DA Form 2407 (Maintenance Request) and, if applicable, a DA Form 2406 (Material Condition Status Report) if additional maintenance is required.

1-3. MXT-350 GENERATOR

a. **Introduction.** Preventive maintenance consists of procedures which minimize generator failures. Component inspection, operational certification, and compliance tests are examples of preventive maintenance. It is most effective when performed according to schedule, thus it is often called "periodic maintenance."

b. **Periodic Maintenance.** A conscientiously conducted visual inspection frequently reveals potential malfunctions before they cause equipment failures which could be dangerous.

(1) <u>Line-set adjustments</u>. The line-set adjustments must be performed at the time of installation. These are the same line-set adjustments performed in paragraph 1-2d. Refer back to paragraph 1-2d and check these adjustments at least once every 90 days or quarterly.

(2) Three-month inspection. Perform the following PMCS procedures at least once every ninety days.

(a) Power-off checks.

1 If necessary, clean the exteriors of the main control cabinet and high-voltage transformer of dust and spills.

2 Instruct the operators on the importance of keeping the equipment clean. Spilling any liquid on the generator can cause a malfunction, particularly if it finds its way into the interior. This is especially true of any liquids which leave a solid residue after drying. It is important to remove any spills promptly with a soft cloth dampened in warm water. Operators should perform regular cleaning with a soft cloth, warm water, and a mild detergent.

3 Inspect all electrical cables, cords, connectors, and fittings for tightness. Check for breaks in the insulation, abrasions, and other damage to cables and connectors. Pay particular attention to areas where cables enter housings or may be subject to stress and wear from mechanical motion.

4 Thoroughly inspect all high-voltage cables and their connections to the X-ray tubes and the high-voltage transformer. Ensure the connections are firmly seated and there are no signs of arcing. Examine the high-voltage transformer for signs of oil leakage. Any indication of leaking oil requires immediate corrective action.

5 Examine all exterior painted or plated surfaces for evidence of deterioration, such as scratches, chipping, or corrosion. Make sure all name plates and warning labels are present, legible, and securely mounted.

(b) Power-on checks.

1 Test all front panel controls and meters for correct operation and to ensure they light properly. Replace any burnt-out lamps.

2 If necessary, open the apertures of both collimators and use an inspection mirror to check the filament of the X-ray tubes to ensure they are lit. Do not look directly into either tube port.

(3) Annual inspection. Perform the above PMCS procedures described in paragraph 1-3b(2) and make the following power-off checks.

(a) Disconnect the high-voltage cable from the high-voltage transformer and X-ray tubes. Inspect them thoroughly and replace them as required.

(b) Clean the terminations and repack the X-ray tube ends with Dow Corning No. 4 vapor-proofing compound and the transformer ends with Shell Diala AX, or equivalent, dielectric oil until it spills over.

(c) Check the oil level in the high-voltage transformer. If needed, add Shell Diala AX, or equivalent, dielectric oil to within one inch (25.4mm) of the top cover.

(4) Operational tests. Perform the following power-on PMCS procedures every 90 days. Refer to the manufacturer's service literature as needed and operate each of the following system functions at least once to ensure it operates.

WARNING

The procedures listed below require the making of exposures. Take all precautions necessary to protect all personnel against unnecessary radiation.

(a) Power circuit.

(b) High-voltage-generator circuit.

(c) High-voltage generator interconnections.

(d) Circuit breakers.

(e) Light circuit.

(f) Exposure circuit.

(g) Ma-overload circuit.

(h) Ma, time, and kvp overload circuit.

(i) Exposure-end signal.

(j) Exposure and autotimer safety circuit.

(k) Filament circuit.

(l) Space-charge compensation.

(m) Filament selection.

(n) Filament-boost circuit.

(o) Fluoro-rate control.

(p) Kvp-meter circuit.

(q) Radiographic and fluoroscopic kvp.

(r) Ma meter and shunt circuit.

(s) Ma meter circuit.

(t) Single-phase impulse-timer circuit.

(u) Time-selector switch.

(v) Back-up timer.

(w) Single-phase SCR-contactor circuit.

(x) Rotor-control circuit.

(y) Spot-film-changeover circuit.

(z) Autotimer-density selection.

(aa) Autotimer and back-up timer interlock.

(bb) Autotimer reset and field selector.

(cc) Auxiliary-relay circuit.

(dd) Autotimer-technique selector.

1-4. MXT-90/15 TABLE

a. **Introduction.** Maintenance for the MXT-90/15 radiographic/fluoroscopic table falls into two basic categories: preventive and corrective. Some preventive maintenance procedures are performed by operators. The information in this section is intended for use by a Medical Equipment Repairer.

b. **General Inspection.** When inspecting the MXT-90/15 table, be sure to do the following.

(1) Check all nuts and bolts, screws, rivets, and other fasteners to ensure they are tight. Also ensure all fasteners are present and in good condition.

(2) Inspect all electrical cables, cords, connectors, and fittings for tightness. Check for breaks in the insulation, abrasions, and other damage to cables and connectors. Pay particular attention to areas where electrical cabling enters housings. It may be subject to stress from table positioning and other mechanical motions.

(3) Examine all exterior painted or plated surfaces for evidence of deterioration, such as scratches, chipping, and corrosion. Ensure all name plates and warning labels are present, legible, and securely mounted.

c. **Counterweight Cable Inspection.** The MXT-90/15 table uses high-tensile-strength aircraft control cables in the counterbalancing system. In normal use, these stranded steel cables are subject to wear which could affect system safety. The cables should be inspected no less than every six months, more often in heavily used systems. The importance of this inspection cannot be overemphasized. To perform this inspection, proceed as follows:

WARNING

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. They must be immediately replaced if there is any evidence of broken or frayed strands, kinks, corrosion other than on the surface, or weakness in any mechanical fitting. The cable replacement procedure is discussed in Lesson 3, paragraph 3-4.

(1) Remove the back cover from the tower.

(2) Move the spot-film device to its highest possible vertical position.

(3) The vertical carriage is connected to the sides of the counterweight holder by means of two cables; one at each end. Visually inspect both of these cables, looking for evidence of kinks. Kinks usually result from twisting and appear as strand separation and distortion in the shape of the cable.

(4) Inspect the cables for evidence of rust or corrosion. Light surface rust and corrosion can be removed without replacing a cable. The cable must be replaced if rust or corrosion has penetrated its interior.

(5) Examine the attachments at both ends of the cables. Make sure there is no evidence of kinking and all mechanical fittings are sound.

(6) Inspect for broken strands by running a soft cloth such as a towel, along the entire length of both cables, including the points of attachment to the counterweight holder. If the cloth snags at any location along the cable's length, it indicates strands are broken.

(7) Move the spot-film device to its lowest possible position. A third cable is attached to the counterweight holder at the center bottom. Inspect this cable by following the procedure described above.

(8) Remove the table top, following the procedure in paragraph 1-4d below.

(9) Inspect all cables for rust or corrosion, kinks, and broken strands, as already described. Check all fittings at the point of attachment on all cables.

(10) Replace all covers after the cables have been inspected or replaced.

d. **Table Top Removal and Replacement.**

(1) Remove the three flat-head Phillips screws from the rear edge of the table top.

(2) Push on the front edge of the top and lift it from the table.

(3) To remove the subtop from the table, move the table-top frame towards the end of the table with the most clearance from the wall.

(4) Remove the bracket at the exposed end of the table which holds the subtop.

(5) Loosen the screws in the brackets holding the subtop at the front and rear of the table.

(6) Move the table-top frame to the other end of the table and repeat steps (4) and (5).

(7) Slide the subtop off the body of the table.

CAUTION: The subtop is fragile! Handle with care.

(8) Replace the subtop by sliding it under the front and rear brackets (two brackets at each end of the table) and replace the foot and head end brackets. Tighten the screws holding the front and rear brackets.

(9) Replace the table top by positioning it on the table-top frame carriage and pushing on the rear edge while guiding it into place. It will be necessary to adjust its longitudinal position in order to align the mounting holes in the table top and carriage.

e. **Operational Check.** The operational tests in this section are also needed to ensure patient safety and ease of operation. When performing these tests, pay particular attention to smoothness and ease of operation. Make sure there is no difficulty of operation, squeaking or other unusual noises, or malfunction(s). Exercise all table motions as follow. (See figure 1-2 for switch locations.)

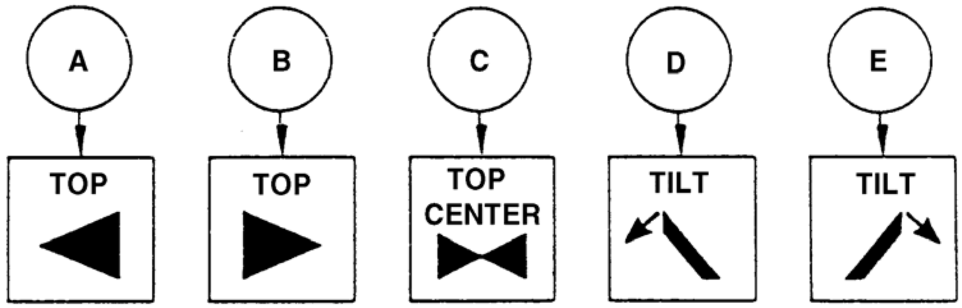

Figure 1-2. Table side controls.

(1) Press and hold the longitudinal foot switch (B) until the table top reaches its limit of travel. It should move approximately 30 inches from its centered position, before it stops.

(2) Press and hold the longitudinal head switch (A) until the table top reaches its limit of travel. It should move approximately 30 inches from its centered position, before it stops.

(3) Press and hold the table center switch (C) until the table top stops. It should move to its center position, from either of the above mentioned longitudinal positions, before stopping.

(4) Press and hold the Trendelenburg tilt switch (D) until the table reaches its maximum tilt. It should tilt 12 degrees toward the head end (-12 degrees Trendelenburg) and stop.

(5) Press and hold the vertical tilt switch (E) until the table top reaches its maximum tilt. The table should tilt 88 degrees toward the foot end before it stops.

(6) Engage all 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.

WARNING

A faulty lock can cause serious injury. Do not use a system with malfunctioning locks.

f. **Lock Adjustments.**

(1) Transverse and compression lock adjustment. The transverse lock is located inside the table, while the compression lock is located in the table tower. The compression lock can be accessed from the top and bottom of the tower without removing covers.

(a) If necessary, turn off the power and remove the table top.

(b) The transverse and compression locks are held in adjustment on two threaded studs by means of nuts and lock washers. Adjustment consists of moving the lock in or out along the length of the studs by the nuts.

(c) Engage the lock and attempt to move the corresponding part. It should take a minimum of 20 pounds of force to move. Locks should not make a "banging" sound when energized. If there is a "banging" sound, move the lock closer to the corresponding part by disengaging the lock and turning the interior nuts approximately one-half turn clockwise. Do the same with the outer nuts. Repeat this procedure as many times as necessary until there is no longer a "banging" sound.

(2) Longitudinal and grid lock adjustment.

(a) If necessary, turn off the power and remove the table top.

(b) The longitudinal and grid locks are held in adjustment on two threaded studs by means of springs secured with washers and cotter pins. Adjustment consists of moving the lock in or out, by tightening or loosening the studs with a hex key wrench.

(c) Engage the lock and attempt to move the corresponding part. It should take a minimum of 20 pounds of force. Locks should not make a "banging" sound when energized. If there is a "banging" sound, disengage the lock and move it closer to the corresponding part by turning the hex-socket studs clockwise approximately one-half turn. Repeat the process as many times as necessary until there is no longer a "banging" sound.

g. **Tilt Drive Chain Tension Adjustment.**

(1) If necessary, remove the drive-mechanism cover at the foot end of the table body.

(2) Use a torque wrench to apply 11 foot-pounds to the tension screw.

(3) Replace all covers on the table.

h. **Cleaning.** Spillage of any liquid on the table can cause a malfunction, particularly if it finds its way into the interior. This is especially so with liquids which leave a solid residue after they dry. It is important to promptly remove spills with a soft cloth dampened in warm water. Regular cleaning can also be accomplished with a soft cloth, warm water, and a mild detergent.

WARNING
Turn the power off when cleaning near electrical wiring.

i. **Lubrication.** All bearings and bearing raceways should be lubricated every six months using a light grade of machine oil (equivalent to WD-40). Check the oil level in the tilt drive and the table-top longitudinal-drive-gear reducers annually. If the level is low, or if there is any sign of leaking, add gear oil equivalent to Shell Valvata No. J-78.

j. **The Tilt-Control Mercury Switches Adjustment.** The table has four mercury switches to prevent table tilt when there is a danger of damage to the table. All four mercury switches are easily adjusted by twisting their position in a clamp until they make contact at the desired angle. Two mercury switches are located at the foot-end of the table, attached at the rear of the table-tilt printed circuit board (PCB). Both of these switches protect the table top from damage.

(1) The switch farthest from the center of the table prevents table tilt from the horizontal to head-end up, when the table top is extended towards the head end. This switch protects the table top from hitting the ceiling of the shelter when the top is extended toward the head end, and the table is tilted. Adjust this switch to stop table tilt when the angle of 34 degrees with the horizontal is reached, unless the table top is in the "center" position.

(2) The other switch attached to the table-tilt PCB protects the table top from hitting the floor. The switch should stop the table from tilting when the table top is extended toward the foot end, and the table is tilted head end up. Adjust this switch to stop table tilt when an angle of 20 degrees with the horizontal is reached, unless the table top is either in the "center" position, or extended toward the head end.

(3) Inside the table body, at the head end, is a terminal strip for most of the table wiring. Attached to this terminal strip are two additional mercury switches. Both of these switches protect the image intensifier system from hitting the ceiling during table tilt. Both switches work in conjunction with the microswitch on the inside bottom of the table body. This switch is activated by the rear counterweight as it moves from head-end to foot-end to counter-balance the spot film device. Therefore, it indirectly represents the longitudinal position of the spot-film device and image intensifier.

(a) The switch closest to the front of the table prevents tilt when the table is vertical, and tilt head-end down is activated, unless the spot film device carriage is in the center of the table. This switch should be set to allow tilt down to 78 degrees when the spot-film device is near the head end of the table.

(b) The switch towards the rear of the table prevents tilt when the table is horizontal, and tilt head-end up is activated, unless the spot film device carriage is in the center of the table or near the foot-end of the table.

(4) If the above procedures are followed and "tilt" is not correctly prevented, check the microswitch sensor on the rear counterweight. The microswitch must be positioned so it will activate when the rear counterweight passes it. Reposition it with a screwdriver, if necessary.

(5) If the microswitch does not work, replace it with part number (p/n) 4181.062.01, SW-V3L-1 21-8 1.285 Arm Microswitch. Replace any of the four mercury switches with p/n 4181.216.03, 5-amp, 115-volt, single-pole, single-throw (SPST) Mercury Switch.

k. **Table-Top-Cam Switch Adjustment.** The table longitudinal-drive-cam switches are set at the factory and should not need adjustments in the field. If adjustment is necessary, follow the procedures below. During operation, table top movement should meet the following specifications.

(1) The table top can be positioned to a maximum of 30 inches past the head end of the table body.

(2) The table top can be positioned to a maximum of 30 inches past the foot end of the table body.

(3) The table top returns to the center position from either the head or foot end using the center-momentary switch located on the front skirt of the table.

(4) With table vertical, the table top should move to either the head or foot end of the table no more than one inch.

l. **Table Top Movement Left-Limit Adjustment.**

(1) Verify adjustment is necessary.

(a) Place a piece of tape on the table top frame 30 inches from the left (head) end. Mark the 30-inch position exactly for reference.

(b) Press the top-left switch (A in figure 1-2) until the table top stops. If the table top stops when the 30-inch reference mark is aligned with the head end of the table body, no adjustment is necessary.

WARNING

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result. Make adjustments to cam orientation first, and then alternate with verification through actuating the table-top-drive system.

(2) Remove the table top and the table sub-top.

(3) Locate the top-drive control-switch assembly (p/n 5536.009.06) mounted to the table bearing top-inner-frame assembly.

(4) Locate cam one on the top-drive control-switch assembly. Cam one is closest to the gear reducer (p/n 6468.062.01).

(5) Using a 1/4-inch wrench, slightly loosen the screw securing the position of cam one.

CAUTION: Damage to the table can result if over-adjustment is done. Small, incremental adjustments alternated with verification must be done to ensure safe operation.

(6) Rotate cam one a small amount in either direction and secure the locking screw.

(7) Press the top-right switch to move the table top back toward center.

(8) Press the top-left switch and observe the table top's new stop position in relation to the 30-inch mark.

(9) If the mark lines up with the table body end, adjustment is complete.

(10) Further incremental adjustment is dependent upon the new stop position.

(a) If the table traveled further out of alignment, cam one must be rotated a small amount in the opposite direction. Go back to step (6) and proceed.

(b) If the table traveled closer to proper alignment, cam one is being rotated in the correct direction. Go back to step (6) and proceed.

(11) Upon completion of adjustment, replace the table sub-top and table top.

m. **Table Top Movement Right-Limit Adjustment.**

(1) Verify adjustment is necessary.

(a) Place a piece of tape on the table top frame 30 inches from the right (foot) end. Mark exactly the 30-inch position for reference.

(b) Press the top-right switch until the table top stops. If the table top stops when the 30-inch reference mark is aligned with the foot-end of the table body, no adjustment is necessary.

WARNING

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result. Make adjustments to cam orientation first, and then alternated with verification through actuating the table top drive system.

(2) Remove the table top and the table sub-top.

(3) Locate the top-drive control-switch assembly (p/n 5536-009.06), mounted to the table bearing top-inner-frame assembly.

(4) Locate cam four on the top-drive control-switch assembly. Cam four is the fourth cam from the gear reducer (p/n 6468.062.01).

(5) Using a 1/4-inch wrench, slightly loosen the screw securing the position of cam four.

CAUTION: Damage to the table can result if over-adjustment is done. Make small, incremental adjustments alternated with verification to ensure safe operation.

(6) Rotate cam four a small amount in either direction and secure the locking screw.

(7) Press the top-right switch to move the table top back toward center.

(8) Press top-left and observe the table top's new stop position in relation to the 30-inch mark.

(9) If the mark lines up with the table body end, adjustment is complete.

(10) Further incremental adjustment is dependent upon the new stop position.

(a) If the table traveled further out of alignment, cam four must be rotated a small amount in the opposite direction. Go back to step (6) and proceed.

(b) If the table traveled closer to proper alignment, cam four is being rotated in the correct direction. Go back to step (6) and proceed.

(11) Upon completion of adjustment, replace the table sub-top and table top.

n. **Table Top Left-of-Center Position Adjustment.**

(1) Verify adjustment is necessary.

(a) Press the top-center switch (C in figure 1-2) and observe that the table top centers itself by ensuring the ends of the table top frame align with the ends of the table body. If the ends are in alignment, no adjustment is necessary.

(b) If the table top centers too far to the left end of the table body, proceed to step (2).

(c) If the table top centers too far to the right end of the table body, proceed to paragraph o.

> **WARNING**
>
> Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result. Make adjustments to cam orientation first, and then alternate with verification through actuating the table top drive system.

(2) Remove the table top and the table sub-top.

(3) Locate the top-drive control-switch assembly (p/n 5536-009.06), mounted to the table-bearing top inner-frame assembly.

(4) Locate cam two on the top-drive control-switch assembly. Cam two is the second cam from the gear reducer (p/n 6468.062.01).

(5) Using a 1/4-inch wrench, slightly loosen the screw securing the position of cam two.

CAUTION: Damage to the table can result if over-adjustment is done. Make small, incremental adjustments alternated with verification to ensure safe operation.

(6) Rotate cam two a small amount in either direction and secure the locking screw.

(7) Press "top-left" to move the table top to the left any amount.

(8) Press "top-center" to center the table top.

(9) If the table top ends align with the table body ends, adjustment is complete.

(10) Further incremental adjustment is dependent upon the new stop position.

(a) If the table traveled further out of alignment, cam two must be rotated a small amount in the opposite direction. Go back to step (6) and proceed.

(b) If the table traveled closer to proper alignment, cam two is being rotated in the proper direction. Go back to step (6) and proceed.

(11) Upon completion of adjustment, replace the table sub-top and the table top.

o. **Table Top Right-of-Center Position Adjustment.**

(1) Verify adjustment is necessary.

(a) Press top-center and ensure the table top centers itself by ensuring the ends of the table-top frame align with the ends of the table body. If the ends are in alignment, no adjustment is necessary.

(b) If the table top centers too far to the left (head) end of the table body, repeat the steps in paragraph 1-4n.

(c) If the table top centers too far to the right (foot) end of the table body, proceed to step (2).

WARNING

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result. Make adjustments to cam orientation first, and then alternate with verification through actuating the table top drive system.

(2) Remove the table top and the table sub-top.

(3) Locate the top-drive control-switch assembly (p/n 5536.009.06), mounted to the table-bearing top inner-frame assembly.

(4) Locate cam three on the top-drive control-switch assembly. Cam three is the third cam from the gear reducer (p/n 6468.062.01).

(5) Using a 1/4-inch wrench, slightly loosen the screw securing the position of cam three.

CAUTION: Damage to the table can result if over-adjustment is done. Make small, incremental adjustments alternated with verification to ensure safe operation.

(6) Rotate cam three a small amount in either direction and secure the locking screw.

(7) Press top-right to move the table top to the right any amount.

(8) Press top-center to center the table top.

(9) If the table top ends align with the table body ends, adjustment is complete.

(10) Further incremental adjustment is dependant upon the new stop position.

(a) If the table traveled further out of alignment, cam three must be rotated a small amount in the opposite direction. Go back to step (6) and repeat the procedure.

(b) If the table traveled closer to proper alignment, cam three is being rotated in the correct direction. Go back to step (6) and repeat.

(11) Upon completion of adjustment, replace the table sub-top and the table top.

p. **Table Top "0-inch" Position (Vertical Mode) Adjustment.** The "0-inch" position cam ensures the table will not move more than one inch when the table is in a vertical position.

(1) Verify an adjustment is necessary.

(a) Apply a piece of tape to each end of the table top frame to cover an area one inch from the end. Measure one inch from the end and mark this. Do this for each end.

(b) Press top-center to center the table top. If the table top does not center itself, follow the procedure in paragraph 1-4n. If it does, proceed.

(c) Raise the head end until the table is a full 90 degrees (vertical).

(d) Press top-left and observe that the table top stops before the reference mark at the left (head) end of the table top frame is aligned with the table body end. If it is out of alignment, proceed to step (2).

(e) Press top-right and observe that the table top stops before the reference mark at the right (foot) end of the table top frame is aligned with the table body end. If it is out of alignment, proceed to step (2). If alignment is correct, no adjustment necessary.

WARNING

Under no circumstances is any adjustment to be performed while the table top is being driven. Serious injury could result. Make adjustments to cam orientation first, and then alternate with verification through actuating the table top drive system.

(2) Lower the head end until the table is 0 degrees (horizontal). Remove the table top and the table sub-top.

(3) Raise the head end until the table is a full 90 degrees (vertical).

(4) Press top-center to center the table top.

(5) Locate the top-drive control-switch assembly (p/n 5536.009.06), mounted to the table-bearing top inner-frame assembly.

(6) Locate cam six on the top-drive control-switch assembly. Cam six is the sixth cam from the gear reducer (p/n 6468.062.01).

(7) Using a 1/4-inch wrench, slightly loosen the screw securing the position of cam six.

CAUTION: Damage to the table and the shelter can result if over-adjustment is done. Make small, incremental adjustments alternated with verification to ensure safe operation.

(8) Rotate cam six a small amount in either direction and secure the locking screw.

(9) Verify both ends of the table top stop before the reference marks align with the respective ends of the table body.

(a) Press top-left to move the table top to the left (up) and observe that the table top stops before the reference mark on the table-top frame aligns with the table body. If alignment is not correct, proceed to step (10).

(b) Press top-right to move the table top to the right (down) and observe that the table top stops before the reference mark on the table-top frame aligns with the table body. If alignment is correct, adjustment is complete. Proceed to step (11).

(10) Further incremental adjustment is dependent upon the new stop position. Any change in one direction affects the other an opposite and equal amount.

(a) If the table traveled further out of alignment, cam six must be rotated a small amount in the opposite direction. Go back to step (7) and repeat.

(b) If the table traveled closer to proper alignment, cam six is being rotated in the correct direction. Go back to step (7) and repeat the adjustment.

(11) Upon completion of adjustment, press top-center to center the table top and lower the head end until the table is 0 degrees (horizontal).

(12) Replace the table sub-top and the table top.

1-5. TUBESTAND

This paragraph discusses maintenance of the Continental X-ray tubestand. Other major components are required to complete the X-ray system. Since these components are subjects of their own paragraphs, they are not discussed here.

a. **Tubestand Preventive Maintenance Checks and Services.** The tubestand requires some basic, periodic maintenance which should be performed every 90 days.

(1) Perform a general inspection throughout the assembly noting any worn or damaged parts. Make any necessary repairs or replacements. Check the hardware of the assembly (nuts and bolts) to ensure they are adequately tightened.

(2) Wipe down the exterior of the tubestand with a mild soapy solution and clean, dry cloths to rid it of dust and foreign materials. Pay particular attention to the steel transport rails.

(3) Apply power to the tubestand and operate each function at least once. Check all travel features to ensure there is smooth travel and to determine each electric lock is operating properly. Check the mechanical locks manually.

(4) Every six months, in addition to the 90-day maintenance, repack all pulleys with Lubriplate. All steel cables should be checked for fraying and wear and replaced, if necessary.

b. **Electrical Lock Failure.** The tubestand is basic in its electrical design. If power is applied and none of the electrically-controlled locks function, you can assume the problem is located at the power source. Check to make sure all connections from the power supply are proper. If so, refer to the manufacturer's literature concerning the appropriate power supply. If there is a malfunction by only one of the electrically controlled locks, check that lock to ensure it is positioned properly. The locks are all adjustable to increase or decrease drag. If the lock continues to malfunction after adjustments are made and after the connections are determined to be adequate, the lock itself should be replaced.

1-6. SPOT-FILM DEVICE

This paragraph contains information on preventive maintenance of the EXT-950 spot-film device (SFD) manufactured by Eureka X-ray Tube Inc.

a. **EXT-950 (DPSC) Spot-film Device Preventive Maintenance Checks and Services .** The spot-film device (SFD) is a reliable, relatively simple mechanical device rarely requiring corrective maintenance. Although component failures are rare, ease of access for maintenance was an important consideration in its design. This keeps "down time" to a minimum, since most components can be rapidly replaced. Following are instructions, keyed to detail drawings, for adjustment of most of the components and assemblies. Most of these straightforward procedures require a minimum of disassembly and can be performed with a basic complement of common hand tools.

(1) Hand tools required. The following common hand tools are required to service the SFD.

(a) Slotted screwdriver.

(b) Pocket screwdriver.

(c) No. 2 Phillips screwdriver.

(d) Set of nutdrivers or a six-inch adjustable wrench.

(e) Set of hex key ("Allen") wrenches.

(2) Thread-locking compound. The use of Loctite^{TM} number 232 thread-locking compound is recommended for use on those assemblies subject to stress or vibration, such as the brake and clutch assembly, motor bracket and adjustment screws and locknuts on the cassette carriage.

b. **Rear Cover Removal and Replacement.**

(1) Loosen the three screws securing the rear cover to the chassis.

(2) Lift the rear of the cover approximately one inch (25mm) to disengage the flange at the front. Slide the cover about 1/4-inch (6mm) toward the rear. Lift the cover off and set it aside in a safe place.

c. **Front Cover and Adapter Plate Removal.** Removal of the front cover provides access for sensor adjustments.

(1) Remove the imaging system following the instructions provided by the manufacturer.

(2) Remove the front cover by removing the three screws securing the rear lip to the chassis. Lift the cover up and back to disengage the front studs.

(3) Remove the imaging system adapter plate by removing the eight screws securing it to the SFD and lifting it from the chassis.

CAUTION: When reassembling, be sure to fasten the imaging system adapter plate securely. Use Loctite^{TM} number 232 on the screw threads after thoroughly cleaning off any oil or grease.

d. **Position Sensing.** The SFD uses a combination of a Hall effect and three opto-electronic (opto-interrupter) sensors in the chassis. Additionally, the power-assist handle uses opto-interrupters (two each) at each end. The chassis-mounted sensors are used for internal interlocking, while the handle-mounted sensors are used to control external power assists for spot-film device vertical and tower horizontal motion. Since both types of sensor, which can be considered functionally equivalent to switches, involve no contact with moving parts, reliability is greatly enhanced over miniature snap-action switches. Consequently, failures are extremely rare and, when the functions are understood, quickly diagnosed.

e. **Adjustment of Chassis Sensors.** Figure 1-3 below shows the locations of the chassis-mounted sensors, their functions, and the connection points on the interface board headers for voltmeter checks.

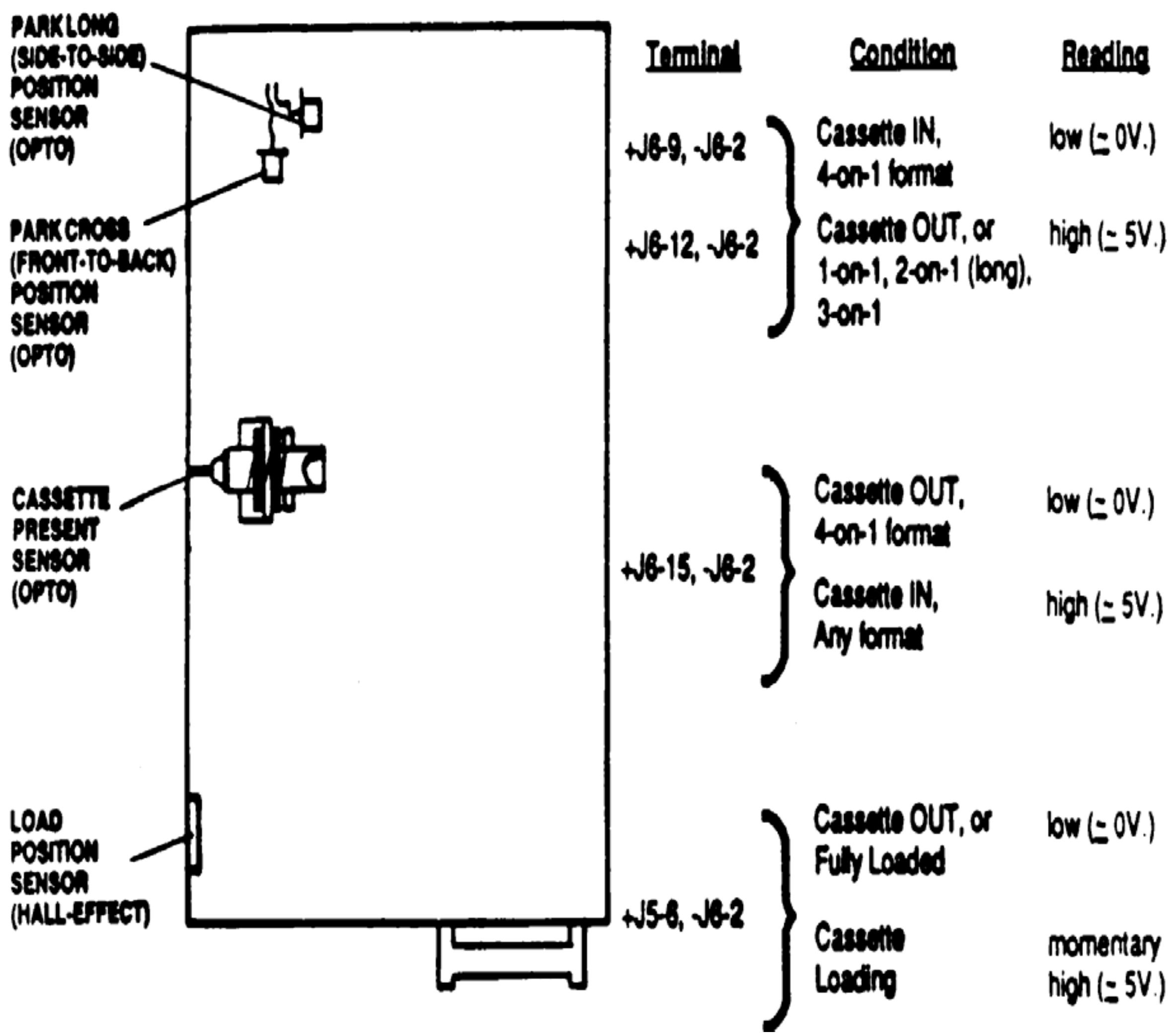

Figure 1-3. Chassis sensor locations.

(1) The cassette-present sensor is in a fixed location and has an electronic sensitivity adjustment. The other three are mounted on adjustable brackets.

(2) Adjustments should not be necessary unless a bracket is inadvertently bent or if a switch has been replaced. Adjust the cassette-present sensor for sensitivity by turning the screw on the top surface until the light-emitting diode (LED) just lights. Ensure there is no cassette in the tray, so the honeycomb diffuser decal is visible to the sensor. The table below shows typical symptoms of misadjustment and the procedures used in re-adjustment.

f. **Establishing Home Position of Cassette Carriage.** The "home" position is similar to "park," but is only achieved when the cassette carriage is fully retracted into the rear left-hand corner of the chassis, as would be the case with a 4-on-1 format selection. This position is extremely important, for it serves as a reference point from which the cassette carriage proceeds. If the reference point shifts from the factory setting as a result of motor mechanical repairs or replacement, for example, the entire procedure below must be done. Rarely will this be necessary however, and the procedure can be used for less extensive repairs, such as a bent sensor bracket.

(1) Remove the F4 motor fuse on the power supply.

(2) Be sure "park" and "cross" position sensors are both out of the contact area.

(3) Turn the power on, and manually move the cassette holder to the center and rear of the unit until the front-outside edge of the cassette holder is perfectly in line with the rear edge of the exposure opening of the main frame.

(4) Press the RESET button on the main central processing unit (CPU) board.

(5) Carefully move the park-position sensor towards the rear edge of the main slide plate until an audible lock-in of relays is heard. Lock the sensor down carefully at that exact position.

(6) Locate and securely fasten the bumper stop flush with the rear edge of the main slide plate.

(7) Manually move the cassette holder toward the left side of the main slide plate until the left-outside edge of the cassette holder is even with the left-outside edge of the main slide plate.

(8) Press the RESET button on the CPU board.

(9) Carefully move the cross-position sensor towards the flag attached to the cassette holder until an audible lock-in of relays is heard. Lock the sensor down carefully at that exact position. Home position has now been established at this point.

(10) Turn the power off and re-insert the F4 motor fuse on the power supply.

(11) Turn the power on, and proceed to check for the proper cassette (holder) location on all formats.

g. **Adjustment of Handle Sensors.** Make adjustments in the right-hand portion of the power-assist handle with the end plug removed.

(1) Two opto-interrupters are located in the recess. These respond to sideward movement. They have been factory-adjusted for optimum sensitivity consistent with tactile "feel" and should suit a large number of users. If less sensitivity is desired, or if a switch is replaced, they can be adjusted. The degree of handle movement between left and right is controlled by the centering of the right-angled "flag" in the slots of the opto-interrupters. Obviously, at rest, the flag should be equidistant from each switch half.

(2) To adjust, loosen the Phillips-head screws securing the slotted area of the flag, slide the flag, and retighten. Figure 1-4 shows the relay contact connection points on the interface-board headers for ohmmeter checks.

	FUNCTION	TERMINALS	RELAY CLOSED	READING
	Tower right (foot)	J9-2, J9-3	K17	Low Res.
	Tower left (head)	J9-1, J9-3	K12	Low Res.

Figure 1-4. Power-assist handle adjustment.

1-7. UNDER-TABLE COLLIMATOR

a. **Maintenance.** The collimator system must be properly maintained to assure compliance with the Center for Devices and Radiological Health (CDRH) regulations and useful life. Preventive maintenance is to be performed once every twelve months. This includes inspection and lubrication of the collimator mechanism. You should also checkout the system under the following conditions.

(1) Premature electronic component failure.

(2) When the collimator is removed from the tube/housing assembly.

(3) When the collimator has been subjected to any external damage.

b. **Operational Checkout Procedures.**

(1) Description. The following procedures require the alignment of the tube/collimator with the SFD and image intensifier be performed and verified as per paragraph (2) below. If after performing this step it becomes evident the collimator shutters are still not evenly shown on the edges of the fluoroscopic image, this procedure should be stopped. Then refer to the alignment procedure in the manufacturer's technical manual for the X-ray table to correct the problem.

(a) Should difficulty arise in obtaining the desired results of this procedure or if maintenance has been performed on the table/tower assembly, the under-table logic PCB calibration procedure described below should be performed.

NOTE: The "RUN" mode must be selected on the under-table logic PCB while performing this procedure.

(b) To select the "RUN" mode place switch SW2 in the "0" position. This places the collimator in "RUN" and the "RUN" message appears in the alphanumeric display. This is the normal operating mode for the collimator system. It allows the collimator logic to properly position the collimator head shutters upon command of the SFD. It also enables the error-detection software of the under-table logic PCB. If a system error is encountered during operation of the collimator logic, the message "ERR1" will be displayed in the alphanumeric display. The message typically indicates the collimator shutters are incapable of driving to their proper position within a time period of approximately four seconds. Possible causes for this can be blockage of the shutter mechanism, broken signal leads, or improper calibration. The error code is display for five seconds, at which time the collimator will again try to adjust itself to the proper position.

NOTE: Upon completion of the calibration procedure, the calibration switch SW2 must be placed in the position 0, RUN, in order for the collimating system to perform properly.

WARNING

It is necessary to make exposures in the following procedure. Therefore, take all precautions needed to protect personnel against unnecessary radiation.

NOTE: The potentiometer adjustments referred to are those found in the Eureka EXT-950 (DPSC) spot-film device.

(2) Collimator centering alignment. Loosen the four collimator-mounting screws. Activate a very low-level fluoro exposure (such as .5ma at 50kvp) and adjust the shutter controls to just display the four shutter blades on the fluoro image. Determine the direction of movement required and shift the collimator (without X-ray) to center all four shutters on the image. Refer to figure 1-5. Tighten the four mounting screws.

NOTE: Some tube carriages provide additional centering adjustments than those mentioned here. Refer to the table manufacturer's manual for any additional adjustments which may be required.

Figure 1-5. Collimator centering.

(3) Fluoroscopic image size (I.I.) adjustment. Select the fluoro mode on the generator and open the collimator shutter blades to their maximum, using the shutter controls on the SFD.

(a) Lower the SFD to its minimum surface-to-image distance (SID). Depress the X-ray switch on the SFD and observe the fluoroscopic image. The collimator blades should be evenly visible at the edges of the display. If they are not, adjust the "NORM" potentiometer, R18, on the SFD interface board until they are.

NOTE: If you are unable to obtain a square image on the image tube, the collimator shutter calibration procedure may need to be performed or leveling of the image intensifier/spot device may need to be checked. Refer to the manufacturer's service manual for shutter calibration procedures.

(b) Vary the SID of the SFD while observing the fluoroscopic image. Verify the image size remains the same as in paragraph (3)(a) above and all collimator blades are visible.

(c) Close the collimator shutter blades to their minimum using the shutter controls on the SFD. Verify a small square or slightly rectangular image is displayed. If it is not, adjust "COLL MIN" potentiometer, R22, on the SFD interface board until the desired image is obtained.

(4) One-on-one (full) film adjustment.

(a) Lower the SFD to its minimum SID. Select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the "park" position. Open the shutter blades to their maximum open position and select the one on one format.

(b) Make an exposure. Make a radiographic exposure and develop the film. Measure the exposed area and verify it is between 9.25 inches, x 9.25 inches, and 9.0 inches x 9.0 inches in size. If it is not, adjust the "FULL" potentiometer, R14, on the SFD interface board to increase or decrease the exposed area as required.

(c) Repeat the procedure if necessary. Repeat this procedure until the exposed area is within the limits described in paragraph (4) (b) immediately above.

(5) Two-on-one longitudinal film adjustment.

(a) With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the "park" position. The collimator blades should be set to their maximum open position.

(b) Select the two-on-one longitudinal format and make two radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 9.25 inches x 4.625 inches and 9.0 inches x 4.5 inches with no more than 3/16-inch gap or overlap between the images. If it is not, adjust "HALF" potentiometer, R15, on the SFD interface board to increase or decrease the exposed area as required.

(c) Repeat this procedure until the exposed areas are within the limits described in paragraph (5) (b) immediately above.

(6) Two-on-one transverse film adjustment.

(a) With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the "park" position. The collimator shutters should be set to their maximum open position.

(b) Select the two-on-one transverse format and make two radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposed area should be between 4.625 inches x 9.25 inches and 4.5 inches x 9.0 inches with no more than 3/16-inch gap or overlap between the images. If it is not, adjust the "HALF" potentiometer, R15, on the SFD interface board to increase or decrease the exposed area as required.

NOTE: Adjusting R15 will also change the size of the images obtained on the two on one ongitudinal format setting. Compare the two films before making this adjustment.

(c) Repeat this procedure if adjustment is required until the exposed areas are within the limits described in (6)(b) above.

(7) Three-on-one film adjustment.

(a) With the SFD at minimum SID and the radiographic mode selected on the generator, insert an unexposed film cassette and advance it to the "park" position. The collimator blades should be adjusted to their maximum open position.

(b) Select the three-on-one format and make three radiographic exposures. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 9.25 inches x 3.125 inches and 9.00 inches x 2.875 inches with no more than 3/16-inch gap or overlap between the images. If it is not, adjust the "1/3" potentiometer, R16, on the SFD interface board to increase or decrease the exposed area as required.

(c) Repeat this procedure until the exposed areas are within the limits described in paragraph (7)(b) immediately above.

(8) Four-on-one film adjustment.

(a) 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. The collimator blades should be set to their maximum open position.

(b) Select the four-on-one format and make four radiographic exposures. Develop the film and measure the exposed areas. The dimension of each exposed area should be between 4.625 inches x 4.625 inches and 4.5 inches x 4.5 inches with no more than 3/16-inch gap or overlap between the images. If necessary, adjust the "HALF" potentiometer, R15, a small amount to increase or decrease the size of the image.

NOTE: Adjusting R15 will have an effect on the image size obtained with the two-on-one longitudinal and two-on-one transverse formats. Compare the images obtained with those formats before making this adjustment.

(c) If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in paragraph (8)(b).

(9) Six on one film adjustment.

(a) With the SFD set at the minimum SID, select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the "park" position. Open the shutter blades to their maximum open position.

(b) Select the six on-one format and make six radiographic exposures on the film. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 4.625 inches x 3.125 inches and 4.5 inches x 2.875 inches with no more than 3/16-inch gap or overlap between the images. If they are not, adjust the "HALF" and "1/3" potentiometers, R15 and R16, to increase or decrease the image size.

NOTE: Adjustment of R15 and R16 will affect the image sizes previously obtained with the two-on-one and three-on-one format selections. Compare the images obtained with those formats before making this adjustment.

(c) If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in (9)(b).

(10) Nine-on-one film adjustment.

(a) With the SFD set at minimum SID, select the radiographic mode on the generator. Load an unexposed cassette into the SFD and place the film in the "park" position. Open the shutter blades to their maximum open position.

(b) Select the nine-on-one format and make nine radiographic exposures on the film. Develop the film and measure the exposed areas. The dimensions of each exposure should be between 2.75 inches x 2.75 inches and 2.5 inches x 2.5 inches with no more than 3/16-inch gap or overlap between the images. If they are not, adjust the "1/9" potentiometer, R17, to increase or decrease the image size.

(c) If adjustment was necessary, repeat this procedure until the exposed areas are within the limits described in (10)(b) immediately above.

(11) Surface-to-image distance tracking verification. Raise the SFD to its maximum SID. Repeat the procedures outlined in paragraphs (4) through (10) and verify the film sizes are within the limits specified for each format. If they are not, it may be necessary to recalibrate the SID tracking system. Refer to the manufacturer's service manual for adjustment procedures.

1-8. OVER-TABLE COLLIMATOR

a. **Maintenance.** The collimator system must be properly maintained to assure both compliance with the Bureau of Radiological Health (BRH) regulations and useful life. Preventive maintenance is to be performed once every twelve months. This includes inspection and lubrication of both the cassette tray(s) and collimator mechanism. Check the collimator if any of the following conditions occurs.

(1) Lamp replacement.

(2) Premature electronic component failure.

(3) When the collimator is removed from the tube/housing assembly.

(4) When the collimator and/or cassette tray have been subjected to external damage.

b. **Operational Checkout Procedures.** The following procedures form a means to check operation of the over-table collimating system. They also form a key troubleshooting aid by using internal SID and indicated radiation (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-inch SID switch will prevent the 40-inch indicator from coming ON. During any of the following tests, you must identify and correct an incorrect indication or operation before continuing with the tests. These procedures are listed in a specific sequence; altering the sequence will result in misjudgment and a waste of time.

NOTE: If you are installing an X-ray system you have legal obligations. Prior to release of the system to the user, the results of each step must be as defined. Enter the appropriate data in the spaces provided in the compliance data-log and retain them for your records as proof these tests were successfully performed.

c. **Equipment Required.**

(1) The X-ray tube support and the table must include angulation indicators to be used for the following tests.

(2) The X-ray tube-support device also must include SID-indicating means.

(3) Measuring tape or ruler to be used as a backup for the SID indicating means and as an operational range measurement.

d. **Collimator Cover Removal.** Refer to figure 1-6. Take the following actions to gain access to the top half of the logic PCB and the lamp-driver PCB behind the front panel.

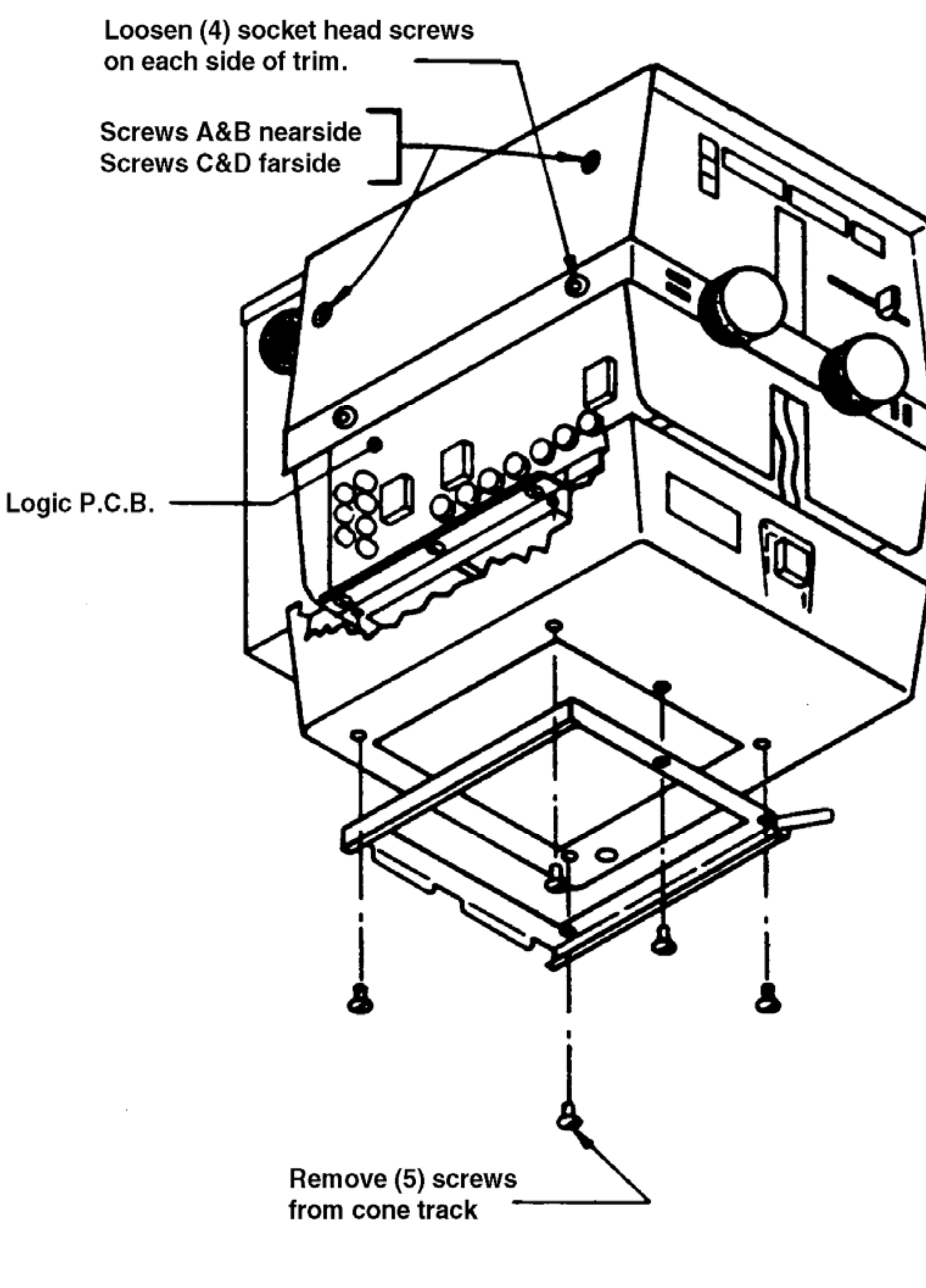

Figure 1-6. Top and bottom cover removal.

(1) Loosen, do not remove, the four screws on the top trim band.

(2) Remove the screws labeled A, B, C, and D in the figure.

(3) Lift the top cover and pull it forward.

(4) Remove the five screws from the cone track and remove the cone track.

(5) The lamp switch may now be removed from the cover and reconnected.

(6) Set the switches on the logic PCB as given in the following chart.

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

e. **Collimator-Tilt Switch Checkout.** Position the tilt switch at 0 degrees, horizontal. Angle the collimator to a 0 degrees beam-down position. Slowly angle the collimator +20 degrees toward a beam-left position and back to -20 degrees toward a beam-right position. Light-emitting diode four must be on at 0 degrees and remain on for +11 degree and -11 degree angles.

(1) Angle the collimator to a +90 degree beam-left position and slowly angle it to 20 degrees down below horizontal (+70 degrees from vertical). Light-emitting diode must be on at +90 degrees and remain on for 11 degrees below horizontal (+79 degrees).

(2) Angle the collimator to a -90 degree beam-right position and slowly angle it to 20 degrees down below horizontal (-70 degrees from vertical). Light-emitting diode-5 must be on at -90 degrees and remain on for 11 degrees below horizontal (-79 degrees). If the collimator tilt switch does not check out, refer to master board schematic 70-08009 in the service literature.

f. **Table-Tilt Switch Checkout (for tilting tables only).** Remove the jumper between TS2-5 and TS2-10. Angle the collimator to 0 degrees beam-down. Angle the table to 0 degrees horizontal and slowly tilt it to +20 degrees and then -20 degrees. Light-emitting diode-4 1-14, must be on with the table at 0 degrees and remain on for +11 degrees and -11 degrees from horizontal.

(1) Position the table at +90 degrees upright (usually about an actual +85 degrees) and angle the collimator to a +90 degree (LED-1 "ON") beam-left position. Slowly tilt the table 20 degrees down from the maximum upright position (+70 degrees). Light-emitting diode-7 must be ON at a maximum upright and remain ON until the table is angled down to +79 degrees. (Light-emitting diode-1 will also be ON).

(2) Angle the table to -90 degrees Trendelenburg and angle the collimator to -90 degrees beam-right (Light-emitting diode-5 ON). Slowly tilt the table 20 degrees down from the maximum-Trendelenburg position. Light-emitting diode-6 should be ON and remain ON until the table is angled down to -79 degrees. (Light-emitting diode-5 will also be "ON").

(3) The tilt monitors must meet the above requirements. If the tilt monitors do not pass each requirement listed, take the following corrective actions.

(4) If a tilting table is installed as part of the system, it is necessary to mount the table-tilt monitor to transfer angular-position information to the collimator. Proper orientation of the monitor is shown in figure 1-7. Remove the jumper between TS2-5 and TS2-10. Connect the table-tilt monitor as shown in figure 1-8.

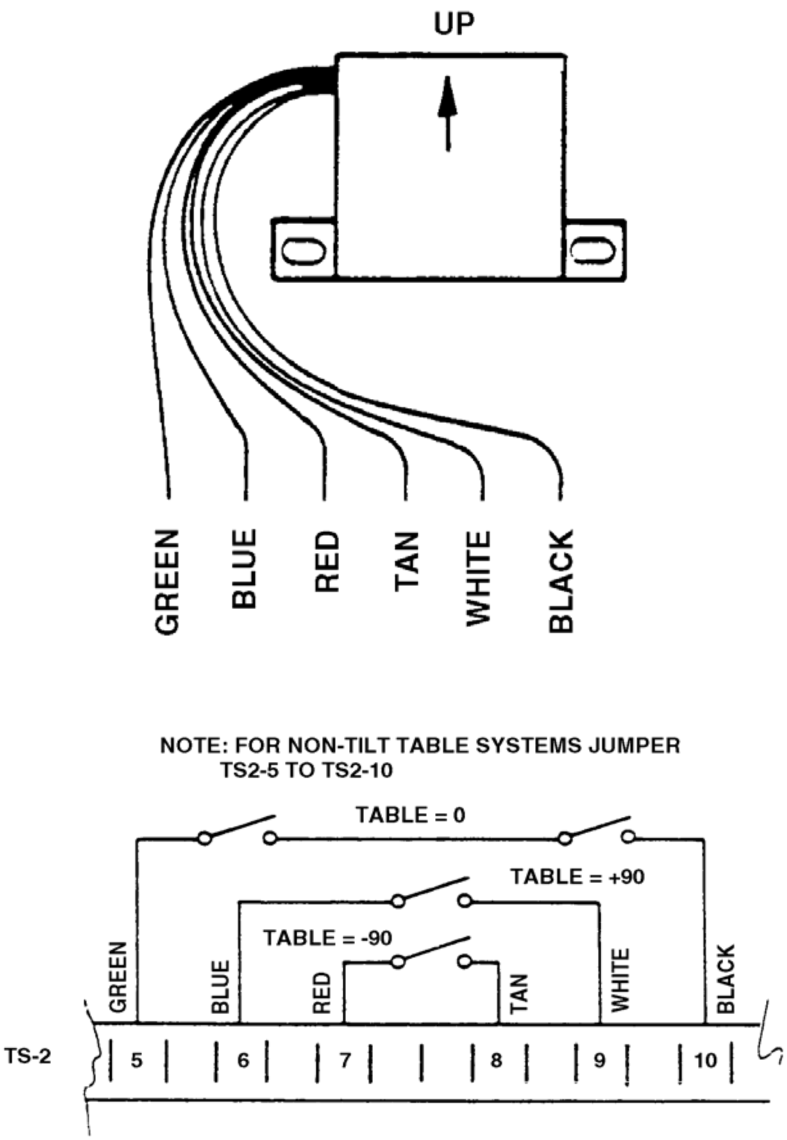

Figure 1-8. Table-tilt monitor connections.

g. **Logic and Collimator Operation Checkout (using internal signals).**

NOTE: The cassette tray must be removed for the following procedures.

NOTE: SW2-1 through 4 and SW3-1 through 4 must be "OFF".

(1) Angle the table to 0 degrees horizontal and the collimator to 0 degrees beam-down position. Light-emitting diode-4 on the logic P.C.B. must be ON. Using a steel measuring rule, measure the distance from the center of the plastic exit window to the center of the cassette tray (image receptor). Set this distance to 30 5/8 ± 1/16 inches in order to achieve a 40-inch focal-spot-to-table-top distance.

(a) The ON and MANUAL indicators on the collimator front panel should be ON.

(b) Light-emitting diode-2 on the logic PCB should be ON.

(2) Set SW2-1 and SW2-3 "ON" to simulate a 14 x 14-inch cassette. Set SW3-4 "ON" to simulate the insertion of cassette in the cassette tray.

(a) Light-emitting diode-2 (IR TRUE) should switch OFF.

(b) The MANUAL indicator should switch OFF.

(c) The HOLD indicator should switch ON.

(3) Set SW3-2 "ON" to simulate a 40-inch SID switch closure. Move the front panel sliding SID scale knob to the 40-inch detented position.

(a) The 40-inch indicator should switch ON.

(b) The collimator-field-size indicators (front panel) should rapidly adjust to about 14 inches x 14 inches 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 inches) should be about 14 x 14 inches. Use test pattern 70-09015.

(4) Set SW3-2 "OFF" (opening of the 40-inch SID switch).

(a) The 40-inch indicators should switch OFF.

(b) The READY indicators should switch OFF.

(c) The HOLD indicator should switch ON.

(5) Set SW3-3 "ON" to simulate the 72-inch SID switch closure. Move the front panel sliding SID scale knob to the 72-inch detented position.

(a) The 72-inch indicator should switch ON.

(b) The collimator field size indicators (front panel) should rapidly adjust to about 14 x 14 inches 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-inch) should be about 7.8 x 7.8 inches (14 x 14 inches at 72 inches with a 56-percent reduction due to 40-inch positioning). Use test pattern 70-09015.

(6) Set SW3-3 "OFF" (opening of 72-inch SID switch).

(a) The 72-inch SID indicator should switch OFF.

(b) The READY indicators should switch OFF.

(c) The HOLD indicator should switch ON.

h. **External Surface-to-Image Distance Signal Checkout (horizontal).** Angle the collimator to 90 degrees with the X-ray beam at the wall mounted cassette holder. Angle the table to 0 degrees horizontal.

(1) If the cassette holder is on the wall adjacent to the head-end of the table, this requires the collimator to be at +90 degrees beam-left.

(a) Light-emitting diode-1 on the logic PCB must be ON.

(b) Set SW3-5 "ON" on the logic PCB to select left-wall operation.

(2) If the cassette holder is on the wall adjacent to the foot-end of the table, this requires the collimator to be at -90 degrees beam-right.

(a) Light-emitting diode-5 on the logic PCB must be ON.

(b) Set SW2-5 "ON" on the logic PCB to select right-wall operation.

NOTE: If the wall-mounted cassette holder is on the wall adjacent to the head end of the table, leave SW3-5 ON and SW2-5 OFF. If it is on the wall adjacent to the foot-end of the table, leave SW3-5 OFF and SW2-5 ON. Only one switch is to be closed at a time.

(3) Move the collimator horizontally until the distance from the source (focal spot) to image receptor (film in cassette) is at a 72-inch SID. Slowly move the collimator to a greater and then to a lesser SID while measuring the actual SID. The 72-inch indicator on the collimator must be ON at a measured 72-inch SID and must switch OFF at a maximum of 72.75 inches and OFF again at a minimum of 71.25 inches SID.

(4) Move the collimator horizontally to a 40-inch SID, and slowly move the collimator to a greater and then to a lesser SID. The 40-inch indicator on the collimator must be ON at a measured 40-inch SID and must switch OFF at a maximum of 40.40 inches and OFF again at a minimum of 39.60 inches SID.

i. **Tilting Table Receptor Light-Emitting Diode Signal Checkout (for tilting tables only).** Angle the table to a full upright position. Angle the collimator beam-left to aim the X-ray beam at the upright table cassette tray. Light-emitting diode-7 on the logic PCB must be ON.

(1) Move the collimator horizontally to a 40-inch SID, and slowly move the collimator to a greater and then to a lesser SID. The 40-inch indicator on the collimator must be ON at a measured 40-inch SID and must switch OFF at a maximum of 40.40 inches and OFF again at a minimum of 39.60 inches SID.

j. **External Indicated Radiation Signals Checkout (tilting or non-tilting tables).**

(1) Set the switches on the logic PCB as given in the following chart.

SW3-1 OFF	SW4-1 OFF
SW3-2 OFF	SW4-2 OFF
SW3-3 OFF	SW4-3 OFF
SW3-4 OFF	SW4-4 OFF
SW2-5 ON	SW3-5 OFF (Beam-Right Operation)
OR	
SW2-5 OFF	SW3-5 ON (Beam-Left Operation)

(2) Angle the collimator 0 degrees beam-down direction with a measured SID of 40 inches measured to the Bucky. For tilting tables, angle the table to 0 degrees horizontal.

(a) The MANUAL indicator should be ON.

(b) Light-emitting diode-2 on the logic PCB should be ON.

(c) The 40-inch indicator should be ON.

(3) Locate a cassette in the table cassette holder and fully insert the tray into the Bucky.

(a) The MANUAL indicator should switch OFF.

(b) The HOLD indicator should switch ON.

(c) Light-emitting diode on the Logic PCB should switch OFF.

(d) The collimator field size indicators (front panel) should rapidly adjust and stop.

(e) The HOLD indicator should switch OFF.

(f) The READY indicators should switch ON.

(g) 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) Angle the collimator to properly aim at the wall cassette holder with the horizontal SID at about 50 inches.

<u>NOTE</u>: Although the cassette was left in the table <u>cassette</u> tray, it should <u>not</u> produce an IR TRUE signal (LED-2 should be ON and the MANUAL indicator should be ON).

(5) Fully insert a cassette into the wall cassette holder.

(a) Light-emitting diode-2 on the logic PCB should switch OFF.

(b) The MANUAL indicator should switch OFF.

(c) The HOLD indicator should switch ON.

(d) All SID indicators should be OFF.

(6) Move the collimator horizontally to each of the available SIDs (40 or 72 inches).

(a) An SID indicator should switch ON.

(b) The collimator field-size indicators (front panel) should rapidly adjust and stop.

(c) The HOLD indicator should switch OFF.

(d) The READY indicators should switch ON.

(e) The light field size should be about the same size as the cassette in the wall cassette holder.

(7) Remove the cassette from the table cassette tray. The removal of the cassette from the table cassette tray should not produce a response.

k. **Checkout for Tilting Tables.**

(1) Tilt the table to full upright. At +79 degrees, and without a cassette in the table Bucky, the following should occur.

(a) Light-emitting diode-2 on the logic PCB should switch ON.

(b) The READY indicators should switch OFF.

(c) The MANUAL indicator should switch ON.

(2) Angle the collimator to the +90 degrees beam-left position. Insert a cassette into the cassette tray and fully insert the tray into the table Bucky.

(a) Light-emitting diode-2 on the logic PCB should switch OFF.

(b) The HOLD indicator should switch ON.

(c) The MANUAL indicator should switch OFF.

(3) Move the collimator horizontally to each of the available SID's to the tilted table (40 or 72 inches).

(a) An SID indicator should switch ON.

(b) The collimator field-size indicators (front panel) should rapidly adjust and stop.

(c) The HOLD indicator should switch OFF.

(d) The READY indicators should switch ON.

(e) The light-field size should be about the same size as the cassette inserted into the table cassette tray.

(4) Repeat steps k (2) through k (3) with the table and collimator tilted to a -90 degrees beam-right position.

l. **Stereo/Tomo Bypass Signal Checkout.**

(1) Angle the collimator 0 degrees beam-down direction with a measured SID of 40 inches measured to the Bucky. For tilting tables, angle the table to 0 degrees horizontal.

(a) The MANUAL indicator should be ON.

(b) Light-emitting diode-2 on the Logic PCB should be ON.

(2) Locate a cassette in the table cassette holder and fully insert the tray into the Bucky.

(a) The MANUAL indicator should switch OFF.

(b) The HOLD indicator should switch ON.

(c) Light-emitting diode-2 on the Logic PCB should switch OFF.

(d) The collimator should rapidly adjust and stop.

(e) The HOLD indicator should switch OFF.

(f) The READY indicators should switch ON.

(g) 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).

(3) Activate the stereographic/tomographic (Stereo/Tomo) switch on the generator.

(a) The READY indicators should switch OFF.

(b) The MANUAL indicator should switch ON.

(4) Deactivate the Stereo/Tomo switch. The collimator should return to the state as indicated in step k (2).

m. **Input Signal Verification Chart.** The charts in figure 1-9 are keyed to the preceding steps and to the signal name appearing on the Logic PCB Schematic 70-08002. A "logic indicator" is located on the logic PCB. Attach a miniature test lead clip on TP-1 and, by the use of a pointed probe, the logic (VIRC, IR, TRUE, VISID OUT, VSID IN, AND VIRL signals are analog and cannot be expressed in "logic" terms) status can be checked when necessary. A logic "HIGH" signal will illuminate LED-3 and a logic "LOW" signal will not illuminate LED-3.

SIGNALS (para ref.)	1-8e	(1)	(2)	1-8f	(1)	(2)	1-8g	(1)	(2)	(4)	(6)	(8)	1-8h	(2)
VIRC (TS4-7) VIRL (TS4-5)														
STEREO/ TOMO (TS4-11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C=0°, T=0° (TS3-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0
C= +90° (TS3-6)	1	0	1	1	0	1	1	1	1	1	1	1	1	1
C= -90° (TS3-7)	1	1	0	1	1	0	1	1	1	1	1	1	1	1
C= +90°, T= +90° (TS3-9)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
C= -90°, T= -90° (TS3-8)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
IR TRUE														
40" SID (TS4-14)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
72" SID (TS4-9)	1	1	1	1	1	1	1	1	1	1	0	1	1	1
EXP.REL.RY (TS4-8)	0	0	0	0	0	0	0	1	0	0	0	0	0	0
TABLE LEFT SIDs (TS4-17)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
TABLE RIGHT SIDs (TS4-16)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
WALL L/R SIDs (TS4-19)	1	0	0	1	1	1	1	1	1	1	1	1	1	1
VERT SIDs (TS4-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0

"X" = Don't Care "1"= Logic High (+15v) "0" = Logic Low (0v)

Figure 1-9. Over-table logic chart.

n. **Final Test Switch Settings.** At the end of this test procedure, be sure to set the test switches as given in the following chart.

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 ON	SW3-5 OFF (Beam-Right Operation)
OR	
SW2-5 OFF	SW3-5 ON (Beam-Left Operation)

o. **Cassette Tray Adjustment.** The collimator has been factory-calibrated around a cassette tray which is calibrated at 500 ohms for an 11 inch (12 1/8 inch outside) cassette. The 11-inch dimension represents exactly one-half of the 1K-ohm cassette tray potentiometer. Check, and adjust if necessary, your cassette trays. Consult the tray manufacturer's manual for adjustment procedures. The following is a size vs ohms chart.

Cassette Size	Ohms between pins 1-5 and 4-8
5 inches	60 Ohms
7 inches	207 Ohms
8 inches	280 Ohms
10 inches	427 Ohms
11 inches	500 Ohms
12 inches	573 Ohms
14 inches	720 Ohms
17 inches	940 Ohms

NOTE: With tilting tables, the table and wall cassette tray potentiometers must be set exactly the same. This is because there is only one SID adjustment in the collimator for a given distance to either Bucky.

1-9. AUTOMATIC EXPOSURE CONTROL

Test the Expos-AID automatic exposure control (AEC) annually to see that it meets the kvp range/optical density tracking specifications. If it does not, repeat the calibration procedures. Also test the system whenever the X-ray generator is recalibrated or there is a change in the screen-film combination used. Visually inspect the Expos-AID cables for signs of wear. Check cable and PCB connectors to ensure they are securely fastened.

1-10. IMAGE INTENSIFIER

a. **General Maintenance.** The 1-7802 image intensifier system requires a minimal amount of maintenance, especially when in use. It is recommended the painted metal portions of the intensifier system be wiped down with a damp cloth, and the outer lens and viewing mirror cleaned with lens tissue and lens-cleaning solution every 30 days. This will prevent dust accumulation which can affect operation of the system.

b. **Storage Maintenance.** When the intensifier system is not in use for an extended period of time or when it is being stored, it becomes necessary to "season" the intensifier tube. "Seasoning" is done by applying electrical current to the tube for a 24 hour period.

(1) If the tube has been installed and has been idle for an extended period of time, such as four to six months, power can be applied to it through the spot-film device. Check to make sure the power supply cord is connected to the spot-film device control panel, then turn the power on and let it run for 24 hours before operating.

(2) If the tube is being stored, "season" the tube every six months. In its uninstalled state, power to the tube can be applied by using the auxiliary power cord supplied with the system. The auxiliary cord is equipped with a bulkhead receptacle which will accept the bulkhead plug on the power supply cord. Once the auxiliary cord and the power supply cord are connected, the auxiliary cord can be plugged into any 120vac line. Allow current to run to the tube for 24 hours.

c. **Image Tube Focus.** The potentiometers for focus adjustment of the intensifier tube are located on the left side of the power supply, and are labeled. The outer cover of the power supply must be removed to gain access to these potentiometers.

WARNING

The screwdriver used to adjust P2 must have an insulating shaft and handle. The potentiometer slider is at 3,800 volts with respect to ground, and the insulation value between the slider and the potentiometer shaft is only 1,000 volts.

(1) For the adjustment procedure, it is necessary to use a 0.2mm spaced metallic (stainless steel or copper) wire mesh of 2/1Omm diameter which can be attached, with masking tape, to the spot-film device directly beneath the intensifier tube. This screen provides an adequate image to ensure proper focusing.

(2) With the screen in place, initiate a fluoroscopic exposure and begin adjusting. To obtain a correct image, first check output voltages V4 (+2.5 to 3.0kvdc) and V5 (+27 ± 0.15kvdc). Then, adjust the g1 electrode voltage, V1, by means of adjusting potentiometer P8 clockwise from the extreme counterclockwise position until the size of the image goes through a maximum size. Stop just beyond the maximum size. Then adjust the g2 electrode, V2, by means of potentiometer P5 until optimum focusing is obtained. Slightly re-adjust the g1 electrode voltage, P8, in both directions to determine the optimum focus position. Once the image is satisfactorily adjusted, discontinue the exposure and replace the power supply's outer cover.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following items by selecting the response that BEST completes the incomplete statement or BEST answers the question.

After you have completed all of these items, turn to "Solutions to Exercises" at the end of the lesson and check your answers with the solutions.

1. Under normal PMCS procedures, how often is the line-set adjustment on the X-ray generator checked?

    a. Weekly.

    b. Monthly.

    c. Quarterly.

    d. Annually.

2. Which of the following are you looking for when you inspect the X-ray's cables?

    a. Scratches.

    b. Corrosion.

    c. Chipping.

    d. Abrasions.

3. How do you inspect the filaments in the X-ray tubes?

    a. By using an inspection mirror.

    b. By reading the filament-current meter.

    c. By interpreting the ma meter reading.

    d. By glancing into each tube port.

4. You are performing a table-operations check. You press and hold the Trendelenburg tilt switch until the table reaches its maximum travel. What is the table's position?

   a. Level, 30 inches from center.

   b. Head end 12 degrees down.

   c. Foot end 88 degrees down.

   d. Head end 12 degrees up.

5. You are checking the generator's line-set adjustment. You are preparing to make a two-second test exposure at the 100L station. What voltage will you set?

   a. 78kvp.

   b. 30kvp.

   c. 25kvp.

   d. 100kvp.

6. How often is PMCS performed on the collimator?

   a. Weekly.

   b. Monthly.

   c. Quarterly.

   d. Annually.

7. You are performing quarterly PMCS on the MX-350 Generator. Which of the following is a power-off check?

   a. High-voltage generator circuit.

   b. High-voltage transformer for oil leaks.

   c. Exposure and autotimer safety circuit.

   d. High-voltage generator interconnections.

8. You are performing PMCS on a tubestand with a single malfunctioning electrical lock. You check the electrical connections and find them in order. What is your next step?

   a. Replacement of the lock.

   b. Rewiring the lock circuit.

   c. Adjustment of the lock.

   d. Lubrication of the lock.

9. During PMCS of the under-table collimator you are performing an operation check. You notice an "ERR1" message in the alphanumeric display. What does it mean?

   a. The shutters cannot move to their proper positions in four seconds.

   b. The calibration switch is not in the "φ RUN" position.

   c. The under-table logic PCB is malfunctioning.

   d. The relay contact-connection points on the interface-board headers need to be adjusted.

10. You are checking out the collimator tilt switch as you perform PMCS on the over-table collimator. You position the tilt switch at 0 degrees horizontal and place the collimator at a 0 degrees beam-down position. Then you slowly move the collimator +20 degrees toward a beam-left position and back -20 degrees toward a beam-right position. Which of the following indicates the correct condition?

    a. LED-1 is on at 90 degrees and remains on for 11 degrees below horizontal.

    b. LED-5 is on at 0 degrees and stays on for 11 degrees above horizontal.

    c. LED-4 is on at 0 degrees and stays on for +11 degrees and -11 degrees angulations.

    d. LED-7 is ON at maximum upright and remains on until the table is angled down to +79 degrees.

11. You are performing PMCS on the image intensifier. What do you use to obtain the optimum focus from the image tube?

    a. A Phillips-head screwdriver.

    b. Potentiometers P5 and P8.

    c. An adjustment of voltages V4 and V5.

    d. Potentiometer P2.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. c (para 1-2, NOTE)
2. d (para 1-2a(2)(b))
3. a (para 1-2a(8), CAUTION)
4. b (para 1-2b(5)(d))
5. a (para 1-2d(9))
6. d (para 1-2f, NOTE)
7. b (para 1-3b(2)(a)(4))
8. c (para 1-5b)
9. a (para 1-7b(1)(b))
10. c (para 1-8e)
11. b (para 1-10c(2))

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2 Isolate Malfunctions to Module Level.

TEXT ASSIGNMENT Paragraphs 2-1 through 2-22.

LESSON OBJECTIVES When you have completed this lesson, you should be able to:

2-1. Troubleshoot functional circuit to isolate malfunctioning components to the module level in the CS-8952 field-deployable X-ray unit.

2-2. Identify the circuitry of the major components of the CS-8952 field-deployable X-ray unit.

SUGGESTION Work the lesson exercises at the end of this lesson before beginning the next lesson. These exercises will help you accomplish the lesson objectives.

LESSON 2

ISOLATE MALFUNCTIONS TO MODULE LEVEL

Section I. CIRCUIT DESCRIPTIONS

2-1. SCOPE

This lesson is concerned with troubleshooting the system and the assemblies in the system and builds on the knowledge of PMCS of the CS-8952 X-ray system. Circuit functional descriptions (CFDs) are provided where needed to show complete functional circuits without regard to physical component placement. Circuit functional descriptions are a bridge between board schematics and system wiring diagrams, and allow service personnel to more clearly visualize the functions of the major circuits in the system.

2-2. POWER CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 1.0

Refer to figure 2-1. The MXR-350 X-ray Generator receives its power via the factory-supplied line cable which is connected into disconnect box "B" as follows: L1 (blk), L2 (wht), and G (grn). The main supply necessary for safe and normal operation of the generator must be between 190 volts and 270 volts, single phase, and either 50Hz or 60Hz.

a. The "NO-LOAD" to "FULL-LOAD" line regulation must be less than an eight-percent change, as measured at the main disconnect box "B."

b. In the control, L1 (blk) and L2 (wht) connect to parallel contacts, to reduce the contact resistance of Re-20 which is the line contactor. The G (grn) conductor in the line cable connects to a grounding stud on the control chassis.

c. At the line contactor Re-20, L1 becomes T1 and L2 becomes T2. Both T1 and T2 connect to the autotransformer through compensation switches. Lead T1 connects via line compensation, coarse, to terminals A1 through A6. T2 connects via line compensation, fine, to terminals A14, through A20, to cover the input voltage required.

CAUTION: The transformer must be connected as close as possible to the incoming line voltage for proper and safe operation of the X-ray system.

d. The line contactor Re-20 is initially supplied voltage via the MAIN push-button switch and L1 and L2. A tap from L1 is fused by F1, becomes L1P, through circuit breaker CB26. Then it becomes L1F across the MAINS push-button switch, and becomes CL1 to one side of the coil for Re-20, through a normally closed pole of relay Re-1 on the rotor-control board.

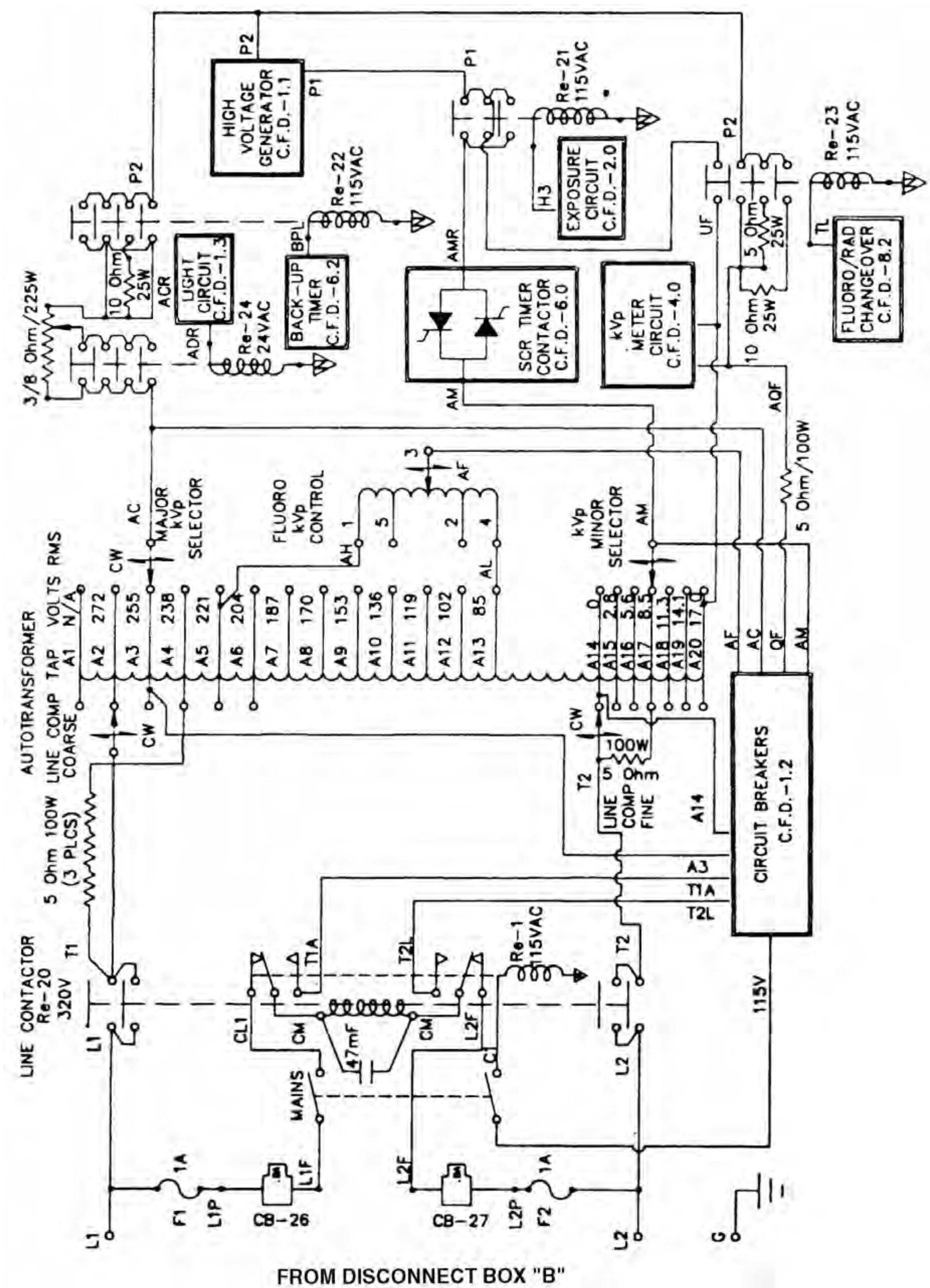

Figure 2-1. Circuit function description 1.0.

e. A tap from L2 is fused by F2 and becomes L2P. Then it goes through circuit breaker CB27, becomes L2F, and through another normally closed pole of Re-1 on the other side of the coil for Re-20.

f. Depressing the MAINS push-button switch will apply the incoming line voltage to Re-20, closing its contacts, and supply the autotransformer with incoming power. Inside the MAINS push-button switch is a lamp which illuminates when the switch is closed.

g. Autotransformer taps A3 and A14 supply the auxiliary power transformer with a constant 240vac. Taps A4 and A13 supply 128vac for the fluoro-kvp control.

h. Lead AC is the common of the major kvp selector switch and connects to one side of the 0.375Ω (3/8Ω) damping resistor. A portion of this resistor is shunted by contactor Re-24. When low ma stations (below 200ma) are selected, the full 0.375Ω-resistor is inserted in series with P2 lead to the high-tension transformer to prevent "ringing" in the high-tension waveform. When either 200-ma or 300-ma stations are selected, contactor Re-24 is closed and only 0.075Ω is inserted.

i. When the autotransformer is energized, 115vac is generated, which closes relay Re-1. The coil of relay Re-20, main contactor, now transfers to the normally open, now closed poles of Re-1 which are supplied via T1A and T2L with 240vac.

j. The kvp selection is via leads A1 and A15 from the autotransformer. Lead AM at this point supplies voltage to the silicon-controlled rectifier (SCR) timer contactor for radiographic exposures. This output of the SCR timer contactor supplies P1 to the high-tension transformer. Leads AC and AM in conjunction with circuit breakers CB23 and CB24 supply the kvp meter circuit.

k. The autotransformer is connected to the major kvp selector via taps A1 through A13, and to the minor kvp selector via taps A14 through A20. All voltages from the autotransformer can be measured at the terminals of the major and minor kvp selectors. The following table lists the autotransformer terminals and the voltage at that terminal with respect to terminal A14.

AC to AM = 288vac			
A1 = N/A	A6 = 204vac	A11 = 119vac	A16 = 5.6vac
A2 = 272vac	A7 = 187vac	A12 = 102vac	A17 = 8.5vac
A3 = 255vac	A8 = 170vac	A13 = 85vac	A18 = 11.3vac
A4 = 238vac	A9 = 153vac	A14 = 0vac	A19 = 14.1vac
A5 = 221vac	A10 = 136vac	A15 = 2.8vac	A20 = 17.0vac

All voltages should be within ± 2 percent.

2-3. HIGH-VOLTAGE GENERATOR CIRCUIT, CIRCUIT FUNCTION DISCRIPTION 1.1

Refer to figure 2-2. The control is connected to the high-voltage (tension) transformer via two factory-supplied interconnecting cables. One cable is terminated into a heavy three-pin connector, J23, supplying primary power to the high-tension transformer. The other cable is terminated into a twelve-pin connector, J22, which supplies the control with information from the high tension-transformer. J22 also transmits information from the control concerning tube selection and technique to the high-tension transformer.

a. In addition to the high-tension transformer, the high-voltage generator circuit includes the following.

(1) Anode bridge.

(2) Cathode bridge.

(3) Unbalance monitor.

(4) Thyrites for over-voltage protection.

(5) Filament transformers for the over-table and under-table X-ray tubes.

(6) Changeover-switch motor and switch assemblies.

(7) Socket wells for both X-ray tubes.

NOTE: All components are housed in a large oil-filled metal tank.

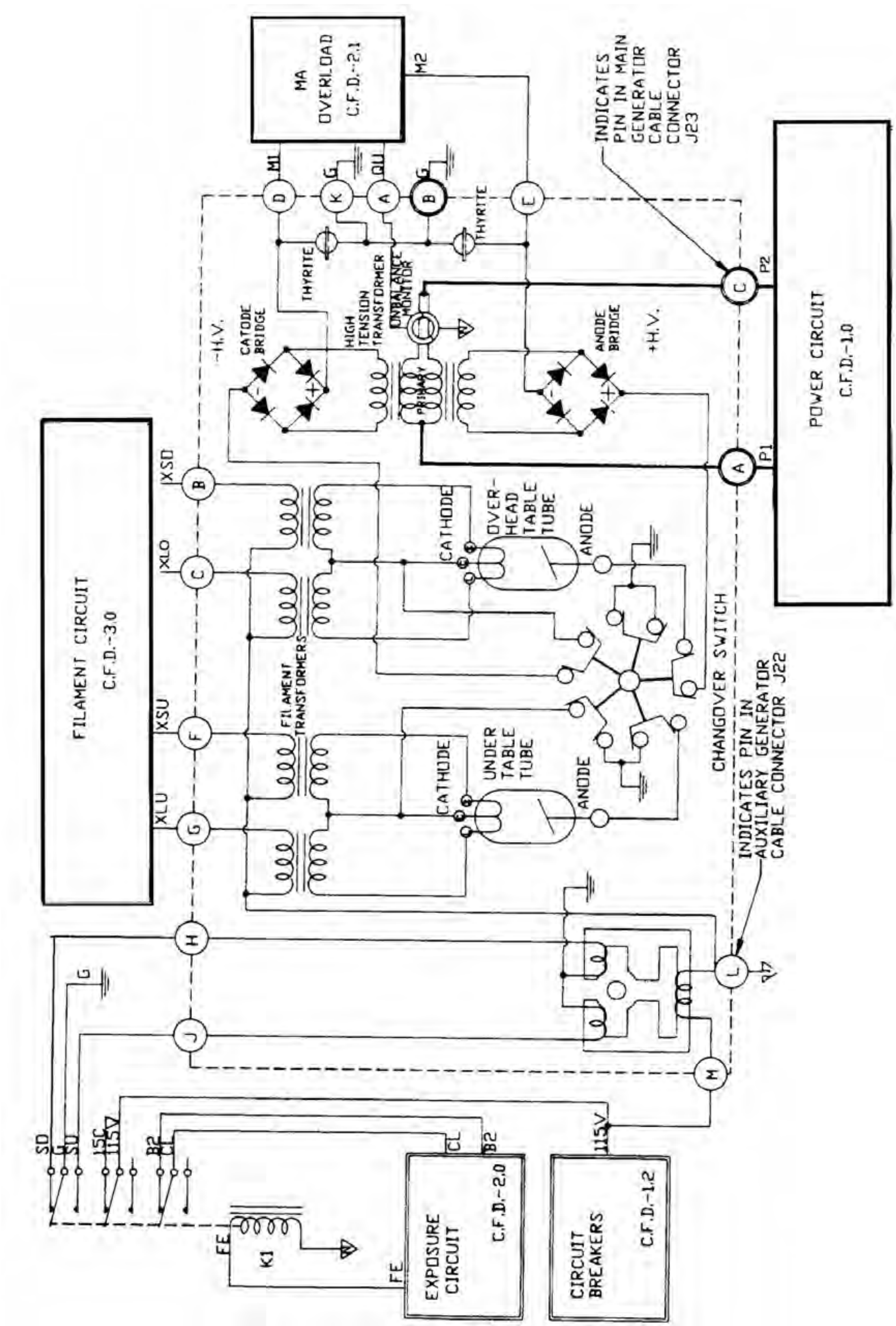

Figure 2-2. Circuit function description 1.1.

b. In the control, the main generator cable and the auxiliary generator cable terminate into the terminal strip. The tables below show the connector pin designation and function of both cables.

AUXILIARY GENERATOR CABLE, J22	
PIN	**FUNCTION**
A	(QU) Primary unbalance monitor output to the ma overload circuit.
B	(XSO) One side of the primary for the filament transformer for the small filament in the over-table X-ray tube.
C	(XLO) One side of the primary for the filament transformer for the large filament in the over-table X-ray tube.
D	(M1) Current output from the cathode bridge to the ma overload circuit.
E	(M2) Current output from the anode bridge to the ma overload circuit.
F	(XSU) One side of the primary for the filament transformer for the small filament in the under-table X-ray tube.
G	(XLU) One side of the primary for the filament transformer for the large filament in the under-table X-ray tube.
H	(SO) Ground side of the stator winding for the changeover switch for selecting the over-table X-ray tube.
J	(SU) Ground side of the stator winding for the changeover switch for selecting the under-table X-ray tube.
K	(G) Ground point for auxiliary generator cable.
L	(N) Common point for the primaries of all filament transformers and return side of the field winding for the changeover switch.
M	(115v) Supply lead for the field winding of the changeover switch.

MAIN GENERATOR CABLE J23	
PIN	**FUNCTION**
A	(P1) Primary side of the high-tension transformer.
B	(G) Ground for the main generator cable.
C	(P2) Primary side of the high-tension transformer

c. Although the high-voltage generator contains one high-tension transformer, it can accommodate two X-ray tubes. This is accomplished through the use of the changeover switch. This switch connects only the high voltage to the desired X-ray tube, either over-table or under-table. One X-ray tube is connected to the diode bridges, the other X-ray tube is at ground potential.

d. The appropriate X-ray tube filaments are energized by selection in the control of its energizing filament transformer. Filament power is supplied to XLO for the large over-table filament, XSO for the small over-table filament, XLU for the large under-table filament and XSU for the small under-table filament.

2-4. CIRCUIT BREAKERS, CIRCUIT FUNCTION DESCRIPTION 1.2

Refer to figure 2-3. All electronic circuits in the X-ray system are protected by the extensive use of circuit breakers. In some instances, fuses are also used in conjunction with circuit breakers as required by certification laboratories. All circuit breakers and fuses in the main control are located on the left side panel when facing the front. The following table lists each circuit breaker by number and the circuit it protects.

CIRCUIT BREAKER	DESCRIPTION	FUNCTION
CB1	230v	230vac buss.
CB2	H2F	230vac to rotor control.
CB3	115v	115vac buss, constant voltage transformer (CVT), fan, high voltage generator, kvp meter circuit, and ma-meter circuit.
CB4	60v	60vac to rotor control.
CB5	24v	24vac ma-meter circuit, light circuit, impulse timer, exposure circuit and exposure-end circuitry.
CB7	24BT	24vac to back-up timer.
CB9	115F	115vac to exposure circuit; ma, kvp, and time-limiting circuit; autotimer selector; and ma-overload circuit.
CB10	15IT	115vac to impulse timer.
CB11	15MS	115vac to mas-meter circuit.
CB12	XSP	115vac from CVT to filament circuit.
CB14	QF	Voltage from wiper of fluoro variac (AF) to fluoro damping resistor (5Ω 100w).
CB17	T1A	Voltage from autotransformer A3 to one side of auxiliary power transformer.
CB18	T2L	Voltage from autotransformer A14 to one side of the auxiliary power transformer.
CB23	AMW	One side of supply to the kvp meter circuit.
CB24	ACKM	One side of supply to kvp meter circuit.
CB26	L1F	One side of line to MAINS switch (CFD 1.0).
CB27	L2F	One side of line to MAINS transfer relay (CFD 1.0).

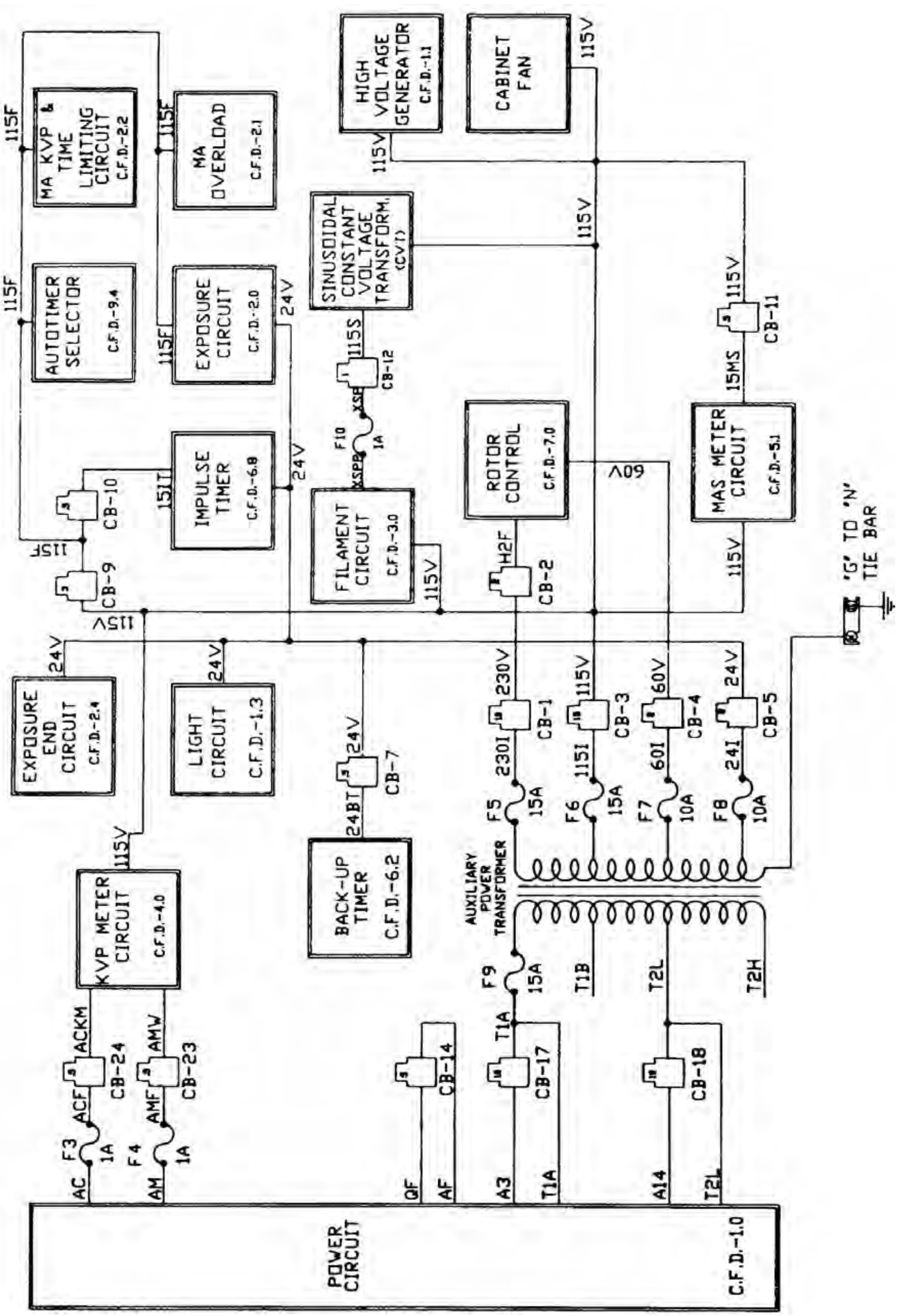

Figure 2-3. Circuit function description 1.2.

2-5. FILAMENT CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 3.0

Refer to figure 2-4. The primary purpose of the filament circuit is to provide a constant current source for the filament transformers as determined by the selected ma and kvp.

a. From the constant-voltage transformer (CVT) on lead XSP through fuse F12 to XSPP, 120vac flows to the transformer which is acting as an impedance transformer. The voltage drop across this transformer varies as the amount of conduction of the MJ15001 transistor in the cooling chimney changes. The diode bridge on the secondary of the impedance transformer acts as a variable resistor load. When the MJ15001 transistor is off and not conducting, the diode bridge acts as an open circuit and the impedance in the primary winding is high. When the MJ15001 transistor is conducting, the diode bridge acts a variable load resulting in a low impedance in the primary with the current being inversely proportional to the impedance.

b. The 115vac supply to the filament drive transformer primary comes from the circuit breakers. The secondary of this transformer produces 40vac, center tapped, to diode bridge BR-1 where it is rectified, regulated to positive (+) 15vdc by 7815 regulator and to negative (-) 15vdc by regulator 7915. The unregulated positive and regulated dc voltage is also used to supply the power to the amplifying transistors for the cooling chimney driving circuit.

c. A feedback transformer is used to provide a current feedback source to sample the amount of current in the filament transformer drive line. This feedback is rectified by BR-2 and is input into pins 5 and 6 of IC1. Pin 7 (TP10) of IC1 will be a positive dc voltage which is representative of the amount of current feedback.

d. On lead XDA (TP11) from the filament selection is a voltage representing the ma station selected. This is the filament set and is input to IC1 at pin 3. Pin 1 of IC1 (TP9) will now output a negative dc voltage which represents the ma station selected.

e. A dc voltage representative of the space charge is on lead XCM from the space charge circuit. This voltage is negative voltage below 78kvp and a positive voltage above 78kvp. At 78kvp that voltage is zero volts.

f. At TP14 is the filament-drive feedback voltage which is a sample of the filament drive voltage. It is this voltage that determines the amount of conduction of the cooling-chimney transistors and ultimately the amount of impedance of the transformer primary.

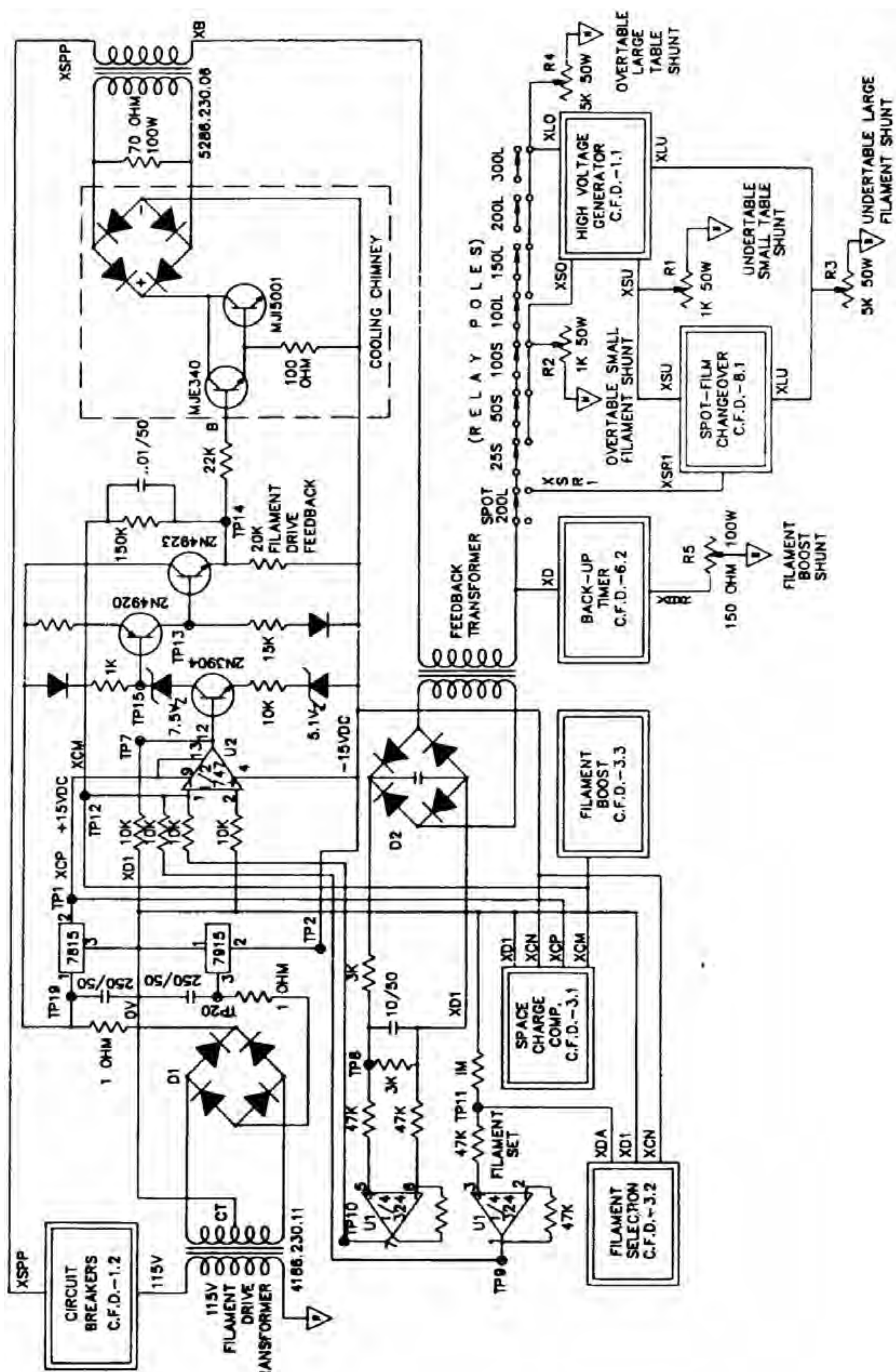

Figure 2-4. Circuit function description 3.0.

g. From leads XLO, XSO, XLU, and XSU are four shunting resistors which are adjustable to provide sufficient current for the focal spots throughout the ma-selectable range. These resistors do this by shunting excessive current to neutral. From the back-up timer comes lead XBR which is active during standby only. Filament current during standby is limited by adjustable resistor R5 called the standby-filament-current sink. This resistor shunts excess filament current to neutral during standby to ensure the filaments are illuminated at a low level which provides longer X-ray tube life with the convenience of preheated filaments.

h. The positive filament-drive-feedback voltage, the positive or negative space-charge voltage, the positive current- feedback voltage, and the negative filament-set voltage are all summed into pin 1 of IC2. The output of IC2 at pin 12 (TP7) will be a positive voltage which varies according to the ma and kvp selected. This voltage is amplified and becomes the filament-drive voltage into the base of transistor MJE340 in the cooling chimney. This transistor causes the conduction of the MJ15001 transistor, varying the conduction of the diode bridge, increasing or decreasing the impedance of the transformer.

i. As the impedance increases in the transformer primary, as when a low ma station is selected, the current decreases and the voltage drop across the primary increases resulting in lower voltage to the filament transformer primaries. As the impedance decreases, such as when a high ma station is selected, the current increases and the voltage drop across the primary decreases resulting in a higher voltage to the filament transformer primaries.

j. A cooling fan is provided for the components in the cooling chimney to prevent overheating. These components are always in a conducting state, even during standby. The filament circuit is designed in such a manner, that even if no filament drive was available, the X-ray tube filaments would not burn out because of over voltage.

2-6. SPACE-CHARGE COMPENSATION, CIRCUIT FUNCTION DESCRIPTION 3.1

Refer to figure 2-5. The reference point, at which the space-charge compensation is zero, is at 78kvp. This reference point is adjusted by the P30 set-point adjust. This potentiometer (pot) is adjusted so pin 10 of the 747 op-amp is at zero volts (TP4) at 78kvp.

a. On lead MVH is a dc voltage representative of the selected kvp which is input to IC9 at pin 2, the inverting input. The output of IC9 at pin 6 (TP17) will be a negative voltage proportional to the selected kvp and is input to the 747 op-amp at the inverting input, pin 7. The output of the 747 op-amp at pin 10 (TP4) will be a positive voltage above 78kvp and a negative voltage below 78kvp.

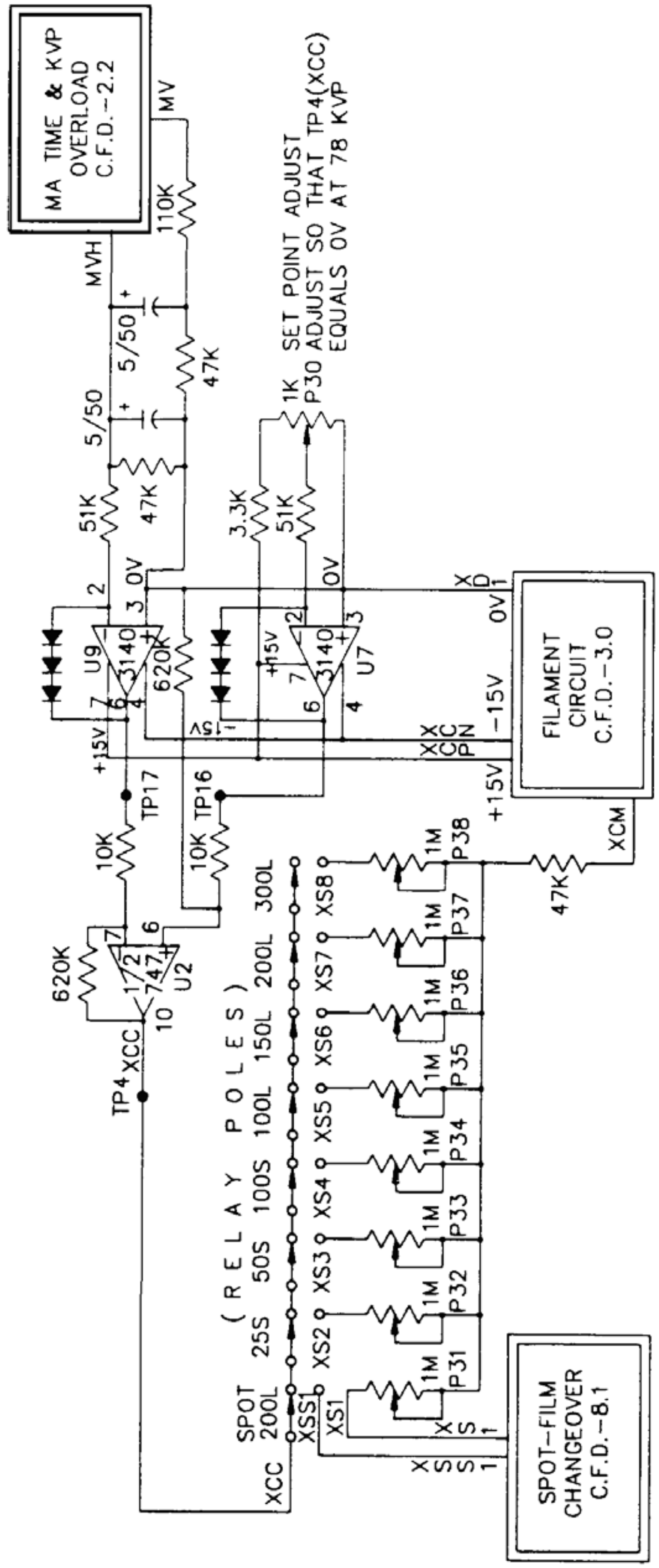

Figure 2-5. Circuit function description 3.1.

b. Assuming 40kvp has been selected, a low positive voltage is on lead MVH into pin 2 of IC9 resulting in a low negative voltage at pin 6. This low negative voltage being input to the 747 op-amp at pin 7 is less negative than the set-point voltage at pin 6. The output at pin 10 will be a low negative voltage and space charge compensation is some portion of that low negative voltage as adjusted by pot P30. By selecting a higher kv (now assuming 78kvp) at IC9, pin 2 becomes more positive, driving pin 6 more negative. On pin 7 of the 747 op-amp, this more negative voltage equals the set-point voltage on pin 6 and pin 10 becomes zero volts. There will be no space-charge-compensation voltage.

c. As the selected kvp increases (now assuming 110kvp) at IC9 pin 2 there is a higher positive voltage, and pin 6 becomes even more negative. This more negative voltage comes to pin 7 of the 747 op-amp increasing the differential between pin 7 and the set-point voltage at pin 6 causing the output at pin 10 to be proportionally positive. The space charge compensation will be a portion of that positive voltage as adjusted by potentiometer P30. The space-charge compensation voltage goes to the filament circuit via lead XCM to modify the filament-drive voltage.

2-7. FILAMENT SELECTION, CIRCUIT FUNCTION DESCRIPTION 3.2

Refer to figure 2-6. On lead XCN is a negative (-) 15vdc voltage which is regulated to negative (-) 8vdc by the 7908 voltage regulator. This voltage is used to supply all parts of the filament-selection circuit and the final result on lead XDA ma set will be some portion of that negative (-) 8vdc. Each ma selection is made by closing a set of normally open relay contacts which selects a series of potentiometers for the coarse ma, fine ma, and added filament-boost adjustments. These pots modify the negative (-) 8vdc as necessary to produce the selected ma. Potentiometers P1 through P8 are the coarse-ma adjustments, P11 through P18 are the fine-ma adjustments, and P21 through P28 are the added filament-boost adjustments for each ma station. Potentiometers P9, P19, and P29 are not used.

a. For discussion purposes assume the 100L-ma selection has been made by depressing the 100L-ma-select push button. Normally open relay contacts XD1/XA5 are now closed and, because of the 100kΩ pull-up resistor, a high comes to pin 1 of IC8. IC8 is a 4532B 8-bit priority encoder. The output is the binary code for the respective input. If more than one input is high simultaneously, the one with the highest number will be encoded while the other input will be ignored. In this discussion with the 100L-ma station selected, pin 1, which is input 4, is high. The output of IC8 will be pin 6, which is the Q4 output, and it is a high to pin 9 of ICs 5 and 6.

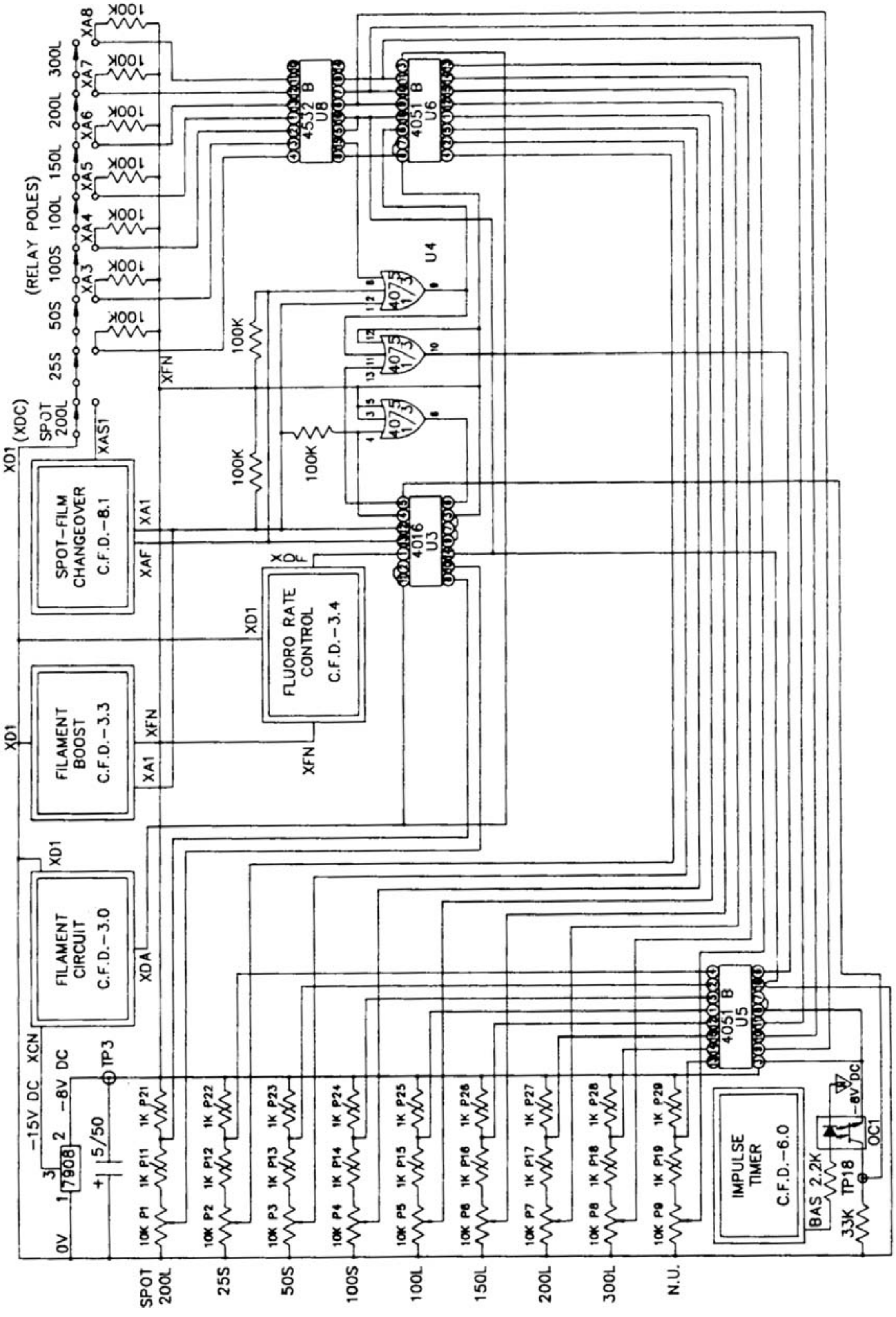

Figure 2-6. Circuit function description 3.2.

b. ICs 5 and 6 are 4051B, one of eight switches. The output is determined by the binary word input to channel or channels A SEL, B SEL, and C SEL. The input channel binary words are A SEL = 1, B SEL = 2, and C SEL = 4. With the 100L-ma station selected, the channel selected on ICs 5 and 6 is C SEL pin 9 which is a binary 4. The output is pin 1 (4) which is high and potentiometers P5 and P15 are selected as the ma-adjust pots. They are connected to the output, pin 3. Pin 3 of ICs 5 and 6 act as inputs or outputs. In the case of IC5 it is an input, and for IC6 it is an output. Accordingly pin 3 of IC6 will output some portion of negative (-) 8vdc as adjusted by P5 and P15 onto lead XDA, which is the ma set lead to the filament circuit. Internal to the chip is a field-effect transistor (FET) switch from pin 1 to pin 3.

c. Pin 3 of IC5 inputs negative (-) 8vdc, which is output at pin 1 at the beginning of an exposure, in effect shorting out P25 during the start of the exposure, giving the filament an added boost at the start of the exposure. This added boost ensures the full selected ma is across the tube from the first impulse of primary power through the last impulse. The negative (-) 8vdc input to pin 3 of IC5 is supplied to pin 1 of IC5 via an internal FET switch in IC5. Before an exposure is initiated, IC5 is inhibited due to OC1 optocoupler being turned off. Effectively, a high is at TP18 to pin 13 of IC4 producing a high at pin 10 of IC4. This high goes to pin 6 of IC5 holding it off.

d. From the impulse-timer lead BAS is high throughout the actual length of exposure turning on the OC1 optocoupler. This causes TP18 to be low and pins 13 and 10 of IC4 to be low, lifting the inhibit from IC5, and shorts out P25 during exposure. When the exposure terminates, TP18 returns high inhibiting IC5. This sequence of events takes place whenever a radiographic exposure is initiated.

e. A spot-film selection alters this sequence. For purposes of discussion, assume the 200L SPOT, spot-film selection has been made. When this spot-film ma is selected, a high exists on pin 13 of IC3 closing pins 1 to 2. This puts leads XDF fluoro adjust and XDA ma-set together. Fluoro ma can now be adjusted via the fluoro-rate control. As long as the cassette tray remains in the out-of-beam position, the changeover switch will remain unchanged; pins 12 and 6 of IC3 will remain low so pins 10 to 11 and 8 to 9 will remain "open." Potentiometers P1, P11, and P21 are not selected into the ma circuit.

(1) When a spot-film exposure is initiated due to the cassette tray moving into the field, FE/RL are closed, energizing relay Re-5-SF and opening the normally closed contacts XAS1/XAF and closing the normally open contacts XAS1/XA1. Pin 13 of IC3 returns low, opening pins 1 to 2 and removing XDF fluoro adjust from the XDA ma-set leads.

(2) Lead XA1 to pin 12 of IC3 is a high which "closes" pins 10 to 11 connecting P1 and P11 to lead XDA ma-set. The boost potentiometer P21 is into pins 8 to 9 of IC3 which are open because pin 6 is low. At the start of exposure OC1 turns on, pins 5 and 6 of IC3 are high, closing pins 9 to 8 and 11 to 10, boost potentiometer P21 is shorted out, and ICs 5 and 6 are held inhibited. At the end of exposure, all return back to a standby state.

2-8. MA-METER AND SHUNT CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 5.0

Refer to figure 2-7. The ma meter is a one-ma full-scale device, scaled for three dc-ma ranges of current indication, 0-10ma, 0-100ma and 0-400ma. With this arrangement, all radiographic ma selections indicate within the central half of the meter from 1/4 scale to 3/4 scale. The indicating range is selected by providing three adjustable meter shunts, which when selected, parallel the meter and pass the majority of the X-ray tube current around the meter.

a. The system is configured so the meter shunt of interest is actually in parallel to the combination of the focal-spot-overload sensor and the ma meter connected in series. The focal-spot-overload sensor is adjusted to 6,000Ω, and the ma meter has an internal resistance of approximately 80Ω. This combination produces a series resistance of 6,080Ω. At 1ma meter current, the voltage across the combination is 6.08 volts for a full-scale meter indication.

b. The meter shunts are sized to pass the remainder of the X-ray tube current. On the 10-ma scale, the shunt resistance is approximately 675Ω, on the 100-ma scale 61.4Ω and on the 400-ma scale, 15.2Ω. The approximate shunt for the expected ma range is selected through a relay-pole series on the ma relay selector circuit board. When the fluoro spot-film mode is selected, two different shunts must be selected dependent on the mode of operation. When fluoro is active, the 0-10-ma scale is selected via a relay on the spot-film changeover to pass the shunt current through lead MMF to the low-current ma-meter shunt.

c. When the radiographic mode is selected by the advance of the spot-film device cassette carrier, the shunt current passes through lead MS1. Lead MS1 connects to a jumper which provides selection of either the middle-shunt range for spot radiographic ma of 25 to 75ma, or the high-current shunt for ma of 100 to 300ma. This provides field selection of the spot radiographic ma. The ma-meter shunt is calibrated using a dc-current source set to the appropriate ma-selection indicator. The variable potentiometer is adjusted so the meter indicates the correct ma.

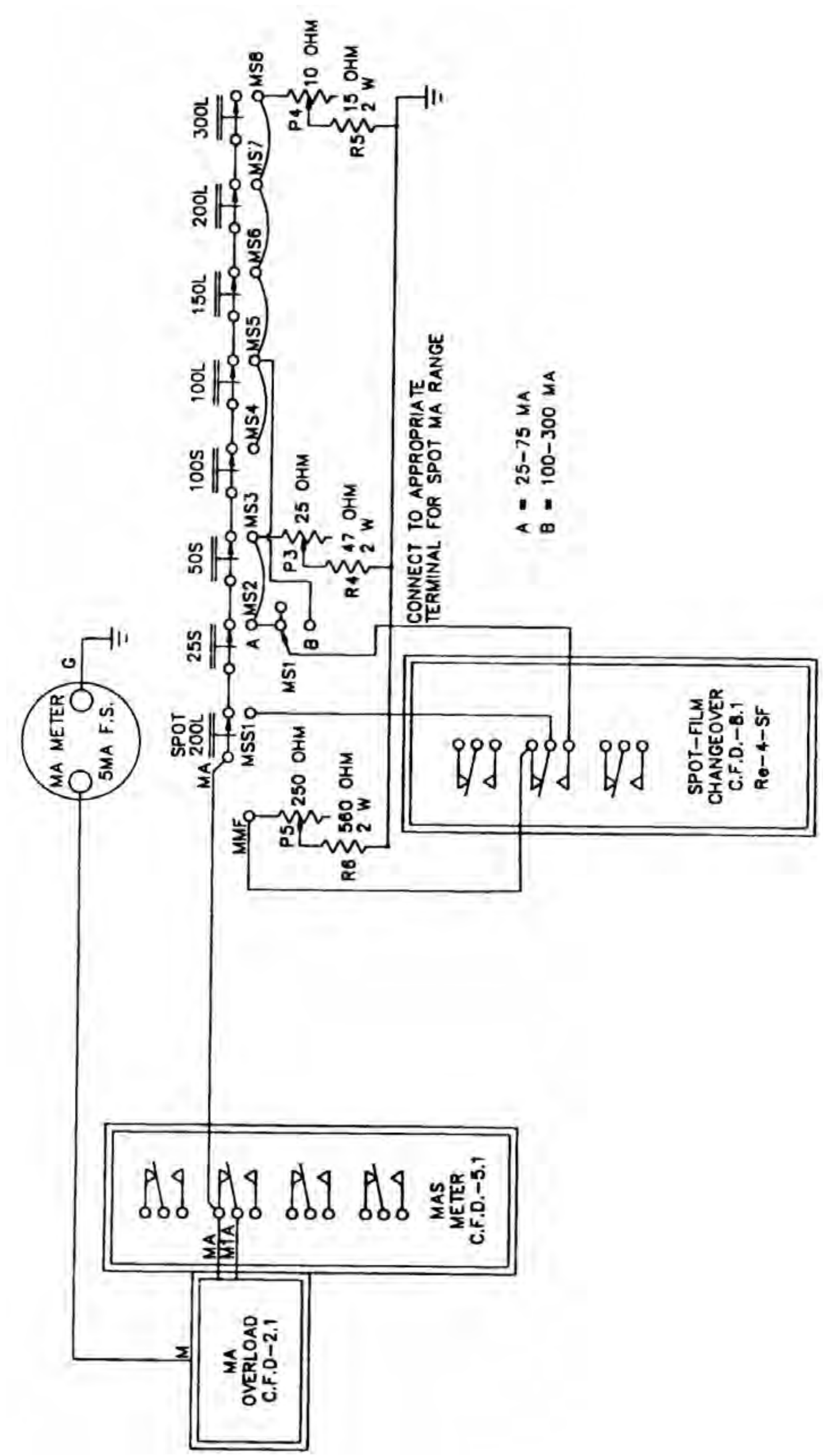

Figure 2-7. Circuit function description 5.0.

d. Using the 200L-ma selection and assuming the X-ray exposure is exactly 200ma and the ma-shunt potentiometers are accurately adjusted, the following current paths are used for ma indication.

(1) From the ma overload on lead M1, is 200ma from the X-ray tube.

(2) Then the current flows through the meter M1 overload circuit to leads M1A/Ma across the normally closed contacts of the mas-meter assembly.

(3) The circuit splits with a shunt current fraction going towards the ma-shunt potentiometers.

(4) The remaining current goes back to the ma overload circuit.

(5) The current returns from the mas-meter circuit on lead M to the ma meter, to ground.

e. The shunt current flows as follows.

(1) Across the normally open, now closed contacts MA/MSS7.

(2) Across ma-shunt potentiometer P7.

(3) To the 10-Ω, 2-watt resistor R5 to ground.

f. When the fluoro footswitch is depressed and a fluoro exposure is initiated, ma through MA to M1A from the ma overload is as follows.

(1) The current flows across the normally closed contacts M1A/MA of relay R1 of the mas-meter circuit.

(2) Then the current flows across the normally open, now closed contacts MA/MSS1 of the 200L spot-film ma-select push button.

(3) The path then goes to the normally closed MSS1/MMF contacts Re-4-SF on the spot-film changeover.

(4) Then across the low-current meter shunt P6 and R6.

(5) And finally, across the ma meter.

g. When a spot film exposure is initiated, Re-4-SF on the spot film changeover is energized, closing the normally open contacts MSS1/MS1, and ma-shunt potentiometer P7 is inserted into the ma circuit. The meter-shunt current is now through P7 and R5 to ground.

2-9. SINGLE-PHASE IMPULSE TIMER CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 6.0

a. Refer to figure 2-8. Power for the timer circuit is supplied by the SCR-timer contactor. The supplies are positive (+) 20vdc and 12vac. All voltages are referenced to the system common "N."

(1) The 12vac supply is fed to an ac input of optocoupler OC1.

(2) The output of OC1 is coupled directly to one section of U1, a quad XOR gate, which buffers and inverts the signal.

(3) The output is shaped by R9 and C4 and applied to the clock input of flip-flop pin 3 of U2.

(4) The clock pulses are again inverted by another XOR gate of U1 and become one of the inputs to each of the triple input NAND gates contained in U3.

(5) The 12vac supply is also rectified, clipped, and shaped by the combination of D1, D2, D3, R3, and R2.

(6) The resulting wave form is applied to the CLR pin 4 of the flip-flop contained in U2. This synchronizes the flip-flop so its output is in phase with the ac line.

(7) The output of flip-flop U2, pin 2, is a square wave which cycles at the same rate as the line frequency whenever the system is turned on. This output is compared with the output of flip-flop U2, pin 12, by an XOR gate in U1.

(8) The flip-flop U2, pin 12, is only clocked during an exposure, so the output of the XOR gate U1, pin 10, will alternate at the same rate as flip-flop U2, pin 1, except only during an exposure. This ensures each successive exposure will begin on the opposite phase of the ac line from the last impulse of the previous one.

b. An exposure timing sequence begins with the application of 115vac from H6T to optocoupler OC2.

(1) This causes the emitter output of OC2 to go high, raising the reset pin 10 of timer in U4 above 0.8vdc and applying a high signal to an input of the first triple-input NAND gate U3 as well as to Q4 and Q3 on the SCR contactor.

(2) This last signal input generates the BAM signal to the backup timer. OC2 also supplies the signal to another XOR gate of U1 which acts as a non-inverting buffer to control reset pin 4 of timer U4 in section 2.

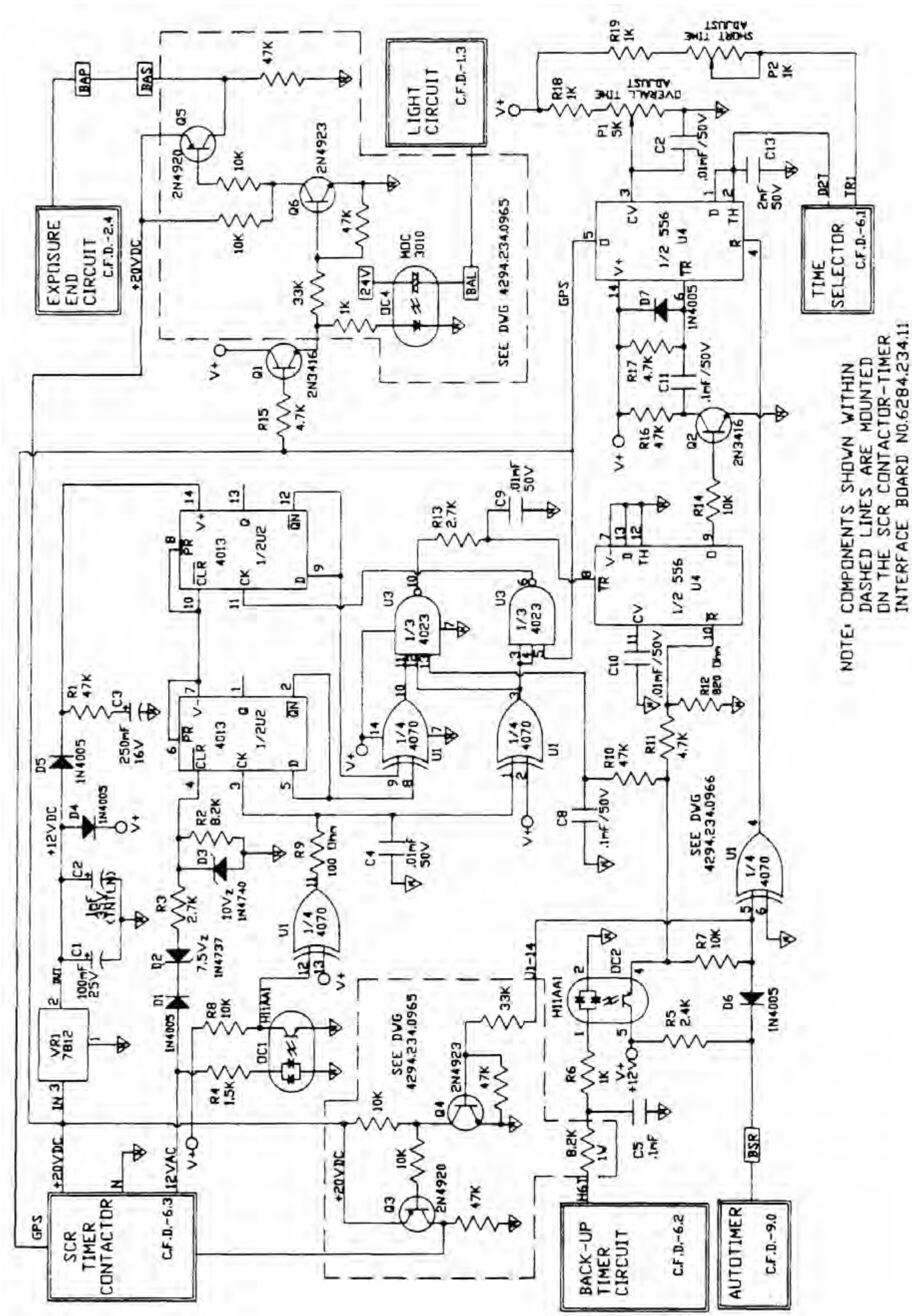

Figure 2-8. Circuit function description 6.0.

(3) When the timer resets are high, both timers U4 may be triggered to begin timing.

(4) When the expose, phase, and clock signal inputs to the first triple-input NAND gate are all simultaneously high, the output goes low, causing the trigger-input pin 8 to U4 timer 1 to go low and turn on the output (pin 9), which goes high.

(5) Because the threshold pin 12 of U4 timer 1 is tied to common, the output will remain on until the timer is reset by removal of the exposure signal from H6T.

(6) The output (pin 9) of U4 timer 1 turns on and turns on the gate of transistor Q2, which causes a negative-going pulse to the U4 trigger input (pin 6) of timer 2. This pulse causes timer 2 to turn on.

(7) The output of timer 2 (GPS) provides the following.

(a) The turn-on signal to the SCR contactor.

(b) The gating signal for Q1 which gates Q6 and Q5 on the SCR contactor to provide the BAS (exposure on) signal.

(c) The input to a triac optocoupler OC4 which illuminates the EXPOSE button.

(8) Additionally, GPS is connected to the second triple input NAND gate U3, allowing the clock-pulses clock flip-flop 2 U2 for the duration of the exposure.

c. The exposure terminates when C13, the timing capacitor for the U4 timer 2, charges to a voltage equivalent to that set by the potentiometer P1 through the resistance selected by the timer switch.

d. In the case of phototimed exposures, a back-up time longer than the expected time is set on the timer switch and the exposure is terminated by the automatic exposure control pulling the BSR signal low. This causes the associated XOR gate to pull the reset pin on timer 2 low, thus terminating the exposure. The exposure cannot be restarted until 115vac is removed from H6T, which resets U4 timer 1.

e. The overall-time-adjust potentiometer P1 is used for setting overall timing accuracy at longer times. The short-time-adjust potentiometer P2 is used for precise timing at short times (1/60 to 1/30sec).

2-10. TIME-SELECTOR SWITCH

The timer is an analog-type switch using a resistance-capacitance (RC) combination. On the impulse-timer deck of the time-selector switch are 24 resistors connected in series which form the "R" part of the timing circuit. As the selected time increases, the total resistance is increased because a greater number of series-connected resistors are selected. These resistors are inserted into the charging path of C13 timer capacitor shown in figure 2-8 in lead D2T.

a. The voltage across the impulse-timer deck is some portion of positive (+) 12vdc as adjusted by the short-time-adjust pot (P2) also shown in figure 2-8. This positive voltage is on leads TR1 and D2T. The back-up timer deck of the time-selector switch utilizes resistors in the same manner as the impulse-timer deck. As the selected back-up time increases, so the total resistance increases.

b. The back-up timer allows an approximately 10-percent increase in exposure time 1 at 50Hz, in the event of failure of the impulse timer. The time increase will be greater at 60Hz. The appropriate back-up time is automatically selected as the regular exposure time is selected. These resistors are inserted into the charging path of C1 capacitor in the timer back-up circuit in lead DBR (figure 2-9). The voltage across the back-up timer deck is some portion of positive (+) 24vdc as adjusted by pot R2 in the back-up-timer circuit. This positive voltage is on leads DBR and 3D.

c. The remaining deck of the time-selector switch acts as an interlock to the ma overload. From lead EER, 115vac is applied across the timer-switch contacts, and exits to lead ERX. When the time selector is on the open contacts of the deck, the safety-reset lamp illuminates to show an improper technique has been entered into the control. It also prevents an exposure.

2-11. BACK-UP TIMER (CIRCUIT FUNCTION DESCRIPTION 6.2)

Refer to figure 2-9. The back-up timer operates in two modes. The first is normal exposure, when the back-up timer causes the back-up contactor to pull in prior to the beginning of an exposure, and releases the back-up contactor after the SCR contactor turns off. During phototiming, if the phototimer terminates the exposure prior to time out, the back-up contactor does not release. The second mode provides for exposure interruption by releasing the back-up contactor immediately when the overload condition is detected.

a. Upon the initiation of the PREP function (or cassette advance during spot filming), signal H3 from the exposure circuit goes to 115vac, energizing relay K4. K4 opens the filament-standby shunt through contacts XBR/XD, bringing the tube filament to full emission.

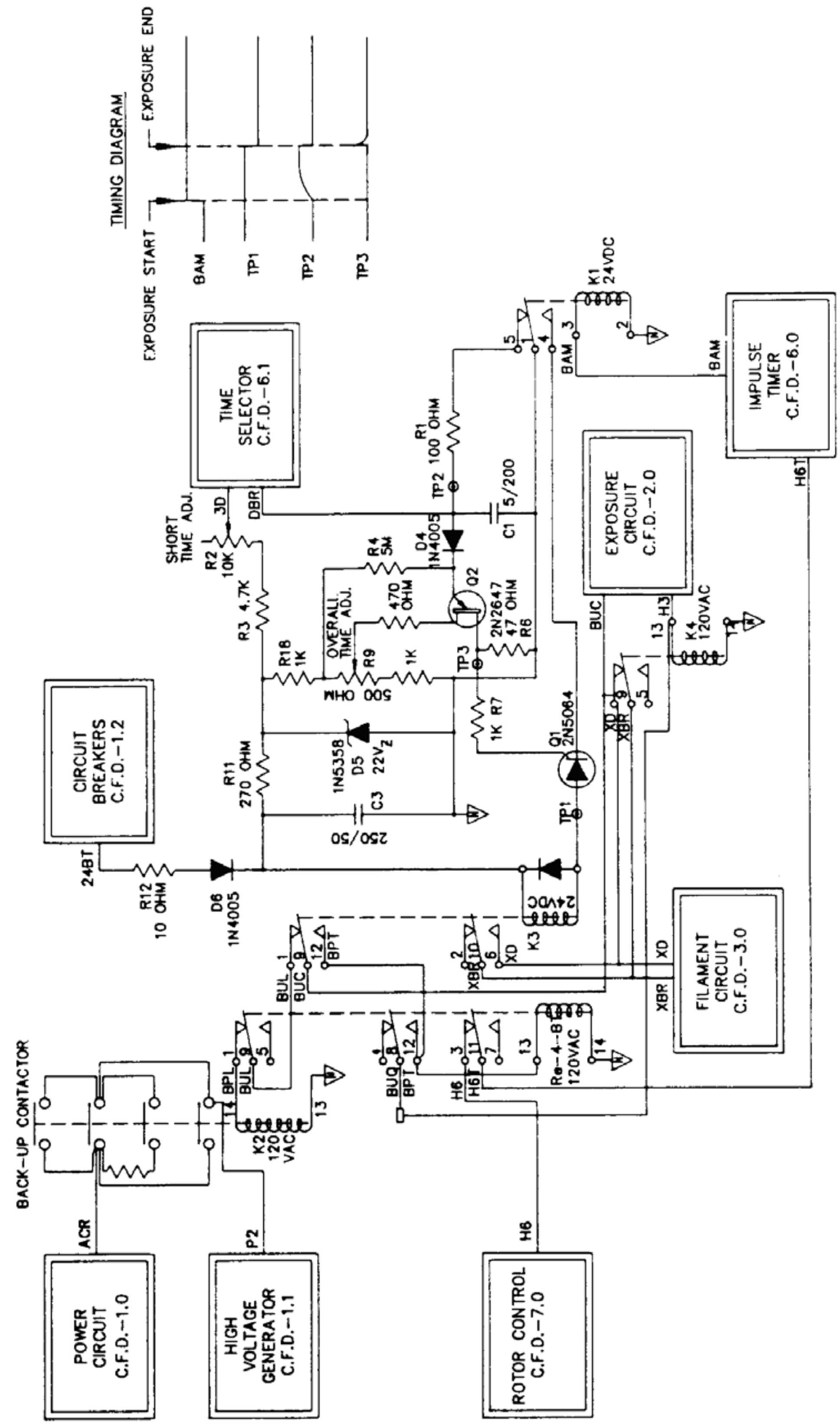

Figure 2-9. Circuit function description 6.2.

b. After the rotor control has completed its boost cycle and the tube anode is up to speed, signal OHO from the rotor control energizes signal BUC through the interlock and safety relay. This causes back-up contactor K2 to close through relay K3 contacts BUC/BUL and through relay Re-4-BT contacts BUL/BPL. When the EXPOSE button is pressed the following occurs.

(1) The H6 (rotor control CFD 7.0) goes to 115vac and becomes H6T, after passing through contacts H6/H6T of the relay Re-4-BT.

(2) The H6T then goes to the impulse timer. Signal BAM from the impulse timer immediately goes high, activating relay K1.

(3) This removes the short from the back-up timer capacitor C1, and the cathode of the SCR connects to the common.

(4) Timing immediately commences, with C1 charging through selected resistors on the timer switch, and potentiometer R2.

(5) When C1 charges to a voltage to the reference set by the potentiometer R9, the unijunction transistor Q2 discharges the capacitor C1 through its emitter/base junction, providing a gating signal to the SCR.

(6) The SCR turns on, activating relay K3. This causes BUC to break from BUL and switch to BPT, forcing the back-up contactor K2 to release and relay Re-4-BT to energize.

(7) Contacts XBR/XD are also made, which cause the filament-standby resistor to be returned to the circuit and reduce the filament to standby level.

c. Concurrently Re-4-BT is energized by BPT. This causes contacts H6/H6T to break, terminating the exposure signal to the impulse timer.

d. When automatic exposure control is employed and terminates the exposure, BAM immediately goes low, deactivating relay K1. This shorts the timing capacitor C1 and inhibits completion of timing cycle. In these circumstances, the back-up contactor K2 remains engaged until signal H3 is released by releasing the PREPARE button or advancing the cassette to the parked (fluoro) position during spot filming.

e. The voltage level on the charging capacitor, at which the unijunction transistor triggers the SCR, is adjusted by potentiometer R9 (overall-time adjust). This adjustment provides a proportional increase or decrease in the back-up time interval for each time selection. Potentiometer P2 (short-time adjust) is in the charging resistor path. It increases or decreases the timer interval by a fixed amount for each time selection.

2-12. SINGLE-PHASE SILICON-CONTROLLED RECTIFIER CONTACTOR CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 6.3

Refer to figure 2-10. From leads 151T and "N," 115vac is applied to the transformer leads BLK and WHT. One secondary operates as a dc-power supply while the other two secondaries develop the dc-gate voltages for SCR-1 and SCR-2. When these SCRs are turned on, the ac voltage from the power circuit on lead AM passes through the SCRs and becomes lead AMR to the high-voltage generator.

a. Across transformer leads RED and VIO is about 48vac center-tapped by the GRN lead. This voltage is rectified, filtered, and regulated becoming a positive (+) 2Ovdc source to the impulse-timer circuit. From VIO lead, 12vac is also applied to the impulse-timer circuit.

b. The remaining two secondaries, leads BLU/BLU and GRY/GRY, are identical in operation. The ac voltage is rectified by the diode bridges, capacitive filtered, and controlled by optocouplers OC2, OC3, and transistors Q7 and Q8. When an exposure is initiated, leads BAM/BAC from the impulse-timer circuit is high, causing the optocoupler OC1 to conduct. A high on the lead GPS turns on the two optocouplers OC2 and OC3. The optocouplers conduct the dc voltage to the base of transistors Q7 and Q8, biasing them on and passing a dc voltage from collector to emitter to the gates of SCR-1 and SCR-2. This gate voltage is about 1.5vdc.

c. Since the duty cycle of the SCRs is 100 percent, both positive and negative cycles pass through to lead AMR. When the timers terminate exposure, leads BAM/BAC and GPS return low and the optocouplers and transistors are turned off, removing the dc gate voltage to the SCRs. The SCRs continue to conduct until the next zero crossover of incoming ac voltage on lead AM and then they inhibit.

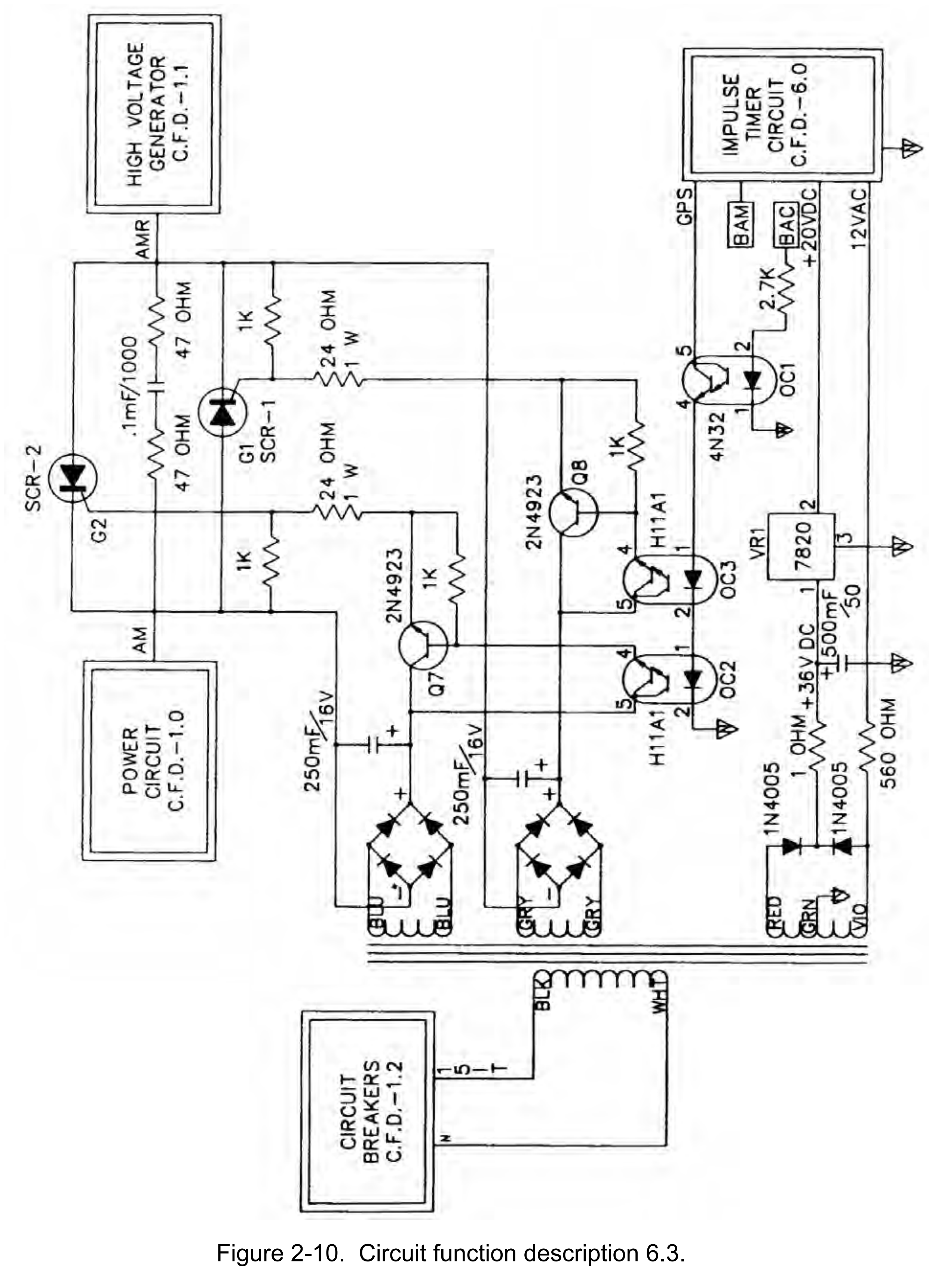

Figure 2-10. Circuit function description 6.3.

2-13. ROTOR CONTROL CIRCUIT (CIRCUIT FUNCTION DESCRIPTION 7.0)

Refer to figure 2-11. Both X-ray tubes: over-table and under-table, are controlled by this controller. The controller starts the anode of the X-ray tube spinning, reduces the voltage across the stator winding of the X-ray tube after a pre-set period of time, maintains a sensing circuit for monitoring the voltage and current of the phase shift capacitor, and removes the stator voltage at the end of the exposure.

a. A jumper wire between leads HF and FE make the provision for continuous rotation of the under-table tube possible. If continuous rotation is not desired, then jumper across HF and H3. It is highly recommended to have continuous rotation on the under-table tube whenever it is in use.

b. The Re-4 tube-select four-pole, double-throw (4PDT) relay is used to connect either the over-table or under-table X-ray tube to the rotor controller. This relay is operated via lead FE. When lead FE is 115vac, the relay is energized and the under-table tube is selected. If lead FE is low, then the over-table tube is selected.

c. The operation of the rotor control is initiated by depressing the PREPARE push button in radiography and by depressing the footswitch in the fluoro mode. For this discussion, assume the over-table tube is in use and the PREPARE push button is depressed for a radiographic exposure.

d. From the exposure circuit via the PREPARE push button is 115vac on lead H3 which branches into two circuits. One circuit is to a set of normally closed contacts on the 4PDT relay Re-3 which is energized when the rotor reaches speed and illuminates the "GO" LED.

e. The other circuit for lead H3 is through a set of normally closed contacts on the tube-select relay Re-4 to the common pin of contact GT1 and GT2 on relay Re-2-RC and also is rectified, filtered, and zenered to become the positive (+) 24vdc source. This 24vdc source turns on transistor Q2 which allows Re-2-RC to energize, closing contacts H3/GT1 and the remaining three sets of normally open contacts close to short circuit the sensors during boost time.

f. Across the boost-time-adjust potentiometer P1 and its series resistors is 24vdc and it is across a 15-M Ohm resistor in series with the 0.1-μFd timing capacitor. Potentiometer P1 sets the trip point and turns on SCR2 (silicon-controlled rectifier) to change from a boost cycle to a RUN cycle.

g. During the boost cycle and while the timing capacitor is charging, 115vac is across the closed contacts H3/GT1 to the GT1 triac and causes it to conduct. From lead H2F comes 230vac through the GT1 triac to the closed contacts Re-4 H7/O7.

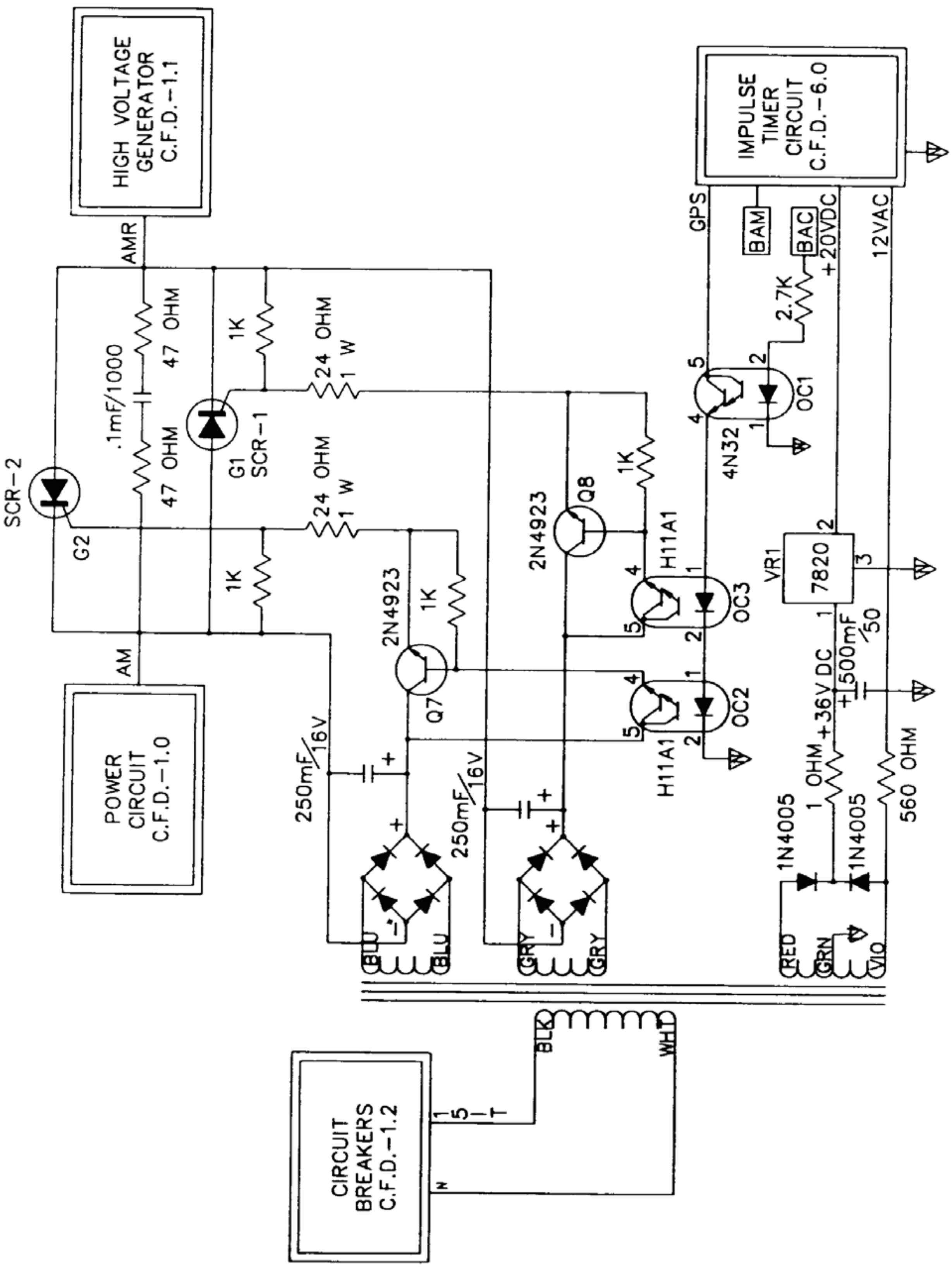

Figure 2-11. Circuit function description 7.0.

h. Also 230vac is applied across the rotor-phase-shift capacitor and exits at the closed contacts of H8/08 of Re-4 to the X-ray tube. 230vac from the GT1 triac turns on an optocoupler OC1, allowing 24vdc to trigger SCR1. Silicon-controlled rectifier 1 conducts, passing 24vdc to the emitter of the transistor Q1, the switch is inhibited until the boost cycle ends.

i. When the 0.1-μFd timing capacitor reaches its preset charge point (set by P1), SCR2 is triggered putting a low on the base of Q2 transistor, turning Q2 off and turning Q1 on. Relay Re-2-RC de-energizes and its contacts return to their normal position with the short circuit removed from the three sensors. When 115vac on lead H3 is switched from the GT1 to the G2 triac.

j. With the GT2 triac turned on, 60vac from lead 601 is reduced to 50vac via the 10-ohm 100-watt slider motor-run-adjust resistor to lead H1F, through the GT2 triac and the three sensing circuits, and across the rotor phase shift capacitor to exit at H7/07 and H8/08 of Re-4 to the X-ray tube. The 50vac now maintains the correct anode speed of about 3,200rpm.

k. The three sensing circuits are: in-phase current sensor, shifted-phase current sensor and capacitor-voltage sensor. These sensors are in series and control the 24vdc to the "GO-NO-GO" relay Re-3 via the 2N5308 transistor. The sensitivity of the three sensors is adjusted by potentiometers P2, P3, and P4. The sensors ensure adequate voltage and current is available to the stator windings of the X-ray tube for proper anode speed before an exposure is permitted. These sensors protect the X-ray tube from being damaged by exposures on a stationary target. When any sensor is inoperative, no exposure is possible due to lack of a rotor-to-speed signal.

l. When transistor Q1 turns on, 24vdc goes to the coil of the "GO-NO-GO" relay Re-3 but it cannot enable u<u>nti</u>l the 2N5308 transistor goes into conduction. The 24vdc goes to the sensors and, if all sensors are operating, turns on the 2N5308 transistor which enables the "GO-NO-GO" relay closing contacts H3/OHO and H5/H6 going to the exposure circuit on lead OHO, and to the back-up timer on lead H6.

m. This gives the two circuits the necessary rotor-to-speed signal for exposure. Also, the "GO" LED is illuminated. When the PREPARE push button is released, lead H3 goes low turning off the GT2 triac, the 24vdc source drops to zero, the "GO" relay inhibits, and the rotor coasts to a stop.

n. In the fluoro mode, the rotor control operates in the same manner with one exception. The tube-select relay is enabled connecting H7/U7 and H8/U8 for the under-table tube.

2-14. SPOT FILM CHANGEOVER CIRCUIT (CIRCUIT FUNCTION DESCRIPTION 8.1)

Refer to figure 2-12. The changeover switch in the spot film device is a mechanically actuated switch operated by the cassette tray itself. When a spot film is commanded, the cassette tray moves forward to the in-beam position closing the contacts FE/RL.

a. The spot-film-preheat adjustment is necessary to keep the large focal spot filament in the under-table tube warm during fluoro so when a spot film is called for, the boost time will not be excessively long. However, the filament cannot be hot enough for emission during fluoroscopy.

b. During fluoroscopy, relay Re-6-SF located on the relay matrix PCB is energized via lead FT from the fluoroscopic timer and contacts TE/TL are closed supplying 115vac, via lead TL to the fluoroscopic exposure control and to the power circuit to energize the fluoro contactor.

c. When the fluoroscopic timer reaches zero time, leads TL/FTE close and relay Re-6-SF remains closed through the FTE diode, holding the contactor and a diode. The fluoro exposure continues, but the fluoro time-expired buzzer sounds. When the fluoro exposure is released, relay Re-6-SF will open.

d. If another exposure is attempted before the fluoro timer is reset, it will be inhibited since Re-6-SF will not close. The fluoro time-expired buzzer will sound to alert the operator to reset the fluoro time.

e. The amount of fluoro time is controlled by a five-minute, synchronous, motor-driven timer, which normally runs whenever fluoro is active and is shut off when fluoro is inactive.

f. A mechanical cam, connected to the dial shaft, operates a single-pole double-throw (SPDT) switch. The switch is held by the cam in its normally opened position when the dial indicator is between five minutes and zero time, and transfers to its normally closed position at zero time. The timer stops at this point. The cam, consisting of two, 180º segments, is both positional and angle adjustable. Since the timer uses a synchronous motor, the angular rate of motion will depend on the frequency of the existing voltage. The rate of motion at 60Hz is 62º per minute. At 5OHz the rate of motion is 51 2/3º per minute.

g. The panel is provided with a reversible decal, indicating the time divisions for each frequency. The zero point on both sides is at the same angular position relative to the placement and the OFF position of the cam need not be changed. The decal facing and start-cam (five minutes) position must be adjusted for the operating frequency of the generator.

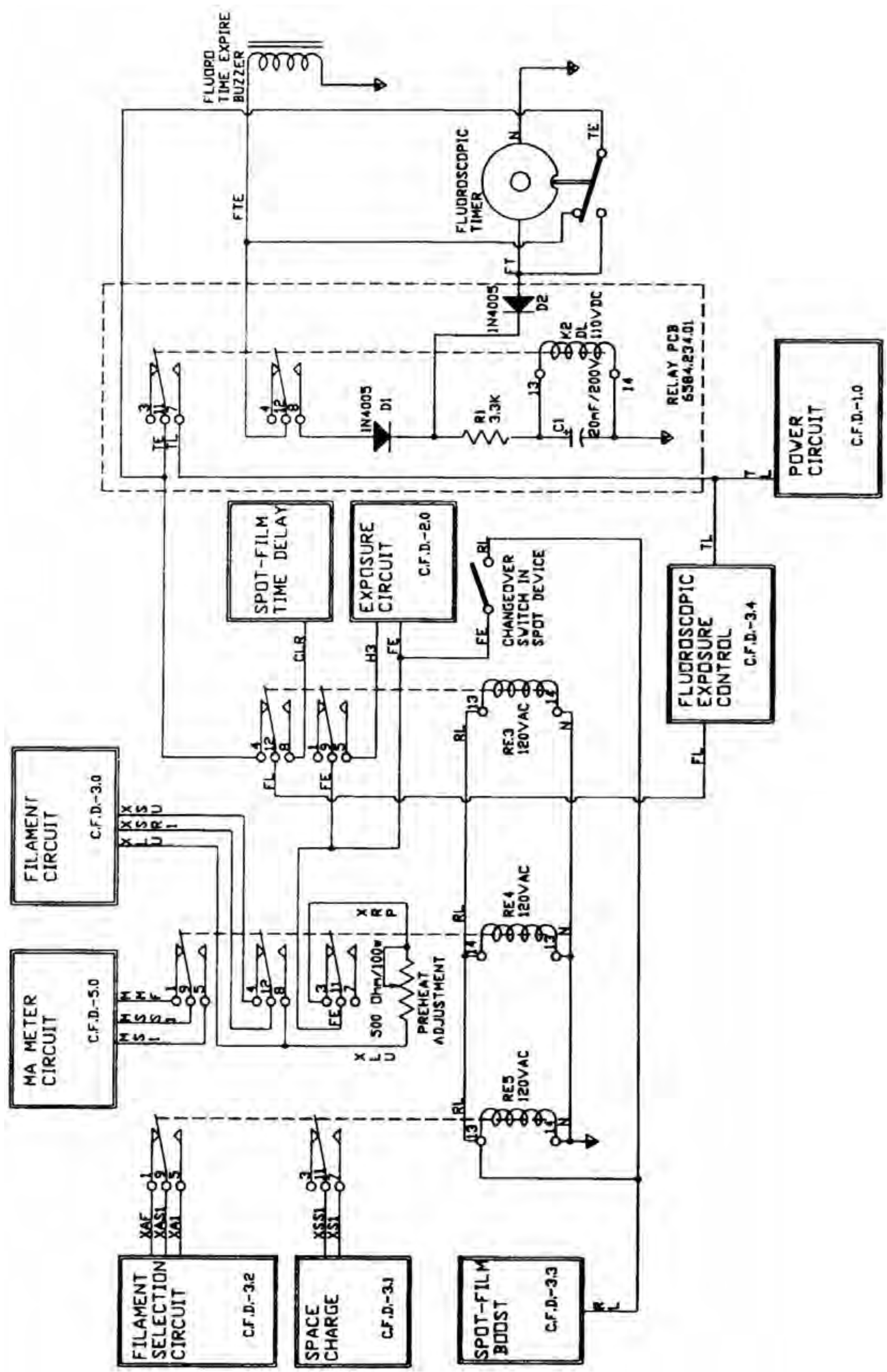

Figure 2-12. Circuit function description 8.1.

2-15. AUXILIARY RELAY CIRCUIT, CIRCUIT FUNCTION DESCRIPTION 9.3

Refer to figure 2-13. The auxiliary relay assembly allows for the selection, for each ma station, of additional control functions not available from either the ma-selection switch or the ma-selector-relay panel.

a. These functions are as follow.

(1) Selection of the ma, time, and kvp adjustment pots.

(2) Filament-drive transformer in the high voltage.

(3) The PREPARE/EXPOSE signal source, to control the panel or footswitch and ion chamber interlock.

(4) Damping resistor selection.

b. On one set of contacts of each selection relay is MVD from the ma-time kvp-overload assembly. The relay appropriate to the ma selection, R1 for 200L SPOT, R2 for 25ma, etc., will be energized. The MVD will output on the selected MY lead back to the ma-time kvp-overload assembly.

c. On a second set of contacts of each selection relay is XD from the filament control. If R1 is energized and 200L SPOT selected, XD outputs on XRS1 to the spot-film changeover, where the selection of XSU for the small focal spot of the under-table X-ray tube in fluoro, or XLU for the large focal spot of the under-table X-ray tube in radiographic, is accomplished.

d. Relays R2 through R4, select XSO for the small focal spot of the over-table X-ray tube. Relays R5 through R8 select XLO for the large focal spot of the over-table X-ray tube. On the third set of contacts of R1 is 115F to either CE normally closed contact, or FE normally open contact. When R1 is off, and a ma selection other than 200L SPOT is made, the PREPARE/EXPOSE enable is to the PREPARE and EXPOSE push buttons on the control panel. When R1 is energized, and 200L SPOT is selected, the EXPOSE enable is to the footswitch.

e. The EFO safety signal is on the third set of contacts of R2 through R8. If any one of these relays is energized, connection to ERO is through the normally open contact of that relay. If none of these relays are energized, and R1 is selected, the connection to ERS is through the common normally closed contacts of the relays in series. This is the ion chamber selection safety when autotiming is selected.

f. On the fourth set of contacts is 24vac. A group of jumper-connection points from the normally open contact of each relay to lead ADR is on the auxiliary relay panel. If a jumper wire is installed, ADR will be at 24vac when that ma station is selected. ADR operates the damper-resistor-shorting contactor.

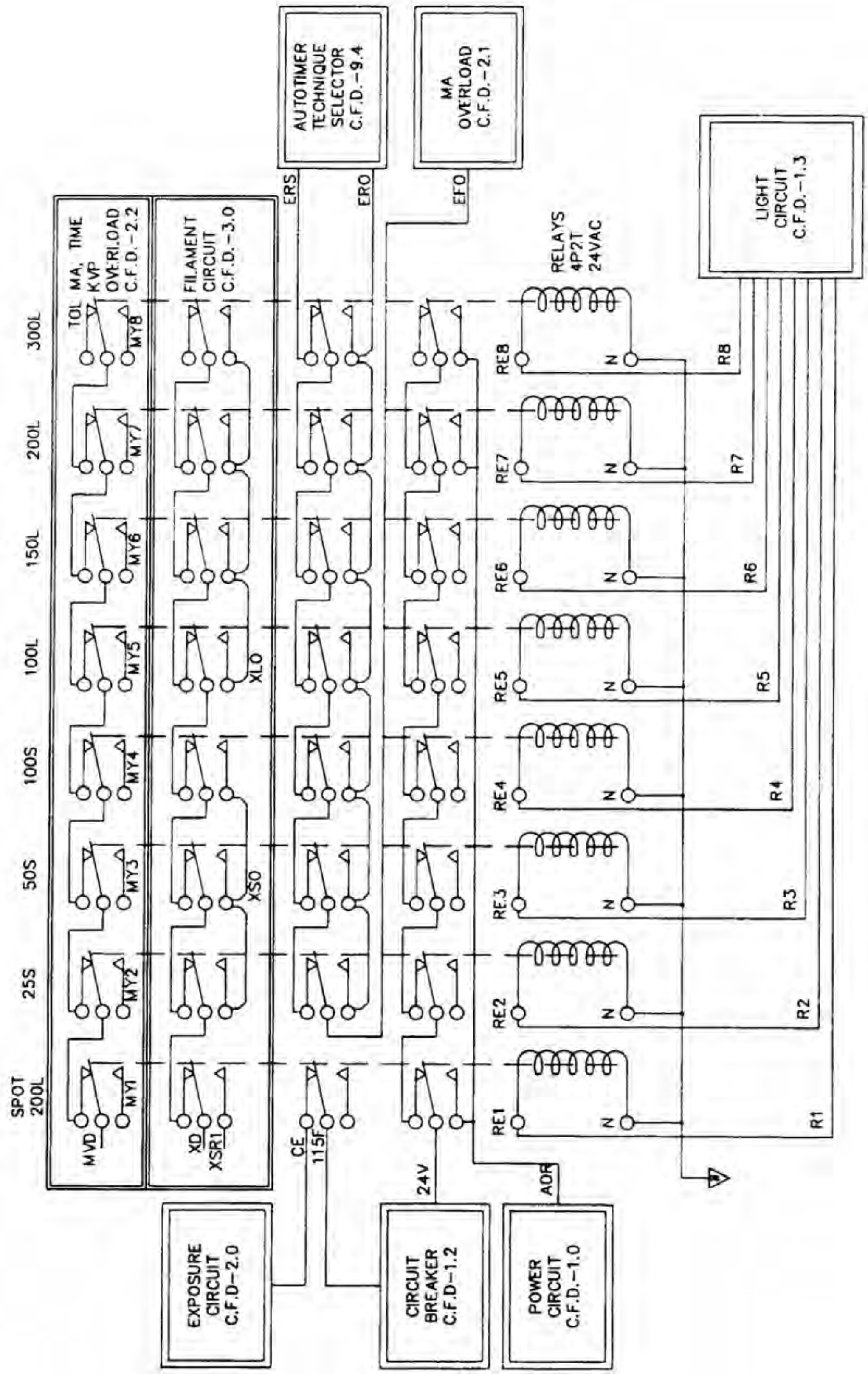

Figure 2-13. Circuit function description 9.3.

Section II. ISOLATION PROCEDURES

2-16. GENERATOR FAULT CONDITIONS

a. **Mains Switch.** If the generator does not turn on or the MAINS switch does not light up, look for the following conditions.

(1) The field generator is not functioning in a tactical shelter.

(2) The mains disconnect is open (Box A and Box B in a tactical shelter).

(3) There is a burnt-out fuse in the mains disconnect.

(4) There is a loose connection on the input cables.

(5) There are blown lines on the contactor fuses.

(6) There is a burnt coil on the contactor.

b. **Prepare Cycle.** If the PREPARE cycle does not complete or the PREPARE light does not come on, one or more of the following may exist.

(1) The rotor cable(s) is(are) not connected or the connection(s) may be loose.

(2) The rotor controller needs adjustment.

(3) The circuit breaker(s) is(are) open in the rotor power supply.

(4) The rotor-controller phase-shift capacitor is shorted or open.

(5) There is a fault on the rotor-controller PCB.

c. **Exposure Cycle.** If the PREPARE sequence appears OK, but the EXPOSURE sequence does not function properly look for the following.

(1) <u>Radiography</u>.

(a) If the SAFETY/RESET light is lit, check the technique factors (operator error).

(b) If the READY light of the over-table collimator is not on, one of the following may be the cause:

1 There is no cassette present (operator error).

2 The over-table collimator is malfunctioning. See the over-table collimator section in this lesson.

3 The back-up contactor is not closed.

(2) Spot film.

(a) If the SAFETY/RESET lamp is lit, check the technique factors (operator error).

(b) Check for a loose footswitch connection.

(c) There could be a fault in the spot-film device.

(d) The malfunction could be caused by a fault in the exposure-delay relay.

(3) Fluoroscopy.

(a) Check for a loose footswitch connection.

(b) There could be a fault in the spot-film device.

(c) The fluoro timer was not set (operator error).

(d) The trouble could be a fault in the fluoro timer (open).

d. **Radiation.** When the EXPOSURE sequence appears OK, but there is little or no radiation, the following conditions may exist.

(1) The circuit breaker could be open in the filament circuit.

(2) There may be a fault in the cooling chimney or filament-control PCB.

(3) There may be a poor high-voltage jack-pin connection.

(4) Check for a loose connection in the primary power wiring.

(5) Look for dirty contacts on the ma-select relay(s).

(6) There could be a fault in the timer PCB.

e. **Safety Light.** When the SAFETY light comes on when you are making an exposure, the following conditions could exist.

(1) The ma requires calibration.

(2) The cooling-chimney filament-driver transistor is shorted.

(3) There is a fault on the filament-control PCB.

(4) The ma overload shunt is open or miscalibrated.

(5) The X-ray tube is gassy and/or arcing.

(6) The X-ray cable is arcing.

(7) The high-voltage generator is unbalanced.

(8) The high-voltage generator is short or open.

f. **Terminated Exposures.** If the autotimer terminates an exposure immediately, the following conditions may be present.

(1) A fault in the ion-chamber pickup. (See AEC troubleshooting, paragraph 2-21.)

(2) A fault in autotimer PCBs. (See AEC troubleshooting.)

(3) Look for an open in the density selector(s). (See AEC troubleshooting.)

g. **Unterminated Exposures.** If the autotimer does not terminate exposures, the following conditions could be present.

(1) The back-up time is set too short.

(2) The wrong field was selected (operator error).

(3) The table is in an incorrect patient position (operator error).

(4) There is a loose or misconnected ion-chamber pickup. (See AEC troubleshooting.)

(5) There is a fault in an ion-chamber pickup. (See AEC troubleshooting.)

(6) There may be a fault in the autotimer PCBs. (See AEC troubleshooting.)

h. **Fluoro.** If there is no fluoro kvp reading or no fluoro image, the following conditions may exist.

(1) The fluoro circuit breaker may be open.

(2) The fluoro variable transformer may be damaged.

(3) Look for a loose power connection to the variable transformer.

(4) Check for an open fluoro damper resistor.

i. **Timing.** If exposure times are inaccurate, check for the following conditions.

(1) The incorrect timer deck has been selected.

(2) Look for dirty or damaged contacts on the time-select switch.

(3) A shorted SCR contactor.

(4) A fault in the timer PCB.

(5) The timer is not calibrated or has gotten out of calibration.

2-17. X-RAY TABLE FAULT CONDITIONS

a. If the table-tilt function is inoperative, check for one or more of the following conditions.

(1) The table is already at its limits (12º Trendelenburg or 88º vertical).

(2) Look for a loose cable connection.

(3) The variable speed-drive may be miscalibrated.

(4) The slow-down adjustment may be miscalibrated.

(5) Look for an open tilt circuit breaker.

(6) The tilt motor may be inoperative or a belt broken, frayed, or otherwise inoperative.

b. If the table body jerks to the side when tilting, check for the following.

(1) The table base may not be stable (level).

(2) The sector-guide bearings may be worn or not adjusted properly.

c. If the table bumps and grinds when tilting, check the tilt chain tension. It may be too loose.

d. If the table locks are inoperative, one or more of the following conditions may exist.

(1) A control switch malfunction.

(2) The lock's circuit breaker may be open.

(3) Check for a loose cable connection.

(4) Check for a fault in the lock-control PCB.

(5) The locks may be improperly adjusted.

e. If the lock(s) hum loudly, check the following.

(1) A failed filter capacitor on the lock.

(2) Locks improperly adjusted.

f. If the fluoroscopic carriage movement binds or drifts, check the following.

(1) A guide bearing which is adjusted too tightly.

(2) Look for dirt or foreign matter in the bearing path.

(3) The problem could be a broken bearing.

(4) Observe the cabling to see if it's catching or rubbing on other objects.

(5) The table may not be level.

g. If the longitudinal carriage binds during movement, check for the following.

(1) A guide bearing adjusted too tightly.

(2) Look for dirt or foreign matter in the bearing path.

(3) As above, look for broken bearings.

(4) Look for cabling which is catching or rubbing on other objects.

(5) Check all of the counterweights for the above conditions.

h. If the grid cabinet binds during movement, one or more of the following conditions may be present.

(1) A guide bearing which is adjusted too tightly.

(2) Dirt or foreign matter in the bearing path.

(3) A broken bearing.

(4) Cabling catching or rubbing on other objects.

(5) Check the counterweights for the above conditions.

i. If cassette sizing in the grid cabinet does not sense properly, check the following.

(1) The tray was not properly inserted (operator error).

(2) Check for loose or broken grid and/or table connections.

(3) The cassette-locating stops could be incorrectly positioned.

2-18. TUBESTAND FAULT CONDITIONS

a. If the tubestand's mechanical motions are binding or not smooth, check for the following conditions.

(1) Bearings which are adjusted too tightly.

(2) Check for foreign material in the bearing path.

(3) Check for locks not releasing.

(4) Check the counterweight for proper adjustment.

(5) The tubestand may not be level.

b. If the electric lock(s) is(are) inoperative, one or more of the following conditions may exist.

(1) Check for a poor cable connection.

(2) There may be pinched or damaged wiring.

(3) If the lock has failed, replace it.

(4) The power supply in the auxiliary box may have failed.

(5) The power-supply circuit breaker may be open.

(6) The lock may be improperly adjusted.

c. If the lock hums loudly, check for the following.

(1) Failed connections on a capacitor attached to the lock.

(2) A lock may be improperly adjusted.

d. If the tubestand will not move in a given direction, check for the following conditions.

(1) The shipping restraint(s) may not have been removed.

(2) The column-rotation lock may not be loosened.

2-19. SPOT-FILM DEVICE FAULT CONDITIONS

a. If the cassette carriage slams or jams during movement, one or more of the following conditions may be present.

(1) The position-sensor flags could be out of adjustment.

(2) Check for a failed position sensor.

(3) Check for loose position sensor connection(s) on the interface PCB.

(4) Check for a cassette partially out of the carrier or not latched in.

(5) The clutch-brake may be inoperative.

b. If the spot-film device itself is inoperative, check the following.

(1) An open power-supply fuse in the auxiliary cabinet.

(2) A fault in the central processing unit (CPU) PCB.

(3) Look for any loose wiring.

(4) Look for loose cable connections.

(5) The power supply switch may not be turned on.

(6) There may be a fault in the power supply.

c. If the cassette carrier does not move, although the motor runs, check for one or more of the following conditions.

(1) Damaged drive-belt teeth or a belt which has jumped a pulley.

(2) Foreign material in the carrier path.

d. If the spot-film device senses the cassette is present without a cassette in the carrier or it never/intermittently senses the cassette is present, the cassette-present sensor may be out of alignment.

e. If the image size on the film is smaller than the size selected, check the following.

(1) The wrong mask or compression cone was placed in field (operator error).

(2) The collimator was incorrectly calibrated or is now inoperative.

2-20. COLLIMATOR FAULT CONDITIONS

a. If the collimator-field lamp does not light, check for the following.

(1) A burned-out collimator field lamp.

(2) An open 27vac power-supply protection fuse (F-2).

b. If the centerline light cannot be centered, check the following.

(1) A prism/slit bracket out of adjustment.

(2) The under-table image receptor may be out of alignment.

(3) The source-to-image distance (SID) is out of tolerance.

c. If the exposure-hold indicator is activated, check for the following conditions.

(1) The shutters are not properly aligned.

(2) The vertical SID is not properly positioned at 40 inches SID.

(3) The horizontal SID is not positioned at a standard SID.

d. If the manual indicator is activated, check for the following conditions.

(1) The collimator may be tilted greater than 10º.

(2) The table is tilted greater than 10º vertically and horizontally.

(3) The cassette tray is not fully inserted.

(4) The cassette is not located in cassette tray.

2-21. AUTOMATIC EXPOSURE CONTROL FAULT CONDITIONS

a. If the safety light appears before exposure or the autotimer-reset light appears after an exposure, check for one or more of the following conditions.

(1) No field or chamber selection (operator error).

(2) The paddle or ion chamber is not in the collimator field. Correct the detector or tube placement.

(3) The generator back-up time (mas) is too short. Set the back-up mas to about four times the expected value.

(4) The chamber or paddle cable is broken. Check system continuity.

(5) A defective chamber or paddle. Replace it.

(6) The generator's X-ray output is low. Check the generator output and collimator.

(7) The autotimer reset light indicates an AEC-terminated exposure at 570mas. If the generator is set at maximum mas, this can be normal. If the generator is not set at maximum mas, this indicates failure of the generator's termination function.

b. If the digital display is extinguished, make the following checks.

(1) The power switch is OFF (operator error).

(2) Normally the digital display dims automatically after about six seconds, and extinguishes after about six minutes. Press the RESET push button.

(3) No power to the AEC. Check the fuse on the power-supply board and cabling.

c. If you experience erratic display data and exposure times, the system may have a defective paddle or chamber cable or detector.

2-22. IMAGE INTENSIFIER FAULT CONDITIONS

a. If the intensifier presents you with fuzzy and distorted images, check for the following conditions.

(1) The mirror is out of adjustment.

(2) Dirty mirror(s) or lenses.

(3) Ionized gas in the intensifier tube. To remedy this condition, apply power to the intensifier tube and let it run for 24 hours without X-rays.

(4) The focus adjustment is out of calibration.

(5) The collimating lens is out of focus. To remedy this condition, refocus the collimating lens and/or tighten the collimator clamp.

b. If the intensifier output glows without the presence of X-rays, it is most likely caused by ionized gas in the intensifier tube. Apply power to the intensifier and let it run for 24 hours without X-rays.

c. If there is no output when X-rays are applied, one or more of the following conditions may exist.

(1) Electrical power is not applied. Check the incoming power connectors.

(2) The power supply has failed. Replace the power supply.

(3) The intensifier insert may be cracked allowing air into it. Replace the image intensifier.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that BEST answers the question or BEST completes the incomplete statement.

After you have answered all of the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the lesson material referenced after the solution.

1. What voltage extremes are tolerable for safe and normal operation of the MXR-350 X-ray generator?

   a. 190 to 270vdc.

   b. 15 to 24vdc.

   c. 100 to 120vac.

   d. 190 to 270vac.

2. What prevents "ringing" in the high-tension waveform?

   a. Zenering of the high-voltage diode.

   b. A 0.375Ω resistor upon selection of low ma stations.

   c. The contact resistance of Re-20 which is the line contactor.

   d. Thyrites for over-voltage protection.

3. What allows a single high-tension transformer to accommodate two X-ray tubes?

   a. The control is connected to the high-tension transformer by two interconnecting cables.

   b. The changeover switch.

   c. The overload circuit.

   d. The diode bridge on the secondary of the impedance transformer acts as a variable resistor load.

4. In the space-charge-compensation circuit, what voltage will be read at TP4 at 78kvp?

   a. 78kvp.

   b. 78 volts.

   c. 0 volts.

   d. 24vdc.

5. Refer to figure 2-8. What is the resistance of R12?

   a. 820Ω.

   b. 10K.

   c. 1.5K.

   d. 100Ω.

6. What determines the voltage across the impulse-timer deck?

   a. The time-selector switch.

   b. The single-phase impulse timer circuit.

   c. The ma station selected.

   d. The short-time-adjust pot (P2).

7. Why must the connection between HF and H3 be made manually?

   a. Continuous rotation of the under-table tube is highly recommended whenever it is in use.

   b. Because it removes the stator voltage at the end of the exposure.

   c. Due to its proximity to lead FE and the tube-select relay.

   d. If lead FE is low the over-table tube is selected.

8. You are called to repair a CS-8952 system in which the generator does not turn on and the MAINS switch does not light up. Which of the following is a likely cause?

   a. A fault on the rotor-controller PCB.

   b. A burnt coil on the contactor.

   c. An open back-up contactor.

   d. A fault in the spot-film device.

9. During PMCS of a CS-8952 X-ray system, the safety light comes on while you are making an exposure. Which of the following conditions could be present?

   a. Dirty contacts on the ma-select relay(s).

   b. A burnt coil on the contactor.

   c. The high-voltage generator could be unbalanced.

   d. The circuit breaker could be open in the filament circuit.

10. You are troubleshooting a spot-film device with a jammed cassette carriage. Which of the following conditions is a probable cause?

   a. Position-sensor flags out of adjustment.

   b. An unloosened column-rotation lock.

   c. The cassette-present sensor may be out of alignment.

   d. An open 27vac power-supply protection fuse (F-2).

11. You diagnose an image intensifier problem as ionized gas in the intensifier tube. How do you remedy the condition?

   a. Open the bleed valve, bleed off the gas, and recharge the tube.

   b. Ground out the intensifier tube.

   c. Momentarily apply maximum kvp and mas to the intensifier tube.

   d. Apply power to the intensifier tube and let it run for 24 hours without X-rays.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. d (para 2-2)

2. b (para 2-2h)

3. b (para 2-3c)

4. c (para 2-6)

5. a (Figure 2-8)

6. d (para 2-10a)

7. a (para 2-13a)

8. b (para 2-16a(6))

9. c (para 2-16e(7))

10. a (para 2-19a(1))

11. d (para 2-22a(3))

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Remove and Replace Defective Modules
TEXT ASSIGNMENT	Paragraph 3-1 through 3-7.
LESSON OBJECTIVES	After completing this lesson, you should be able to:
	3-1. Remove and replace defective modules in the CS-8952 field-deployable X-ray unit.
SUGGESTION	After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

REMOVE AND REPLACE DEFECTIVE MODULES

3-1. GENERAL

When X-ray system failures occur, they must be corrected. Correcting malfunctions often makes it necessary to remove system parts or assemblies in order to gain access to the faulty components. The information in this lesson will assist you in the correction of malfunctions by providing instructions for the replacement of defective parts.

3-2. HAND TOOLS REQUIRED

a. Slot-head screwdrivers (including a small-blade pocket screwdriver).

b. Number one and Number two Phillips-head screwdrivers.

c. Needle-nosed pliers.

d. A set of SAE open/box-end wrenches or a six-inch (150mm) adjustable wrench.

e. An inspection mirror.

f. Wiring labels.

g. A shorting bar.

h. A set of hex-key wrenches.

i. A spirit level.

j. LocTite™ number 232.

NOTE: It is recommended these procedures be performed only by a qualified medical equipment repairman.

3-3. GENERATOR PARTS REPLACEMENT

The rectifiers in the high-voltage transformer of the generator are the only components discussed in this part of the lesson.

WARNING

The high-voltage rectifiers are located inside the high-voltage transformer where extremely dangerous voltages are produced during system operation. It is vital to ensure all personnel in the area of the generator are aware maintenance of the high-voltage circuitry is in progress.

a. Make sure power to the generator is locked in the off position at the system main-disconnect switch. Tag the switch to notify all personnel that maintenance is in progress.

b. Disconnect all cables from the auxiliary cabinet and remove the four screws holding the cabinet on the top of the transformer. Lift the cabinet from the transformer.

c. Disconnect the three-prong power plug from the top of the high-voltage transformer. Do not disconnect the twelve-pin auxiliary plug.

WARNING

Label and disconnect all four X-ray tube high-voltage cables from the transformer. These cables often store a potentially fatal electrical charge. Use a shorting bar or other similar device to discharge each cable as it is disconnected.

CAUTION: The high-voltage transformer housing is filled with highly purified dielectric oil. Impurities in this oil are capable of causing damage to transformer components when power is applied.

d. While it is not necessary to drain the oil from the transformer to replace the high-voltage rectifiers, it is important to maintain its purity during the procedure. This includes not only ensuring impurities do not enter the housing interior, but your hands and arms must be free of dirt and perspiration before performing the following steps.

e. Thoroughly clean the top of the high-voltage transformer housing. Carefully remove the access cover from the top of the high-voltage transformer housing. This cover is fitted with a cork gasket which may have become brittle with age and adhere to the access cover, transformer housing, or both. Use caution to ensure the screws, small pieces of cork, or dirt do not fall into the dielectric oil in the transformer housing.

CAUTION: Always scrape away from the access port and screw holes if scraping is needed to remove remnants of the gasket from the transformer housing.

f. Ensure your hands and arms are free of dirt and perspiration.

g. The high-voltage rectifiers are vertically mounted on plug-in strips on the side of the access port closest to the power plug. Each of these strips is fitted with a banana plug on one end and a banana receptacle on the other. They can only be installed correctly.

CAUTION: The high-voltage rectifier strips must be replaced as a set. Failure in one will damage all the others.

h. After the high-voltage rectifier strips have been replaced, re-install the access cover and restore the transformer to operation by following this procedure in reverse. Replace the cork access-cover gasket each time the cover is removed.

3-4. MXT-90/15 TABLE PARTS REPLACEMENT

a. **Table Top Removal and Replacement.** It is necessary to remove the table to gain access to the locks and cables which may need replacement. Refer back to paragraph 1-4d in Lesson 1 for instructions on removal and replacement of the table top.

b. **Upper Vertical-Carriage Cable Replacement.** The tower's vertical carriage is attached to the counterweight holder by means of three cables. The two upper cables are attached to the upper corners of the counterweight holder. Take the following actions to replace these upper cables.

(1) Tilt the table to the vertical position.

(2) Remove the rear cover from the tower. Notice how each upper cable is routed up from the counterweight carriage-equalizer bar, over a pulley, down beneath another pulley and up again, where it anchors in a block on the tower by a stop sleeve swaged onto its end. Each cable is attached to the carriage equalizer by means of a swaged-in loop.

(3) Remove the counterweights on the rear of the counterweight carriage.

(4) Disengage the looped end of the cable from the groove at the end of the counterweight equalizer.

(5) Disengage the stop-sleeve end of the cable from its slotted block at the top of the tower and remove the cable.

(6) Install the replacement cable by following the procedure in reverse. Remember, the two upper cables support the counterweight carriage, even if only one of them is being replaced. It is important to ensure both cables are routed over their pulleys and the looped ends engage the grooves in their respective ends of the counterweight equalizer bar.

(7) Replace the rear cover on the tower.

c. **Front Counterweight Cable Replacement.**

(1) The table should be in the horizontal position.

(2) If the front counterweight cable needs to be replaced, remove table top and sub-top.

(3) Loosen and remove the cable adjustment, which is located at the foot-end of the front counterweight.

(4) Disconnect the cable from the carriage.

(5) Install a replacement cable and adjust the tension with the cable adjustment.

d. **Rear Counterweight Cable Installation.**

(1) The table should be in the horizontal position.

(2) If the rear counterweight cable needs to be replaced, remove the table top and sub-top.

(3) There are two cables for the rear counterweights.

(4) Loosen and remove the cable adjustment, which is located at the foot-end of the rear counterweight.

(5) Disconnect the appropriate cable from the carriage and the counterweight.

(6) Install a replacement cable and adjust the tension with the cable adjustment.

e. **Cabinet Counterweight Cable Replacement.**

(1) The table should be in the horizontal position.

(2) If the grid-cabinet counterweight cable needs to be replaced, remove the table top and sub-top.

(3) Loosen the cable adjustment, which is located at the foot-end of the grid cabinet.

(4) Disconnect the appropriate cable from the grid cabinet and counterweight.

<u>NOTE</u>: It may be quicker to remove the appropriate counterweight pulley from the end of the table.

(5) Install a replacement cable and adjust the tension with the cable adjustment.

f. **Vertical (Compression) Lock Replacement.**

(1) Turn off the power and remove the table top and sub-top.

(2) Locate the compression lock. Label all wiring to this lock and disconnect it.

(3) Remove the compression lock by loosening the securing nuts and backing out the mounting screws.

(4) Install the replacement lock, following this procedure in reverse.

(5) Energize the table and engage the lock. Attempt to move the tower. It should take a minimum of 20 pounds of force to move the carriage. Locks should not make a "banging" sound when energized. Adjust the compression lock, following the procedures discussed in Lesson 1 (paragraph 1-4f).

g. **Transverse (Front-Back) Lock Replacement.**

(1) Turn off the power and remove the table top and sub-top.

(2) Locate the transverse lock. Label all wiring to this lock and disconnect it.

(3) Remove the nuts holding the lock on the two studs. Do not disturb the nuts behind the lock-mounting brackets. Slide the lock off the studs.

(4) Install the replacement lock, following this procedure in reverse.

(5) Energize the table and engage the lock. Attempt to move the transverse carriage. It should take a minimum of 20 pounds of force to move the carriage. Locks should not make a "banging" sound when energized. Adjust the transverse lock, following the procedures discussed in Lesson 1.

h. **Longitudinal (Head-Foot) and Grid Locks Replacement.**

(1) Turn off the power to the table and remove the table top.

(2) Position the grid chamber at the foot-end of the table and move the longitudinal carriage to the head-end.

(3) Locate the longitudinal lock (the grid lock is located next to the grid). Label all wiring on the lock and disconnect it.

(4) Notice the longitudinal (or grid) lock is suspended on two threaded, shouldered studs. A spring, retained by a cotter pin and washer on each stud, holds the lock away from the carriage when it is disengaged.

(5) Remove the cotter pin, washer, and spring from each stud. It may be necessary to climb into the table body to perform this step. An inspection mirror may be helpful when removing the hardware from the stud at the head end of the lock.

(6) Use a hex key wrench to back out both studs until the lock can be removed.

(7) Install the replacement lock by following the procedure in reverse.

(8) Energize the table and engage the lock from the spot-film device front panel. Attempt to move the longitudinal carriage. It should take a minimum of 20 pounds of force to move the carriage. Locks should not make a "banging" sound when energized. Adjust the longitudinal lock, following the procedure in Lesson 1.

i. **Tilt Drive Chain Replacement.**

(1) Turn off the power to the table and the remainder of the system.

(2) Wedge two lengths of heavy lumber between the bottom of the table body and the floor at the head-end of the table.

(3) Remove the drive-mechanism cover at the foot-end of the table leg.

(4) Remove the protective cover over the gear reducer.

(5) Loosen the chain tension and move the belt to the gear box for further slack on the head-end.

(6) Remove the two hex socket-cap screws and hardware at each end of the chain. Remove the chain.

(7) Use two of the screws and the associated hardware you removed in step 6, to attach the replacement chain to the chain guide at the foot end of the table.

(8) Thread the chain around the gear-box sprocket and idler to the head-end anchor position. Secure the assembly in place with the hex socket-cap screws.

(9) Re-tension the chain (refer to paragraph 1-4g in Lesson 1).

(10) Remove the wooden wedges.

(11) Replace the covers.

3-5. TUBESTAND PARTS REPLACEMENT

If it is determined a steel cable needs replacing, remove the collimator and the over-table X-ray tube first.

a. **Collimator Removal.** Remove the collimator using the following procedures.

(1) Cut off power at the main power source.

(2) Carefully remove the collimator's protective blade cover. Be very careful with the small blades on the collimator because they are easily damaged. Disconnect the collimator cable from its plug connector on the bracket at the left rear of the tube carriage.

(3) Turn the entire assembly (collimator and X-ray tube) over.

CAUTION: The collimator can easily fall from the tubestand when its retaining rings are removed. While one person removes the over-table collimator, a second person must hold the tube carriage at an accessible height.

(4) Unlock the collimator by removing the lock screws in the split ring which screws into notches in the upper and lower swivel rings. Remove the split ring.

(5) Remove the lower swivel ring.

(6) Remove the collimator from its upper swivel ring and rest it on a flat surface.

(7) Carefully replace the protective cover over the collimator blades.

b. **X-ray Tube Removal.** Remove the over-table X-ray tube using the following procedures. While one person removes the over-table X-ray tube, a second person must hold the tube carriage at an accessible height.

(1) Rotate the X-ray tube up (port down).

(2) Disconnect the anode cable from the anode-cable port and the cathode cable from the cathode-cable port.

WARNING

Use the shorting bar on the cable tips to discharge potentially fatal charges which may be stored in the cables.

(3) Disconnect the tube's rotor cable from its plug connector on the bracket side at the left rear of the tube carriage (as viewed from the front).

CAUTION: The X-ray tube may fall from the tubestand when its retaining screws are removed. Since it weighs approximately 42 pounds (20 kilograms), have another person hold it in place while performing the following steps.

(4) Remove the four screws from the collimator ring and the outer tube-mount spacer to remove the tube from the tubestand.

(5) Remove the X-ray tube and place it on a flat surface.

(6) Inspect both spacers to ensure they are serviceable. If necessary, replace them by removing the four screws holding the tube-mount spacers and collimator to the tube.

c. **Steel Cable Replacement.** Use the following procedures to replace a defective steel cable in the tubestand.

(1) Remove the three 3/8-inch bolts securing the column to the longitudinal carriage and carefully lay the column down.

(2) With the column in this position, pull the counterweight to the top opening in the column and remove the defective cables from the counterweight as well as the vertical carriage. Replace them with new cables.

(3) With the replacement cables attached, carefully lift the column back into the upright position and secure it to the longitudinal carriage with the three, 3/8-inch bolts.

d. **X-ray Tube Installation.** Reinstall the X-ray tube using the following procedures.

(1) Rotate the tube carriage so the carriage-tube mounting surface faces upward. Have another person hold the carriage in this position.

(2) Remove the four screws holding the inner tube-mount spacer to the tube.

(3) Position the X-ray tube on the tubestand with its port facing down.

(a) Position one tube-mount spacer (1/16-inch thick) between the X-ray tube mounting surface and the tubestand mount.

(b) Ensure the cable sockets point toward the vertical column.

(4) Attach the tube to the tubestand with the four screws, through the collimator ring and the second (outer) tube-mount spacer.

(5) Connect the tube's rotor cable to its plug connector on the bracket at the left rear of the tube carriage (as viewed from the front).

(6) Connect the anode cable to the anode-cable port and the cathode cable to the cathode-cable port. Make sure these cables are routed so the tube assembly can roll ± 180º from a "ports-down" position.

(7) Allow the assembly to rotate, via gravity, so the X-ray tube is down (ports up).

e. **Collimator Installation.** Reinstall the over-table collimator using the following procedures.

(1) Remove the cover protecting the collimator blades.

(2) Turn the collimator upside down and position it on its upper swivel ring. Ensure its front panel faces away from the vertical column.

(3) Install the split ring around the collimator lower swivel ring and upper swivel ring. The hinge of the split ring must line up with the pin in the lower swivel ring. Be sure the screw is tight.

(4) Position the collimator so it is "square" with the X-ray tube and tighten the lock screw in the split ring that screws into notches in the upper swivel ring and the lower swivel ring. The collimator should now be locked in place. Carefully replace the collimator's protective cover over the blades.

(5) Connect the collimator cable to its plug connector on the bracket at the left rear of the tube carriage.

(6) The column can be leveled by placing the spirit level on the column rails and adjusting the four leveling screws on the ends of the main frame.

(a) The accuracy of leveling should be checked with the column at both end positions as well as in the center of the rail.

(b) To facilitate setting the leveling screws, move the column to the opposite end of the rail.

(c) Once you have determined the rail is level, tighten the screws on the floor-mounting brackets.

3-6. SPOT-FILM DEVICE PARTS REPLACEMENT

a. **Interface Printed Circuit Board Removal.**

(1) Turn off the power to the SFD.

(2) Remove the rear cover by loosening the three screws securing it to the chassis. Lift the rear cover about one inch to disengage the flange at the front. Slide the cover about 1/4 inch toward the rear. Lift it off and set it aside in a safe place.

(3) Disconnect all ribbon-cable connectors and headers from the circuit board. Individual wires, including those in harnesses, are wired to the headers. It may be necessary to use a pocket screwdriver or similar tool to pry the ends of the headers away from the circuit board. Alternate from end to end to avoid bending the pins. Do not use any more force than absolutely necessary.

(4) Remove the five screws, three in the rear and two in front, securing the board. Lift out the board. Reassembly is the reversal of the above procedure.

b. **CENTRAL PROCESSING UNIT Circuit Board Removal.**

CAUTION: Special precautions are necessary when handling static-sensitive components such as the CPU and peripheral devices. Irreparable damage can be caused by touching an input lead, especially when done in a low humidity environment. The following points should be followed to minimize the possibilities of damage. All ac-test equipment used, in addition to surrounding electrical apparatus, should be grounded in accordance with National Electrical Code Standards, as well as local codes. All work surfaces should be covered with copper or aluminum and grounded by use of a strap or braid to a solid earth ground. All personnel working on the equipment should be grounded to the work surface by means of a metallic wrist strap in series with a one-megohm resistor.

(1) Turn off the power to the SFD.

(2) Remove the rear cover, following the instructions in paragraph 3-6a(2), above.

(3) Remove the two screws in the front of the interface board.

(4) Disconnect ribbon connectors P11 and P12. Hinge back the interface board and disconnect P1, P2, and P3 where they plug into the CPU Board. Observe the same precautions as for removing the connectors on the interface board.

(5) Remove the six 1/4-inch nuts securing the circuit board to the chassis. Lift out the board. Reassemble by reversing the above procedure.

c. **Front Panel Circuit Board Removal.**

(1) Turn off power to the SFD.

(2) Remove the two screws on each side of the SFD near the front.

(3) Remove the decorative knobs from the collimator-shutter-slide controls.

(4) Lift the rear of the front-panel assembly approximately 1/2-inch (13mm), while sliding it to the rear. Lift out the assembly.

(5) Disconnect all ribbon cables and headers. Observe the same precautions as for removing the connectors on the interface and CPU boards.

(6) Remove the 10 screws holding the board in place. Lift out the circuit board. Reassemble by reversing the above procedure.

d. **Stepper Motor Replacement.**

(1) Turn off power to the SFD.

(2) Remove the rear cover, following the instructions in paragraph 3-6a (2) above.

(3) The stepper-motor wiring is connected to the stepper-motor driver (the black anodized unit in the corner) by means of a header. Cut the cable tie securing the harness and remove the motor wires from the header (black--terminal 1, orange - terminal 2, yellow--terminal 3, and red--terminal 4).

(4) Manually rotate the shaft linking the stepper motor to the clutch/brake assembly until the setscrews on the couplings are visible.

(5) Loosen the setscrews on the motor and clutch/brake sides of the shaft to allow axial movement. Slide the shaft toward the clutch/brake so the output shaft of the motor is disengaged from the coupling.

(6) Loosen the tensioning pulley above the motor assembly.

(7) Remove the four motor-bracket screws, then disengage the pulley from the cogged belt.

CAUTION: When handling the belt, never force it or pry it over a pulley flange. To slide a belt in or out of position, remove the pulley.

(8) Carefully lift out the motor by angling it slightly for clearance.

(9) Note the pulley is installed on the shaft extending from the mounting side of the motor. Remove the pulley and save it for installation on the replacement motor shaft. Note the motor shaft has a flat. Ensure the setscrew is resting on the flat before tightening it.

(10) Install the new motor, following the above procedure in reverse.

(11) Re-tension the belt so it does not deflect more than 3/8-inch (9mm).

(12) Tighten the tensioning pulley.

(13) Reconnect the motor wiring to the header. Refer to step (3) above for the connection points with regard to color coding. Secure the harness with a new cable tie.

e. **Clutch/Brake Assembly Replacement.**

(1) Turn off power to the SFD.

(2) Remove the rear cover, following the instructions in paragraph 3-6a (2), above.

(3) The clutch/brake wiring is connected both to a header mounted to the interface board and to the ac-input-terminal block in the rear corner of the SFD chassis. Carefully cut the cable ties securing the wiring.

(4) Remove the white wire from terminal 1 of header J6 and the black wire from terminal 3. Remove the red wire from terminal 4 of the ac-input terminal block.

(5) Manually rotate the shaft linking the stepper motor to the clutch/brake assembly until the setscrews on the couplings are visible.

(6) Loosen the setscrews on the motor and clutch/brake sides of the shaft to allow axial movement, then slide the shaft toward the motor so the input shaft of the clutch/brake is disengaged from the coupling.

(7) Loosen the tensioning pulley above the clutch/brake assembly.

(8) Remove the four screws securing the clutch/brake assembly to the chassis.

(9) Disengage the pulley from the cogged belt and lift out the assembly. Observe the caution note in the previous subparagraph.

(10) Note the pulley is installed on the shaft extending from the <u>output</u> side of the assembly. Remove the pulley and save it for installation on the replacement clutch/brake-output shaft. When re-installing, tighten one setscrew into the keyway to help prevent loosening.

(11) Install the new clutch/brake assembly following the above procedure in reverse.

(12) Re-tension the belt so it does not deflect more than 3/8-inch (9mm).

(13) Tighten the tensioning pulley.

(14) Reconnect the wiring to the header and terminal block. Refer to step (4) for connection points with regard to color coding. Secure the harness(es) with (a) new cable tie(s).

NOTE: The two drive belts are constructed of a high reliability fiberglass/neoprene/nylon composite and should last throughout the life of the unit. To ensure smooth operation and to prevent premature failure, belts being stored should be protected against sharp bending or creasing. They should never be subjected to extremely high or low temperatures, high humidity, or high ozone concentrations while being stored. If a belt must be replaced, follow the procedure below. The belt driven from the clutch/brake (on the observer's left when facing the front) is referred to as the "front-to-back" belt. The belt driven directly by the motor is the "side-to-side" belt.

f. **Front-To-Back Belt Replacement.**

(1) Turn off power to the SFD.

(2) Remove the imaging system following the instructions provided by the manufacturer.

(3) Remove the rear cover, following the instructions in paragraph 3-6a (2).

(4) Remove the front cover by removing the three screws securing the rear lip to the chassis. Lift the cover up and back to disengage the front studs.

(5) Remove the imaging-system adapter plate by removing the eight screws securing it to the SFD and lifting it from the chassis.

(6) Loosen the tensioning pulley above the clutch/brake assembly.

(7) Disconnect the flag on the carriage from the belt.

(8) If necessary, remove the four screws securing the clutch/brake assembly to the chassis.

(9) Remove the worn or broken belt and install the replacement belt. (Reassembly is a reversal of the above procedure.)

CAUTION: Be sure to fasten the imaging system adapter plate securely. Use Loctite™ #232 on the screw threads after thoroughly cleaning off any oil or grease.

(10) Be sure to re-tension the drive belt (3/8-inch [9mm]) deflection).

g. **Side-to-Side Belt Replacement.**

(1) Perform steps 3-6f (1) through (5) as detailed above in the procedure for replacing the front-to-back belt.

(2) Remove the front panel as outlined in the subparagraph above.

(3) Loosen the tensioning pulley above the motor assembly.

(4) Locate the front-idler pulley in the access hole below the right-hand side of the front panel. To determine the point of belt removal, see figure 3-1.

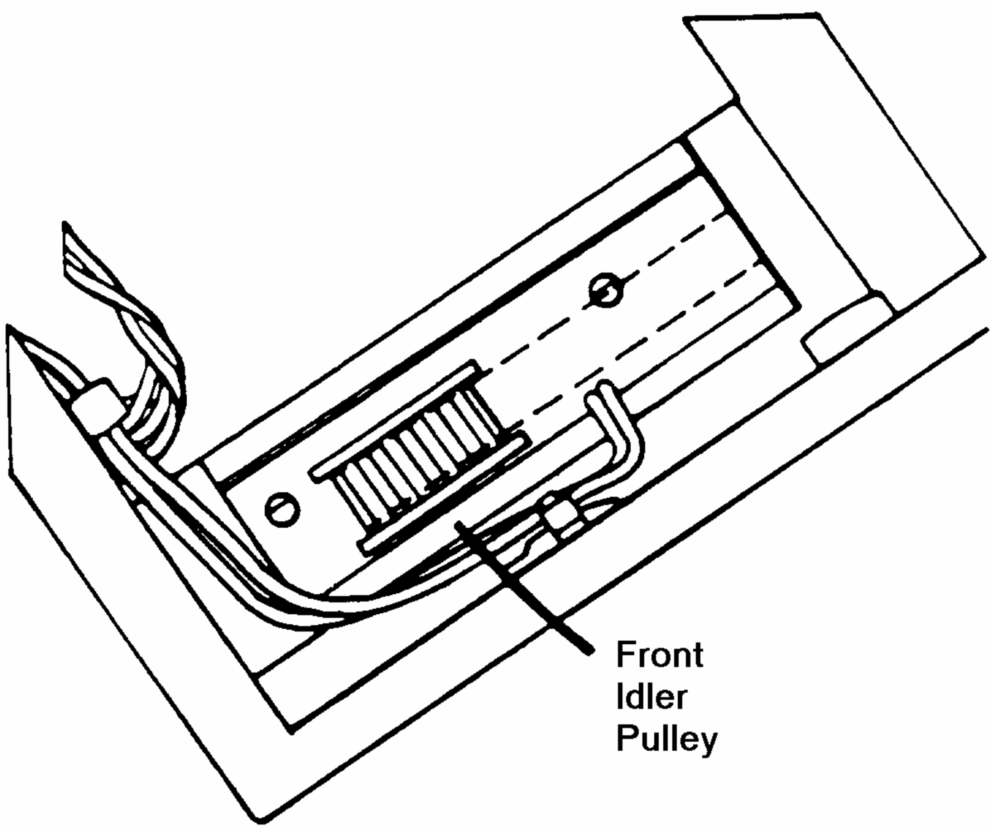

Figure 3-1. Front-idler pulley detail.

(5) Rotate the leadscrew so the setscrew in the pulley is accessible.

(6) Remove the two screws securing the leadscrew-mounting bracket to the chassis.

(7) While supporting the pulley from below, pull the leadscrew free by moving it away from the pulley.

(8) If necessary, remove the stepper-motor assembly.

(9) Remove the worn or broken belt and install the replacement belt. Carefully form a loop with the leadscrew pulley and reattach the leadscrew bracket before hooking the belt over the front idler. Hook the belt over the motor pulley last. Reassemble by reversing the above procedure. Remember to re-tension the belt to 3/8-inch deflection.

3-7. IMAGE INTENSIFIER PARTS REPLACEMENT

Only replacement of the power supply is discussed in this paragraph.

a. **Power Supply Removal.**

(1) To remove the power supply, first disconnect the power cable from the spot-film device control panel.

(2) Remove the cover on the power supply if you have not removed it already.

(3) Disconnect the eight wires running from the tube to the power supply, making sure you note where each wire is terminated.

(4) There are four Phillips-head screws holding the power supply to the mounting bracket. Remove those screws and pull off the defective power supply.

b. **Power Supply Replacement.** To attach a new power supply, reverse the above procedure.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response that BEST answers the question or BEST completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Before you replace the high-voltage rectifiers in the high-voltage transformer, how do you notify all personnel that maintenance is in progress?

   a. With a revolving red light.

   b. With a revolving yellow light.

   c. By tagging the system main-disconnect switch.

   d. By posting a notice in the maintenance room.

2. The high-voltage rectifier strips cannot be installed incorrectly. How is this accomplished?

   a. By limiting replacement to qualified, experienced medical equipment repairmen.

   b. By color coding.

   c. By placing written instructions beside them.

   d. By the use of banana plugs and receptacles.

3. You must replace the front counterweight cable in the MXT-90/15 table. What must you remove to gain access?

   a. The table top and sub-top.

   b. The spot-film device.

   c. The front cover on the table.

   d. The front cover on the spot-film device.

4. How many counterweight cables are provided for the <u>rear</u> counterweights of the MXT-90/15 table?

   a. One.

   b. Two.

   c. Three.

   d. Four.

5. You are replacing the transverse lock on an MXT-90/15 table. What do you take care not to disturb?

   a. The nuts holding the lock on two studs.

   b. The mounting screws.

   c. The counterweight pulley.

   d. The nuts behind the lock-mounting brackets.

6. The table's longitudinal lock is suspended on two threaded, shouldered studs. What holds the lock away from the carriage when it is disengaged?

   a. The lock cover.

   b. A lobed cam on the overhead support.

   c. A spring, retained by a cotter pin and washer on each stud.

   d. The nuts behind the lock-mounting brackets on each of the two studs.

7. PMCS has uncovered a defective tubestand cable which must be replaced. What must you complete before replacing the tubestand cable?

   a. Replacement of all cables in the MXT-90/15 table.

   b. Removal of the collimator and over-table X-ray tube.

   c. Removal of the table top and sub-top.

   d. Removal of the protective cover over the gear reducer.

8. What attaches the over-table X-ray tube to the tubestand?

   a. The anode and cathode cables.

   b. The tube-rotor cable.

   c. The tube-support bracket and tube-support sling.

   d. Two tube-mount spacers and the collimator ring.

9. What item of equipment is indispensable for personal safety when removing the over-table X-ray tube?

   a. A shorting bar.

   b. A spirit level.

   c. An inspection mirror.

   d. Wiring labels.

10. You are removing the CPU PCB from the spot-film device. Which connectors do you disconnect?

    a. All ribbon connectors and headers.

    b. P1, P2, P5, P10, and P12.

    c. P1, P3, P8, and TP14.

    d. P1, P2, P3, P11, and P12.

11. How much deflection is allowed on belts within the SFD?

    a. 1/4 inch.

    b. 3/8 inch.

    c. 7/16 inch.

    d. 9/16 inch.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. c (para 3-3a)
2. d (para 3-3f)
3. a (para 3-4c(2))
4. b (para 3-4d(3))
5. d (para 3-4g(3))
6. c (para 3-4h(4))
7. b (para 3-5)
8. d (para 3-5b(4))
9. a (para 3-5b(2), WARNING)
10. d (para 3-6b(4))
11. b (paras 3-6d(11), e(12), f(10), and g(9))

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4 Prepare and Process a Food and Drug Administration Form 2579

TEXT ASSIGNMENT Paragraph 4-1 through 4-8.

LESSON OBJECTIVES After completing this lesson, you should be able to:

4-1. Identify when the Form FDA 2579 must be completed.

4-2. Identify how the Form FDA 2579, Report of Assembly of a Diagnostic X-ray System is completed.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 4

PREPARE AND PROCESS A FOOD AND DRUG ADMINISTRATION FORM 2579

Section I. PREPARATION

4-1. GENERAL

Due to medical and legal implications relating to the exposure of humans to ionizing radiation, accurate records are required to verify all assemblies, services, adjustments, and calibrations of diagnostic X-ray equipment have been performed is such a manner as to minimize patient exposure. Form Food and Drug Administration (FDA) 2579 is the required record of the assembly and installation of certified diagnostic X-ray systems. A blank Form FDA 2579 is shown in figure 4-1.

NOTE: Forms printed prior to April 1989 are obsolete and are not to be used.

4-2. WHEN REQUIRED

a. A Form FDA 2579 must be prepared whenever a specified component of a diagnostic X-ray system is installed in any Department of Defense (DOD) activity which is certified to comply with the Standard. The Standard is 21, Code of Federal Regulations (CFR), Part 1020, Standards for Protection Against Radiation.

b. A Form FDA 2579 must be prepared whenever any active or inactive military member or civilian employee of the DOD, who, in the course of official duties, installs certified X-ray equipment in any activity of the Federal or state governments of the United States, regardless of the location.

c. A Form FDA 2579 must be prepared if the manufacturer's labeling contains a statement such as "This component is certified to comply with the Standard in effect at the date of manufacture," and the date of manufacture was 1 August 1974 or thereafter.

d. A Form FDA 2579 is also required when the installation or assembly of X-ray diagnostic equipment is performed as an off-duty activity of DOD personnel who are engaged in authorized self employment or are employed by another individual or corporation.

4-3. WHEN NOT REQUIRED

The Form FDA 2579 is not required when the X-ray system components are temporarily installed as "loaners."

FOR FDA USE ONLY	DEPARTMENT OF HEALTH AND HUMAN SERVICES PUBLIC HEALTH SERVICE FOOD AND DRUG ADMINISTRATION **REPORT OF ASSEMBLY OF A DIAGNOSTIC X-RAY SYSTEM**	*Form Approved; OMB No. 0910-0213* *Expiration Date: August 31, 1988.* C 651561 ←

1. EQUIPMENT LOCATION

a. NAME OF HOSPITAL, DOCTOR OR OFFICE WHERE INSTALLED	
b. STREET ADDRESS	
c. CITY	d. STATE
e. ZIP CODE	f. TELEPHONE NUMBER

2. ASSEMBLER INFORMATION

a. COMPANY NAME	
b. STREET ADDRESS	
c. CITY	d. STATE
e. ZIP CODE	f. TELEPHONE NUMBER

3. GENERAL INFORMATION

a. THIS REPORT IS FOR ASSEMBLY OF CERTIFIED COMPONENTS WHICH ARE *(Check appropriate box(es))*

- ☐ NEW ASSEMBLY - FULLY CERTIFIED SYSTEM
- ☐ REASSEMBLY - FULLY CERTIFIED SYSTEM
- ☐ REASSEMBLY - MIXED SYSTEM *(Both certified and uncertified components)*
- ☐ REPLACEMENT COMPONENTS IN AN EXISTING SYSTEM
- ☐ AN ADDITION TO AN EXISTING SYSTEM

b. INTENDED USE(S) *(Check Applicable box(es))*

☐ GENERAL PURPOSE RADIOGRAPHY	☐ PODIATRY	☐ CT HEAD SCANNER	☐ DENTAL PANORAMIC
☐ GENERAL PURPOSE FLUOROSCOPY	☐ UROLOGY	☐ CT WHOLE BODY SCANNER	☐ RADIATION THERAPY SIMULATOR
☐ TOMOGRAPHY *(Other than CT)*	☐ MAMMOGRAPHY	☐ HEAD - NECK *(Medical)*	☐ C - ARM FLUOROSCOPIC
☐ ANGIOGRAPHY	☐ CHEST	☐ DENTAL - INTRAORAL	☐ DIGITAL
	☐ CHIROPRACTIC	☐ DENTAL - CEPHALOMETRIC	☐ OTHER *(Specify in comments)*

c. THE X-RAY SYSTEM IS *(check one)*	d. THE MASTER CONTROL IS IN ROOM	e. DATE OF ASSEMBLY
☐ STATIONARY ☐ MOBILE		*(mo.)* *(day)* *(yr.)*

4. COMPONENT INFORMATION *(If additional space is needed for this section use another form, replacing the preprinted number with this Form Number and complete Items 1, 4, and 5 only)*

a. THE MASTER CONTROL IS	b. CONTROL MANUFACTURER	d. CONTROL SERIAL NUMBER
☐ A NEW INSTALLATION ☐ EXISTING *(Certified)* ☐ EXISTING *(Non-certified)*	c. CONTROL MODEL NUMBER	e. SYSTEM MODEL NAME (CT Systems Only)

Complete the following information for the certified components listed below which you installed. For beam limiting devices, tables and CT gantries enter the manufacturer and Model number in the indicated spaces. For other certified components, enter in the appropriate blocks how many of each you installed in this system

f. **SELECTED COMPONENTS**

BEAM LIMITING DEVICE	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
TABLES	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
CT GANTRY	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED

g. **OTHER CERTIFIED COMPONENTS** *(Enter number of each installed in appropriate blocks)*

☐ X-RAY CONTROL	☐ CRADLE
☐ HIGH VOLTAGE GENERATOR	☐ FILM CHANGER
☐ VERTICAL CASSETTE HOLDER	☐ IMAGE INTENSIFIER
☐ TUBE HOUSING ASSEMBLY *(Medical)*	☐ SPOT FILM DEVICE
☐ DENTAL TUBE HEAD	☐ OTHER *(Specify)*

5. ASSEMBLER CERTIFICATION

I affirm that all certified components assembled or installed by me for which this report is being made, were adjusted and tested by me according to the instructions provided by the manufacturer(s), were of the type required by the diagnostic x-ray performance standard (21 CFR Part 1020), were not modified to adversely affect performance, and were installed in accordance with provisions of 21 CFR Part 1020. I also affirm that all instruction manuals and other information required by 21 CFR Part 1020 for this assembly have been furnished to the purchaser and within 15 days from the date of assembly, each copy of this report will be distributed as indicated at the bottom of each copy.

a. PRINTED NAME	b. SIGNATURE	c. DATE

6. COMMENTS

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☆U.S. GPO: 1987-171-727

Figure 4-1. Blank Form FDA 2579.

4-4. WHO MUST REPORT

a. Prepare and process a Form FDA 2579 if you had direct supervisory control over the assembly or installation of certified, specified components by Department of Army (DA) personnel under conditions requiring a report of assembly.

b. Prepare and process a Form FDA 2579 if you were the contractor's representative who had direct supervisory responsibility for an assembly or installation performed within the territorial limits of the United States.

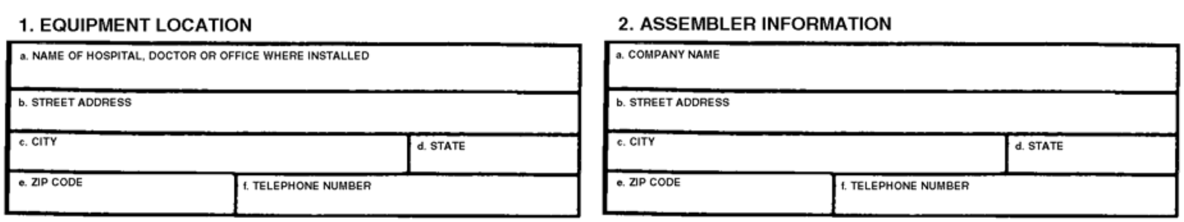
c. Prepare and process a Form FDA 2579 if you were the senior medical equipment repairer supervising the assembly or installation of certified X-ray diagnostic equipment performed outside of the United States.

NOTE: Civilian contractors are not bound to prepare or submit a Form FDA 2579 for assembly or installation of any X-ray component performed outside the United States.

4-5. PREPARATION OF THE FOOD AND DRUG ADMINISTRATION FORM 2579

a. **Section 1, Equipment Location.** Refer to figure 4-2. Complete boxes "a" through "f" listing the official name, address, and telephone number of the medical or dental activity in which the component or diagnostic system is installed.

b. **Section 2, Assembler Information.** Refer to figure 4-2. Complete boxes "a" through "f" listing the name, address, and telephone number of the equipment installer or assembler. In the event a civilian contractor installed the equipment, that name and address would appear here.


1. EQUIPMENT LOCATION
a. NAME OF HOSPITAL, DOCTOR OR OFFICE WHERE INSTALLED
b. STREET ADDRESS
c. CITY
d. STATE
e. ZIP CODE
f. TELEPHONE NUMBER

2. ASSEMBLER INFORMATION
a. COMPANY NAME
b. STREET ADDRESS
c. CITY
d. STATE
e. ZIP CODE
f. TELEPHONE NUMBER

Figure 4-2. Sections 1 and 2.

c. **Section 3, General Information.** See figure 4-3 for this portion of Form 2579.

3. GENERAL INFORMATION

a. THIS REPORT IS FOR ASSEMBLY FOF CERTIFIED COMPONENTS WHICH ARE *(Check appropriate box(es))*

- ☐ NEW ASSEMBLY - FULLY CERTIFIED SYSTEM
- ☐ REASSEMBLY - FULLY CERTIFIED SYSTEM
- ☐ REASSEMBLY - MIXED SYSTEM *(both ceritified and uncertified components)*
- ☐ REPLACEMENT COMPONENTS IN AN EXISTING SYSTEM
- ☐ AN ADDITION TO AN EXISTING SYSTEM

b. INTENDED USE(S) *(Check applicable box(es))*

	☐ PODIATRY	☐ CT HEAD SCANNER	☐ DENTAL PANORAMIC
☐ GENERAL PURPOSE RADIOGRAPHY	☐ UROLOGY	☐ CT WHOLE BODY SCANNER	☐ RADIATION THERAPY SIMULATOR
☐ GENERAL PURPOSE FLUOROSCOPY	☐ MAMMOGRAPHY	☐ HEAD - NECK *(Medical)*	☐ C - ARM FLUOROSCOPIC
☐ TOMOGRAPHY *(Other than CT)*	☐ CHEST	☐ DENTAL - INTRAORAL	☐ DIGITAL
☐ ANGIOGRAPHY	☐ CHIROPRACTIC	☐ DENTAL - CEPHALOMETRIC	☐ OTHER *(Specify in comments)*

c. THE X-RAY SYSTEM IS *(Check one)*	d. THE MASTER CONTROL IS IN ROOM	e. DATE OF ASSEMBLY
☐ STATIONARY ☐ MOBILE		*(mo.)* *(day)* *(yr.)*

Figure 4-3. Section 3. (1) Complete item 3a, "This report is for assembly of certified components which are:" by checking the appropriate box.

(a) Check "New Assembly - fully certified system" if the system is an original installation of a fully certified system.

(b) Check "Reassembly - fully certified system" if the system is not the original installation of a fully certified system.

(c) Check "Reassembly - mixed system" if the system installed has both certified and uncertified components.

(d) Check "Replacement components in an existing system" if components have been replaced in an existing system.

(e) Check "An addition to an existing system" if the assembly is an addition to an existing system whether the addition is certified or not.

(2) Complete item 3b, "Intended use(s)," by checking the appropriate box.

(a) Check "General purpose radiography" if the system or addition to the system is to be used for general purpose radiography.

(b) Check "General purpose fluoroscopy" if the system or the addition to the system is intended for general purpose fluoroscopy.

(c) Check "Tomography" if the system or the addition is intended for tomography.

(d) Check "Angiography" if the system or the addition is to be used for angiography.

(e) Check "Podiatry" if the system or the addition is intended for podiatric use.

(f) Check "Urology" if the system or the addition is intended for urologic use.

(g) Check "Mammography" if the system or the addition is to be used for mammography.

(h) Check "Chest" if the system or the addition is intended for use with the chest.

(i) Check "Chiropractic" if the system or the addition is intended for chiropractic use.

(j) Check "CT head scanner" if the system or the addition to the system is to be used as a CT head scanner.

(k) Check "CT whole-body scanner" if the system or the addition is intended for use as a CT whole-body scanner.

(l) Check "Head-neck" if the system or the addition is intended for medical use with the head and neck.

(m) Check "Dental-intraoral " if the system or the addition to the system is intended for dental-intraoral use.

(n) Check "Dental-cephalometric" if the system or the addition is intended for dental or cephalometric use.

(o) Check "Dental panoramic" if the system or the addition is intended for dental panoramic use.

(p) Check "Radiation therapy simulator" if the system or the addition is to be used as a radiation therapy simulator.

(q) Check "C-arm fluoroscopic" if the system or the addition to the system is intended for C-arm fluoroscopic use.

(r) Check "Digital" if the system or the addition to the system is intended for digital use.

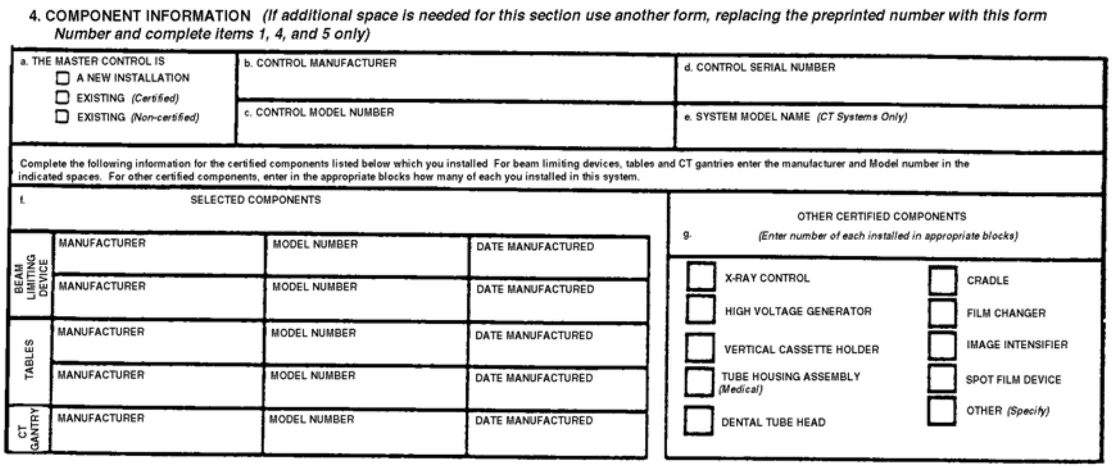
(s) Check "Other" if the system or the addition to the system is intended for any use not otherwise stated in a. through r. above.

(3) Indicate whether the system is stationary or mobile by checking one of the boxes in 3c.

(4) Enter the location of the master control room in block 3d.

(5) Enter the date of assembly in block 3e. Enter the date numerically in the MM-DD-YY format.

d. **Section 4, Component Information.** Section 4 is illustrated in figure 4-4.


4. COMPONENT INFORMATION *(If additional space is needed for this section use another form, replacing the preprinted number with this form Number and complete items 1, 4, and 5 only)*

a. THE MASTER CONTROL IS
☐ A NEW INSTALLATION
☐ EXISTING *(Certified)*
☐ EXISTING *(Non-certified)*

b. CONTROL MANUFACTURER

c. CONTROL MODEL NUMBER

d. CONTROL SERIAL NUMBER

e. SYSTEM MODEL NAME *(CT Systems Only)*

Complete the following information for the certified components listed below which you installed For beam limiting devices, tables and CT gantries enter the manufacturer and Model number in the indicated spaces. For other certified components, enter in the appropriate blocks how many of each you installed in this system.

f. SELECTED COMPONENTS

BEAM LIMITING DEVICE	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
TABLES	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED
CT GANTRY	MANUFACTURER	MODEL NUMBER	DATE MANUFACTURED

g. OTHER CERTIFIED COMPONENTS *(Enter number of each installed in appropriate blocks)*

☐ X-RAY CONTROL
☐ HIGH VOLTAGE GENERATOR
☐ VERTICAL CASSETTE HOLDER
☐ TUBE HOUSING ASSEMBLY *(Medical)*
☐ DENTAL TUBE HEAD
☐ CRADLE
☐ FILM CHANGER
☐ IMAGE INTENSIFIER
☐ SPOT FILM DEVICE
☐ OTHER *(Specify)*

Figure 4-4. Section 4.

(1) Use an additional form if more space is needed for this section. Replace the preprinted number on the additional form with the form number on the original form and complete items 1, 4, and 5 only.

(2) Complete item 4a "Master control" by checking the appropriate box identifying whether the master control is a new installation, an existing certified system, or an existing non-certified system.

(3) Complete item 4b "Control manufacturer" by entering the name of the manufacturer who produced the control.

(4) Complete item 4c "Control model number" by entering the model number of the control.

(5) Complete item 4d "Control serial number" by entering the serial number of the control.

(6) Complete item 4e "System model name" by entering the model name of the CT system (if applicable).

(7) Complete item 4f "Selected components" by entering the name of the manufacturer, the model number, and the serial number in the spaces indicated for beam-limiting devices, tables and C1 gantries. If the component has no serial number, enter the date the item was manufactured in place of the serial number.

(8) Complete item 4g "Other certified components" by entering how many other certified components you installed in the system. Enter the quantity in the appropriate blocks.

e. **Section 5, Assembler Certification.** Figure 4-5 shows the assembler's certification block.

5. ASSEMBLER CERTIFICATION

I affirm that all certified components assembled or installed by me for which this report is being made, were adjusted and tested by me according to the instructions provided by the manufacturer(s), were of the type required by the diagnostic x-ray performance standard (21 CFR Part 1020), were not modified to adversely affect performance, and were installed in accordance with provisions of 21 CFR Part 1020. I also affirm that all instruction manuals and other information required by 21 CFR Part 1020 for this assembly have been furnished to the purchaser and with 15 days from the date of assembly, each copy of this report will be distributed as indicated at the bottom of each copy.

a. PRINTED NAME	b. SIGNATURE	c. DATE

6. COMMENTS

FORM FDA 2579 (3/86) PREVIOUS EDITION IS OBSOLETE. White Copy - FDA,HDZ - 309, 5500 Fishers Lane, Rockville, MD 20857

Figure 4-5. Section 5.

(1) Read the assembler's certification carefully and in its entirety. The assembler's certification reads as follows ensure that you understand and have properly performed the stated actions prior to signing.

"I affirm that all certified components assembled or installed by me for which this report is being made, were adjusted and tested by me according to the instructions provided by the manufacturer(s), were of the type required by the diagnostic x-ray performance standard (21 CFR Part 1020), were not modified to adversely affect performance, and were installed in accordance with provisions of 21 CFR Part 1020. I also affirm that all instruction manuals and other information required by 21 CFR Part 1020 for this assembly have been furnished to the purchaser and within 15 days from the date of assembly, each copy of this report will be distributed as indicated at the bottom of each copy."

(2) Review all requirements stated in the assembler certification statement prior to signing block 5b.

(3) Complete block 5a "Printed name" by typing or legibly printing your full name and grade/rank as the assembler of the diagnostic X-ray system.

(4) Complete item 5b "Signature" by signing the block in blue or black ink with your payroll signature.

(5) Complete block 5c "Date" by entering the date numerically, i.e., the month/day/year the certification is signed.

(6) Complete item 6 "Comments" by recording any explanatory information related to earlier entries.

Section II. PROCESSING

4-6. DISTRIBUTION

a. Complete and forward two copies of Form FDA 2579 through command channels to the Commander, US Army Medical Material Agency (USAMMA), ATTN: SGMMA-MP, Frederick, MD 21701 within 15 days from the date of installation.

b. Consider the installation of a certified component complete after USAMMA has reviewed the Form FDA 2579 and determined the assembly/installation is in compliance with the Standard. The USAMMA will then have 15 days to forward the Form FDA 2579 to the Bureau of Radiological Health (BRH).

c. One copy of the form is retained at the USAMMA for each form originated by or for DA activities. Retain the copy until each specified component identified on the form has been salvaged, transferred to float, reported in a new installation, or for five years, whichever comes last.

d. The Chief of Biomedical Equipment Maintenance retains the purchaser's (pink) copy of every Form FDA 2579 for his medical activity. He retains the purchaser's copy until each specified component identified on the form has been salvaged, transferred to float, or installed on another X-ray system.

e. Note in writing the disposition of each of the specified components on the Form FDA 2579. The Chief of Biomedical Equipment Maintenance advises the USAMMA within 15 days after salvaging, transferring, or relocating any certified X-ray component or X-ray system. This action is taken in order to maintain consistency with USAMMA.

4-7. ASSEMBLY BY DEPARTMENT OF ARMY PERSONNEL

To process the Form FDA 2579 when Department of Army (DA) personnel assemble or install certified components, take the following actions.

a. Provide the purchaser's (pink) copy of the completed Form FDA 2579 to the Chief of Biomedical Maintenance (or to other agents as designated by the major medical command).

b. Forward all of the other copies through command channels to the Commander, USAMMA, ATTN: SGMMA-MP, Frederick, MD 21701.

4-8. ASSEMBLY BY NON-DEPARTMENT OF ARMY PERSONNEL

To process the Form FDA 2579 when the assembly or installation of certified components is accomplished by other than DA personnel, take the following actions.

a. Provide the purchaser's (pink) copy of the completed form to the Chief of Biomedical Maintenance (or to other agents as designated by the major medical command).

b. Prepare and forward a certified, legible reproduction of the purchaser's (pink) copy of the form through command channels to the Commander, USAMMA, ATTN: SGMMA-MP, Frederick, MD 21701.

(1) Type or legibly print all information from the original Form FDA 2579 onto a new form.

(2) Type or legibly print the installer's name in the certified copy of the installer's signature block.

(3) Make the following remark in the block 6, "Comments": "Certified copy of Form FDA 2579 # __________". Have the appropriate responsible personnel sign the above statement.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS: Answer the following exercises by marking the lettered response that BEST answers the exercise or BEST completes the incomplete statement.

After you have completed all the exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. You are assisting the Chief of Biomedical Maintenance to install a Continental CS-8952 Field Deployable Radiographic /Fluoroscopic X-ray system in the post hospital at Camp Rutter, Okinawa. The equipment bears a label stating it is certified to comply with the Standard in effect at the date of manufacture, which was June 1991. Must you prepare a Form FDA 2579?

    a. Yes, the unit was manufactured after 1 August, 1974.

    b. No, the unit was manufactured after 1 August, 1974.

    c. No, the Chief should prepare the document.

    d. Yes, I installed the unit in an activity of the DOD.

    e. No, the equipment was installed outside the United States.

2. During his off-duty hours and unassisted, SGT Hostettler installed a new certified X-ray system in a chiropractor's office (a non-DOD agency). Is he required to prepare a Form FDA 2579?

    a. Yes, the unit was installed within the United States (US).

    b. No, the unit was not installed in a DOD activity.

    c. No, the unit is a "loaner."

    d. Yes, it is a certified system manufactured after August 1974.

    e. No, he was off duty and employed by another individual.

3. What information is entered in Section 2 of the Form FDA 2579?

   a. Information about the place the unit was installed or assembled.

   b. Information about the person installing or assembling the unit.

   c. Information about the components installed or assembled.

   d. General information about the system installed or assembled.

4. When you sign off on Section 5 of the Form FDA 2579, to what are you attesting?

   a. You tested and adjusted, did not modify, and installed the system in accordance with 21 CFR part 1020.

   b. You assembled/installed the system in accordance with the manufacturer's instructions.

   c. You supervised in the assembly/installation of the certified X-ray system.

   d. You assembled/installed a non-certified X-ray system or non-certified components to an existing system.

5. When is the installation of a certified X-ray system complete?

   a. When you complete the Form FDA 2579.

   b. When you process the Form FDA 2579.

   c. When the system has been is tested, adjusted, calibrated, and accepted by the user.

   d. When the USAMMA has reviewed the Form FDA 2579 and determined it is in compliance with 21 CFR Part 1-20.

6. What is the final processing step for the Form FDA 2579 for X-ray systems installed by DA personnel?

   a. Prepare and forward a legible reproduction of the purchaser's copy to the Commander, USAMMA.

   b. Forward the pink copy to the Chief of Biomedical Maintenance.

   c. Forward all but the pink copy to the Commander, USAMMA.

   d. Signing off in Block 6b and dating Block 6c.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 4

1. c (para 4-4)

2. e (para 4-3b)

3. b (para 4-5b)

4. a (paras 4-5e(1), (2))

5. d (para 4-6b)

6. c (para 4-7b)

End of Lesson 4