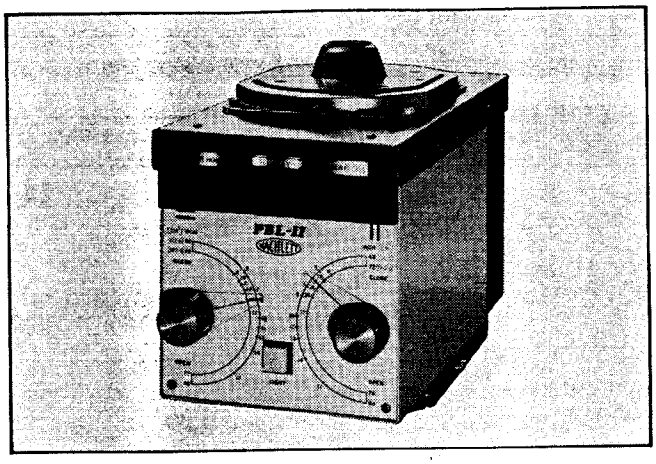
PBL-II 150
semi-automatic collimating system



INTRODUCTION
This light weight, medium duty collimator provides positive beam limiting in accordance with DHEW regulations[1] at fixed source-to-image distances (SIDs), and offers continuous cassette size-sensing capability for all standard and metric size cassettes.

Two versions of this collimator are available:

- PBL-II 150 - used with x-ray tubes having normal inherent filtration levels, typically below 1.0 mm;
- PBL-II 150 LF - used with x-ray tubes having high inherent filtration.

Both are designed for use with stationary general purpose radiographic equipment and are intended for use in non-institutional environments with low to medium patient volume.

Sequencing circuitry eliminates the need to reset the shutters each time a cassette is inserted so long as the cassette is the same size as the one previously used and the shutters have not been "coned down." When in the **READY** mode, a small, round red **RESET** light on the front panel goes on when the shutters are sized less than the cassette size, and following reinsertion of a same size cassette the shutter knobs will have to be readjusted.

This cost-effective design provides versatile performance and simplified operation while using state-of-the-art circuitry and components to assure high reliability and serviceability, but is NOT for applications employing ceiling tube supports, independently tilting tables, and mammographic or tomographic procedures. Refer to Machlett price list for collimators designed for these applications.

Designed to mount to the housing port boss or tube support plate, this collimator is compatible with most x-ray tube units. Refer to Machlett compatibility data.

The continuous cassette size-sensing circuitry allows compatibility with a variety of Bucky trays and wall cassette holders in addition to the tray supplied.

For greater versatility and rapid procedure changes, an accessory track is provided which accepts the full line of Machlett slide-mount accessories.

DESCRIPTION
This collimating system is composed of these units:

- PBL-II 150 collimator (with mounting kit);
- logic unit/power supply module;
- Liebel - Flarsheim continuous cassette size-sensing tray and installation kit.
- interconnecting cables.

The stylish modern enclosure is constructed of double steel walls, the outer wall lined with lead for x-ray protection, while maintaining a compact size for easy positioning. Two pairs of manually controlled lead shutters, directly driven from two front panel knobs, limit the x-ray field size. A conical lead entry barrier with a square aperture extends into the tube port to provide suppression of off-focus radiation.

A unique wedge-shaped filter provides uniform filtration and is part of a retractable mirror/filter assembly. To allow inspection of the x-ray tube target, this assembly can be quickly flipped out of the beam by means of a screwdriver inserted into an externally accessible slot, eliminating the necessity of disassembling or removing the collimator.

For simple, convenient alignment, a cool operating, high intensity lamp projects a light field and a Bucky light line. The light field is coincident with the x-ray field, with well defined edges for visual sizing, and a cross-hair pattern, projected onto the diagnostic area, allows easy centering. The Bucky light line provides a narrow beam for longitudinal centering of the Bucky cabinet.

A quickly removable rear cover on the collimator allows fast replacement of the projection lamp, and readily accessible adjustment points allow convenient alignment.

A measuring tape is available that mounts on the enclosure for convenient, precise measurement of the SID.

The collimating system is supplied with a Liebel-Flarsheim Cassette Size Sensing Tray, which offers continuous sizing capability. This tray may be used for either upright or table operation, and is equipped with a cassette support block for positive cassette location when used in an upright cabinet. A rugged Heavy Duty tray is also available. This tray is interchangeable with the standard tray, and should be selected where heavier duty usage is indicated.

Table or upright operation is selected by loading the film cassette and pointing the collimator towards the desired image receptor. A compatible size sensing wall cassette holder may be substituted for the upright Bucky.

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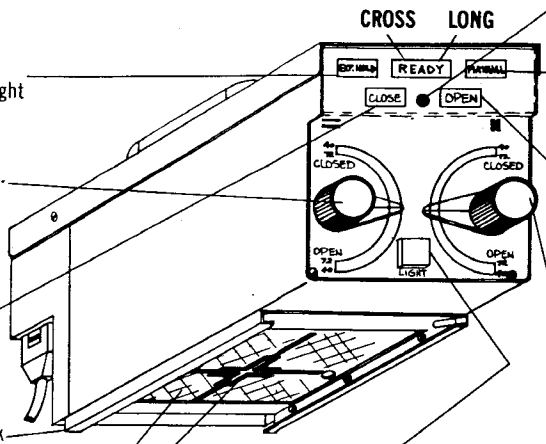
OPERATION



Lights RED when x-ray field size is smaller than cassette size. Upon changing cassette with a new cassette of the same size, the collimator will have to be readjusted.

If not lit, then changing the cassette and reusing the same cassette size will not require shutter readjustment.

This dual-section lamp lights (GREEN) when shutters are properly positioned. In the PBL mode, an exposure can be made only when both lamps light.

Lights (RED)
- until SID is set
- when shutters are incorrectly positioned

Goes out only when both READY lamps light or in Manual mode.

This dial positions the cross shutters. Two scales, **40"/72"**, represent standard SID* settings. Incremental numbers along scales represent field coverage (in inches).

Lights (WHITE) to indicate one or both shutters are adjusted to a size larger than the film and should be closed. If lighted, **"OPEN"** lamp will be off.

Accessory track

Plastic exit window

This cross-hair pattern is projected onto the diagnostic area.

Pushbutton lights projection lamp and starts automatic timer.

This dial positions the long shutters. Two scales, **40"/72"**, represent standard SID settings. Incremental numbers along scales represent field coverage (in inches).

Lights (AMBER) when:
- collimator is tilted more than 10° from vertical or horizontal;
- cassette is not in its holding device;
- Bucky tray is not properly inserted in cabinet.

When lamp is lighted, positive beam limiting mode is defeated.

Lights (WHITE) at start of semi-automatic operation, if either or both shutter pairs are initially set at a size smaller than the film cassette. If lighted, **"CLOSE"** lamp will be off and shutters must be opened.

NOTE

When the OPEN lamp is lighted and if the x-ray field size is increased—this starts the logic processing sequence that drives the collimator lamps as described in TYPICAL OPERATION SEQUENCE (positive beam limiting mode).

TYPICAL OPERATING SEQUENCE

SEMI-AUTOMATIC OPERATION
(positive beam limiting mode)

- Select SID to be used.
- Press the LIGHT pushbutton momentarily to project an image of the equivalent x-ray exposure area. The projection lamp times out automatically.
- Center the cassette into the table Bucky tray and clamp into position.
- Insert tray into the Bucky cabinet. EXP. HOLD lamp and either OPEN or CLOSE lamp lights.

OBSERVE collimator front panel lamps:

- If the **OPEN** lamp lights, simultaneously open both pairs of shutters until the lamp goes out, and the **CLOSE** lamp lights. (If only one pair of shutters is opened, the **OPEN** lamp will not go out until the other pair is also opened to an x-ray field size larger than the pre-selected cassette size).

—OR—

- If the **CLOSE** lamp lights, simultaneously close the shutters until both halves of the **READY** lamp light.
- Both the **CLOSE** and **EXP. HOLD** lamp will go out.
- When the **READY** lamp lights, this indicates an exposure can be made.
- If the RED lamp is not lit, then changing the cassette and reusing the same cassette size will not require shutter readjustment.

NOTE

With the READY lamp lighted, the x-ray field size can be manually reduced by dialing a smaller size with the front panel indicator dials.

MANUAL OPERATION
(manual mode due to tilted operation or no cassette in tray)

- **MANUAL** lamp lights.
- Select SID to be used.
- Place film cassette in desired position.
- Press the **LIGHT** pushbutton momentarily to project an image of the equivalent x-ray exposure area. (The projection lamp times out automatically).
- Adjust the **CROSS** and **LONG** shutter dials to produce an x-ray field equal to the desired image area.
- The x-ray field size is now set.

Positive Beam Limiting is available at discrete SID's:

- vertical at 40"
- horizontal at 40" and 72"

The compact self-contained logic/power supply unit converts analog input signals from SID monitors and image receptors to digital levels, then processes these signals to light indicator lamps on the front panel and control the exposure interlock. State-of-the-art electronic logic is used throughout - a minimum number of discrete circuit elements combined with input buffering - resulting in high reliability and high noise immunity. Simple servicing is provided by test points and an easily replaceable integrated circuit board mounted on a hinge bracket. A single cable between the logic unit and the collimator simplifies wiring and provides a neat appearance.
An exposure interlock circuit connects to the x-ray generator to prevent exposures until all controls are properly set. A multi-tapped transformer is provided to extend lamp life at higher line voltages.

EQUIPMENT SUPPLIED

- PBL-II 150 or 150LF collimator, with spacers and mounting hardware;
- integral logic and power supply unit with interconnecting cables; and
- Liebel-Flarsheim cassette size sensing tray and Bucky installation kit.

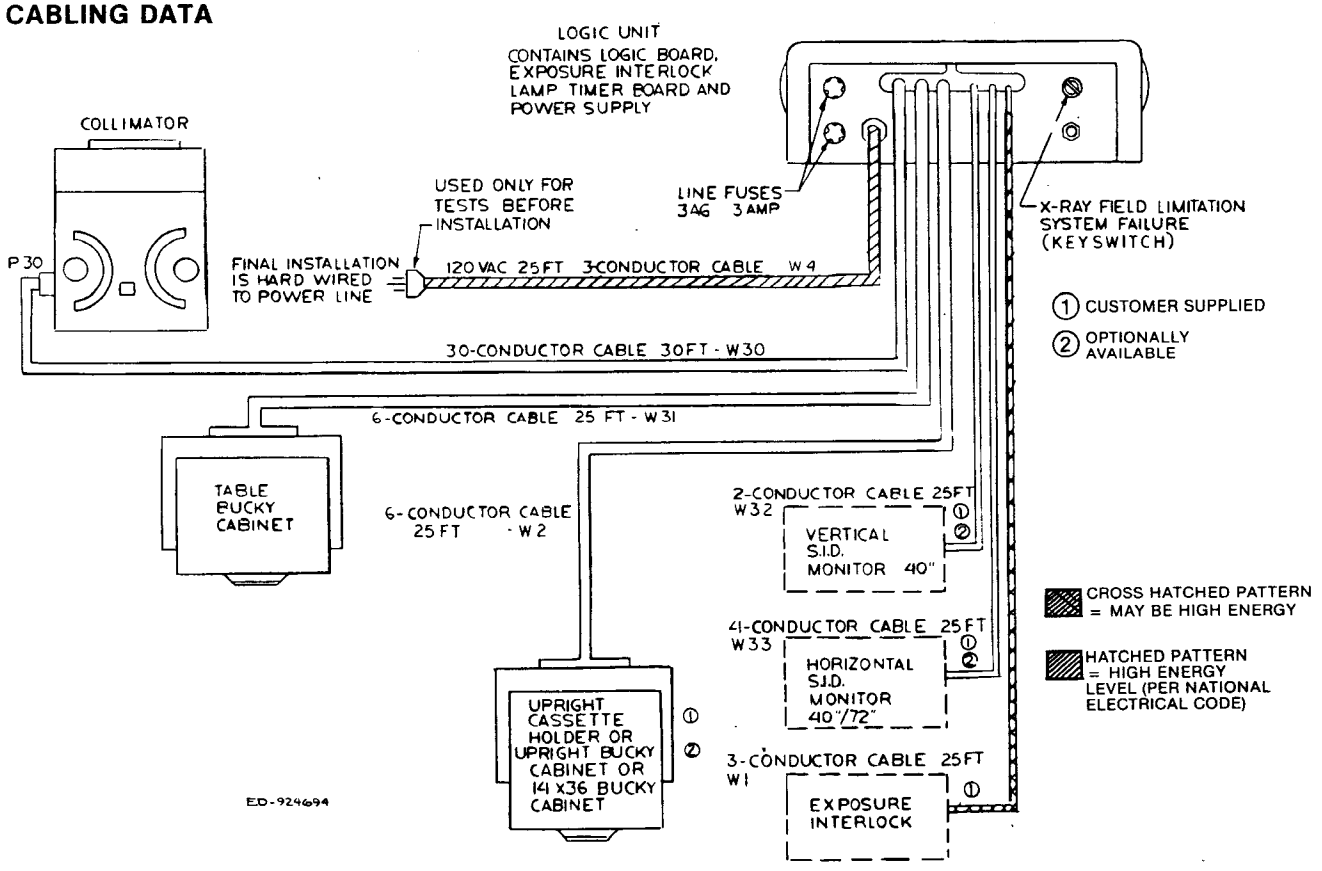
EQUIPMENT COVERED
Refer to PARTS LIST to determine the model number and serial numbers covered by this manual
TABLE OF CONTENTS
Refer to last page of this manual

SPECIFICATION

Operation:	either semi-automatic (positive-beam limiting mode)* or manual mode
Projected x-ray field:	square or rectangular pattern
Film coverage range:	continuously variable from closed to 17" x 17" at 36" SID, proportionate coverage at greater SIDs
Indicator dial accuracy (minimum):	corresponds to x-ray field size within 2% of the SID
X-ray field accuracy:	When READY lamp activates, length and width of x-ray field correspond to image receptor dimensions within 2% of source-to-image distance. (4% for the sum of length and width errors)
Bucky light line alignment:	Light line can be centered to x-ray field centerline within 1% of source-image distance
Light field to x-ray field accuracy:	corresponds to x-ray field size and centering within 2% of the SID
Cassette tray interface:	Compatible with any standard Liebel-Flarsheim Bucky cabinet (or equivalent). Special tray available for Midwest Equipment Co. 14" x 36" Upright Bucky cabinet*

*PBL not required at 14" x 36"

CABLING DATA

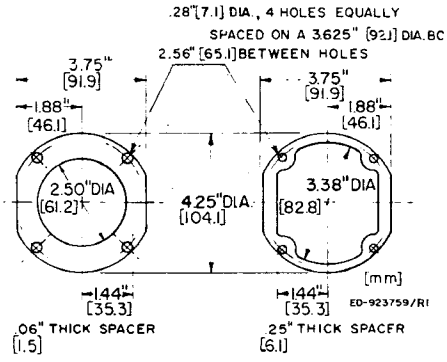


[1]Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968, enforced thru the Bureau of Radiological Health.

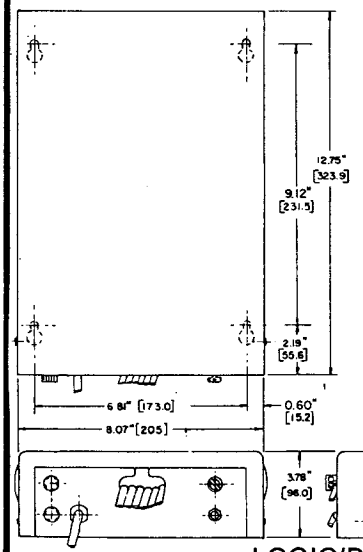
Light field edge contrast ratio (minimum):	4:1
Radiation shielding:	for use with equipment rated to 150 kVp
Rayproofing (leakage radiation):	less than 25 mR/hr at one meter from focal spot of x-ray tube, measured at 150 kVp at 4mA
Inherent filtration (aluminum equivalent at 70 kVcp and above):	
PBL-II 150	2.0 mm (minimum)
PBL-II 150 LF:	1.0 mm (minimum)
Projection lamp	
type:	FCS-quartz halogen
power:	150 W
voltage:	24 volts (nominal)
base:	2-prong plug-in
socket:	GE QCS-2
Light output:	more than 15 foot-candles at one meter (40")

Projection lamp timer:	turns off lamp after 25 ± 10 seconds ON period
Fuses -	
line:	(2) MDX, 3 Amp (slow-blow)
logic board:	(2) 3 AG, .75 Amp
Exposure interlock:	isolated form A contacts rated at 2 Amps @ 125 VAC (resistive load)
Power requirements:	111-134 VAC, 50/60 HZ @ 1.7 Amps, 170 Watts (maximum)
Weight:	
collimator:	17.5 lbs.
logic unit:	16 lbs.
Mounting	See OUTLINE DATA
Spacers supplied	
¼ (0.25) inch:	1 each
1/16 (0.0625) inch:	3 each

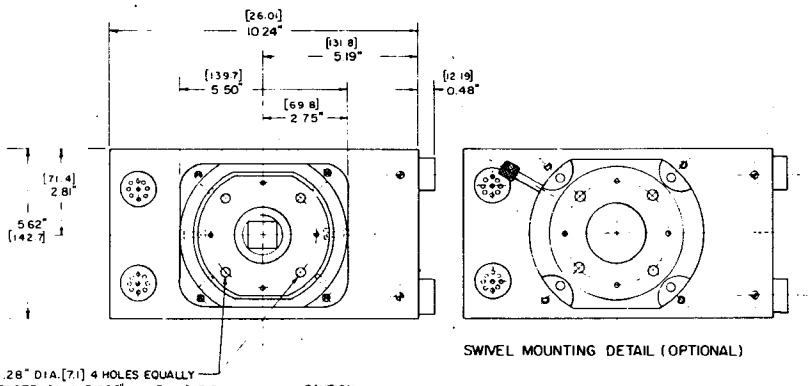
OUTLINE DATA



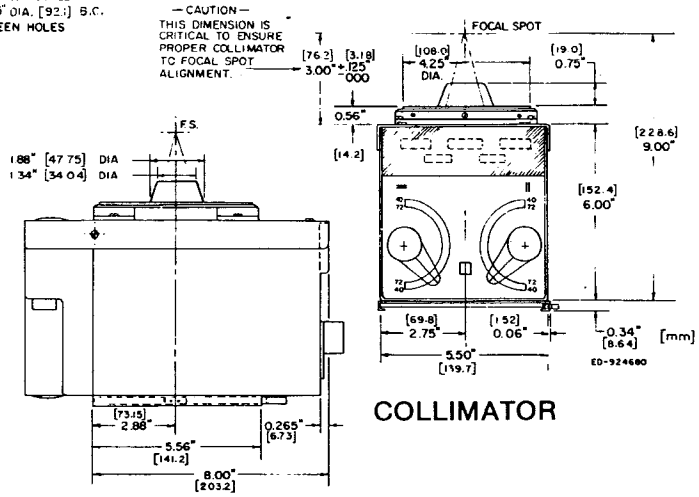
SPACERS



LOGIC/POWER SUPPLY UNIT ED-992232 [MM]



SWIVEL MOUNTING DETAIL (OPTIONAL)



COLLIMATOR

NOTE: Cassette size sensing tray fits any standard Liebel-Flarsheim (or equivalent) Bucky cabinet.

NOTE

Swivel Mounting Neck allows the collimator to rotate 360° in any direction to x-ray tube unit (indexed at 90°). A thumbscrew secures collimator in desired position.

You Have Legal Obligations

Those who manufacture and assemble:

- any manufactured or assembled product capable of emitting electronic product radiation; and
- any component affecting that emitted radiation are subject to DHEW regulations[1].

Any person assembling, repairing or replacing one or more certified products into an x-ray system must follow the instructions of the original manufacturer(s) and file the required DHEW[1] assembly reports.

Failure to follow the manufacturer's instructions, or modification of any component by user or assembler which will affect radiation safety, causes the user or assembler to assume full responsibility for that product.

The manufacturer is required to prescribe maintenance information and a schedule of performance to ensure equipment complies with specified parameters. After installation the assembler/installer must supply manufacturer's data (including this manual) to the equipment purchaser. The equipment purchaser must follow maintenance instructions.

INSTALLATION

2-1 UNPACKING

Carefully unpack the equipment and check for visible damage incurred during shipment. Any damage should be referred to the agency that delivered the equipment. Verify all contents against the packing list and collect published data for further reference.

NOTE

The plastic window on the bottom side of the collimator is fragile. Do not remove the protective plate until instructed to do so.

The hardware supplied can be checked against the Parts List of this manual. (Interconnecting cables are already prewired to the logic unit.)

Hardware for the cassette tray installation is listed in the PARTS LIST.

2-2 MOUNTING

Spacing between the collimator top cover plate and focal spot is CRITICAL. See OUTLINE DATA. Use spacers as required. Two types of mounts are available:

- non-swiveling mount
- optional swivel mount

2-3 SPECIAL EQUIPMENT FOR INSTALLATION OF COLLIMATOR

- non-swiveling mount — .094" hex key (Allen) wrench with at least 2.75" [70 mm] straight length is recommended so that full turns of each center adjustment set screw can be made without removing the wrench from the screw.
- swivel mount - a ¼ inch open-end wrench is required to adjust the swivel mount retaining screws.

2-4 COLLIMATOR MOUNTING (NON-SWIVEL MOUNT)

Collimator mounting involves removing the inner ring from the collimator, fastening the inner ring to the x-ray tube port boss, and fastening the collimator to the inner ring assembly.

1. Remove inner ring from top of collimator by loosening the two safety screws and four center adjustment set screws located around the periphery of the outer ring.

NOTE

The inner ring of the mount has a factory-assembled lead barrier that should not be removed.

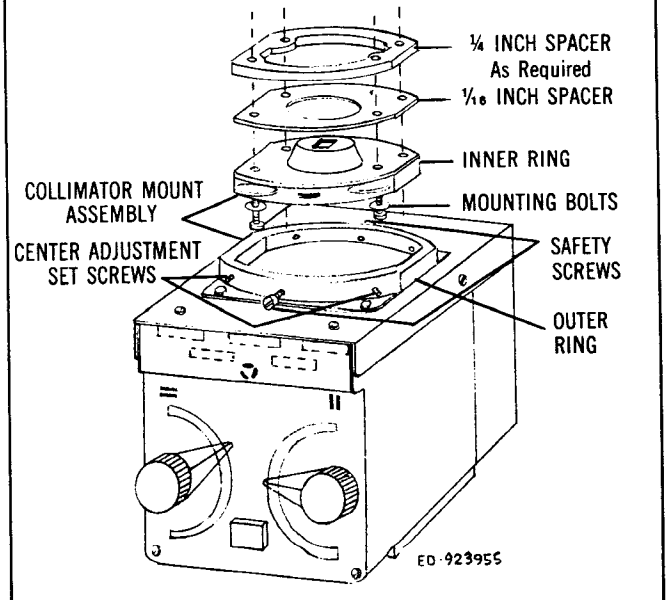
2. Select the spacers and mounting bolts necessary to conform to the critical dimension (see OUTLINE DATA). Use proper length bolts to ensure that at least 5 threads are engaged in tapped holes of port boss or adapter plate.

NOTE

For convenience, trunnion ring mounted tube housings may be rotated upward to facilitate mounting of spacer(s) and inner ring.

3. Attach inner ring (lead side up) to either housing port boss or tube support arm, with appropriate spacer inserted. Use lock washers. TIGHTEN SCREWS SECURELY.
4. Thread rear safety screw in about .25" [6.3 mm], leaving front screw flush with inside of outer ring. The centering adjustment set screws should be threaded so that their points are just flush with inside of outer ring.
5. Lift collimator up to the installed inner ring (rear section first), fit outer collimator mounting ring over inner ring and hook rear safety screw into inner ring rear slot.
6. While still supporting collimator, thread front safety screw in, then tighten both front and rear safety screws. The collimator is now supported in place.
7. Center the collimator in mount by first rotating slightly (to square it with tube unit and tabletop cen-

COLLIMATOR MOUNTING NON-SWIVEL MOUNT



terline). Thread four Allen set screws in equally, visually keeping equal spacing between outer and inner rings on all sides of collimator.

8. Inspect installation and verify that collimator is mounted correctly and is safely installed. Tighten screws.
9. Remove the protective plate that guards the plastic window by sliding it off the accessory track.
10. Collimator is installed and ready for ALIGNMENT.

2-5 COLLIMATOR MOUNTING (SWIVEL MOUNT)

CAUTION

OBSERVE MINIMUM CLEARANCE DIMENSION TO ENSURE THAT COLLIMATOR ENTRY BARRIER IS NOT DAMAGED WHEN COLLIMATOR IS MOUNTED TO TUBE. (LEAD DIAPHRAGM OR CONE IN SOME TUBES MUST BE REMOVED OR MODIFIED IN ACCORDANCE WITH MANUFACTURERS' INSTRUCTIONS). SEE OUTLINE DATA.

1. Remove swivel mounting neck from top of collimator by removing the four outer ring mounting screws.

NOTE

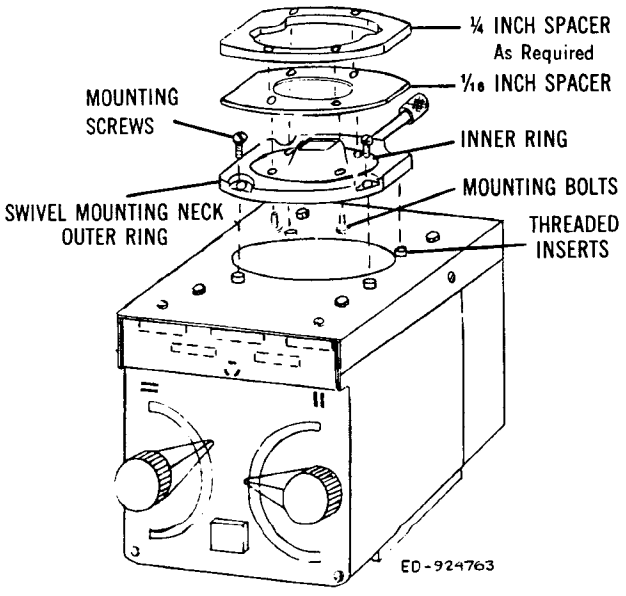
The inner ring of the mount has a factory-assembled lead barrier that should not be removed.

2. Select the spacers, lockwashers and mounting bolts necessary to ensure that the proper collimator to focal spot distance is maintained. (See OUTLINE DATA). Use proper length bolts (with lockwashers) to ensure that at least 5 threads (¼ inch) are engaged in tapped holes of port boss or adapter plate.

NOTE

For convenience, trunnion ring mounted tube housings may be rotated upward to facilitate mounting of spacer(s) and inner ring.

COLLIMATOR MOUNTING SWIVEL MOUNT



3. Attach swivel mounting neck to port boss of x-ray tube housing using four Fillister Head screws and split lockwashers.
4. Reinsert the four outer ring mounting screws into the counterbored holes.
5. Lift the collimator to the swivel mounting neck and engage the four mounting screws into the four threaded inserts.
6. Securely tighten the four screws using a ¼-inch wrench.
7. Check the installation thoroughly for safe and proper mounting.
8. Remove the protective plate that guards the plastic window by sliding it off the accessory track.

2-6 LOGIC UNIT MOUNTING

The logic unit is designed to mount in various installation configurations; however, DO NOT LOCATE logic unit:

- where dirt, moisture or other foreign materials are present;
- in an area of high electrical interference (autotransformers, contactors, motor start cables, locks, etc.);
- in an area which is heated by other apparatus;
- in a manner which prevents convection cooling.

The Logic Unit MUST be located;

- so that the keyswitch is accessible in case of an emergency or for servicing.
- out of range of the primary x-ray beam
- in a manner which allows one of the ventilation holes to be at the highest point of the mounted logic. The cable entrances will therefore be on the side or bottom of the upright logic unit, never on the top.
- in an area where surrounding air is at normal room temperature.

It is recommended that the logic unit be located in the x-ray room as close to the x-ray source/receptor as practical. This permits calibration and maintenance to be performed by one person. Locations distant from the source/receptor require two persons to perform maintenance and calibration; one to perform the procedure and one to observe the results.

Since the chassis of the logic unit is used as the template for mounting, the circuit board should be removed or positioned to avoid damage during this procedure as follows:

1. Remove cover of logic unit;
2. Remove the four screws in the logic board (opposite the connector).
3. Hinge up the board to a comfortable angle, and twist a large screwdriver blade between each corner of the board and the mating connector, until the board is free.
4. Safely store logic board until logic unit is mounted, then follow these steps in reverse order to reassemble logic unit.

Use the chassis as a template. Locate it in its final position and mark the full outline of four key-slots on the mounting surface. Drill the mounting surface and securely mount, using suitable hardware. After fastening in place with the screws located in the small area of the slot, test the security of the mount. If it is likely that the chassis can slide beneath the screw heads, locate two extra screws in the large area of two of the key-slots to prevent loosening.

CAUTION

DO NOT SUPPLY POWER TO THE UNIT WHEN MOUNTING THE CHASSIS.
DO NOT UNDER ANY CIRCUMSTANCES SUBSTITUTE OTHER THAN LABELED FUSE VALUES OR TYPES FOR ORIGINAL EQUIPMENT.

When choosing a location for installation, cable lengths must be considered. In addition, input power must be obtained from a source which will only provide power when the x-ray control is turned on and when the attached x-ray tube is selected.

Measured line voltage AC-60 Hz	Connect to this tap on power transformer
111 - 122	115
122 - 134	125

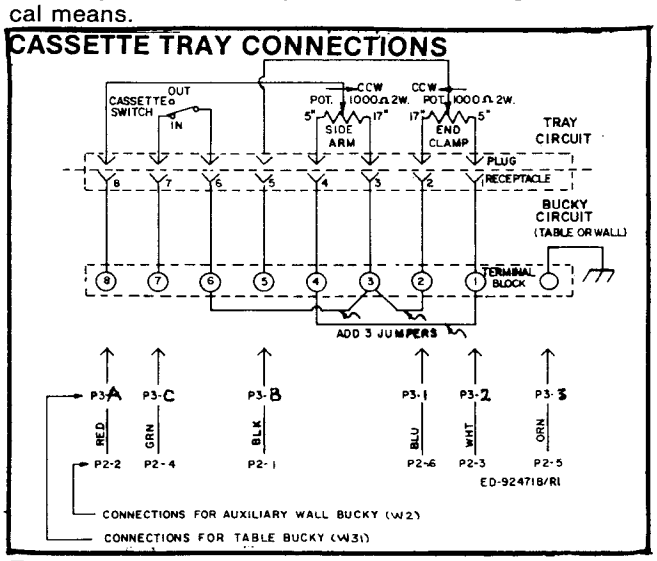
The power transformer has two line input taps, one must be selected depending on the measured line voltage. If the line voltage is less than 122 VAC, the wire remains on the 115 tap. If the line voltage exceeds 122 VAC, the wire should be reconnected to the 125 tap. This step is important in prolonging the life of the collimator lamp.

Verify that a minimum of 21.0 VAC is obtained at the collimator projection lamp pins (with lamp lit).

2-7 CASSETTE TRAY INSTALLATION

Installation is accomplished according to the instructions packed with the cassette tray. This system utilizes a LIEBEL-FLARSHEIM size sensing cassette tray. This cassette tray contains a switch and two potentiometers to signal the presence and dimensions of a cassette. This cassette tray, and the system will accept all cassette sizes from 5 inches through 17 inches or metric equivalents.

All cassette holders used with this system must provide these signals. In addition, any cassette holder that will not accept all cassette sizes from 5 through 17 inches must reject the unaccepted cassette through mechanical means.



This alternate sensing cassette holder must also meet the following requirements:

- When any size cassette is located in the cassette holder, voltage signals must be produced with values as shown in Table 3-1 for both cross-table and long-table dimensions.
- If a resistive divider is intended to be connected to the 15 volt source in the logic, each divider must be 1,000 ± 20 ohms and connected to the logic in an identical manner as the LIEBEL-FLARSHEIM cassette tray.

It is essential that the alignment procedures and lubrication schedule be followed as detailed in the instructions provided with the tray. In addition, it is important to form the pins and leads in the rear of the receptacle in a manner that retains the "floating" action designed into the receptacle. It is also essential that the receptacle and plug not be allowed to fully seat; as instructed, 1/32 inch of insertion distance must remain when the cassette tray is firmly against its mechanical limits. The cassette tray must be adjusted, according to the instructions supplied, to eliminate side-play of the tray in the guide-tracks of the Bucky (or equiv.).

While the alignment guides aid the on-center alignment, they will not compensate for improper installation or inadequate initial alignment of the receptacle. The cassette tray insertion is frequently handled with varying amounts of force, and with the combined tray/cassette weight, the receptacle will fail in a short time if not properly installed.

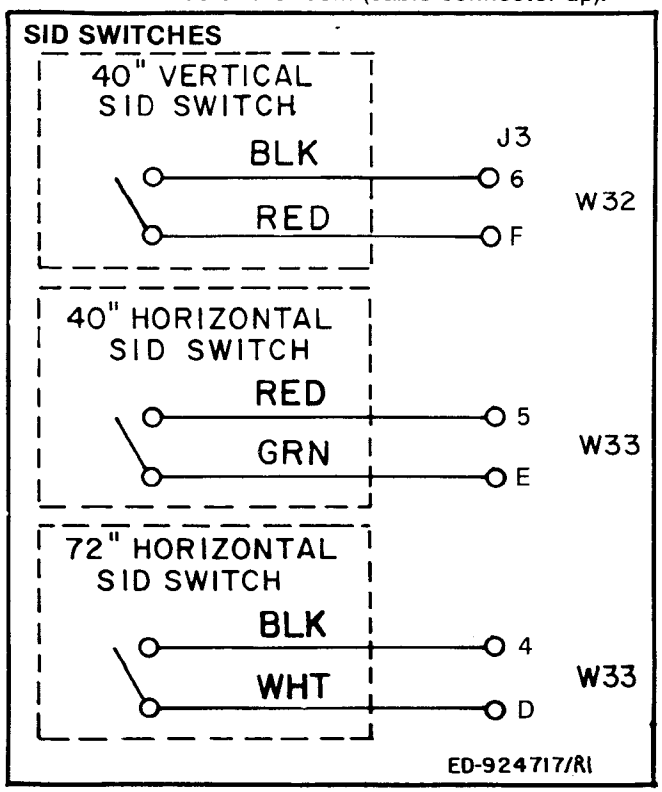
Finally, jumpers must be added to the terminal block in the cassette tray. See CASSETTE TRAY CONNECTIONS.

2-8 UPRIGHT CASSETTE TRAY INSTALLATION

If a wall-mounted cassette tray or automated wall-cassette holder is to be used with the system, its location relative to the collimator must be identified.

Locate the Beam Direction Selector jumpers on the Logic board. If an upright cassette is to be used, a jumper must be cut and removed in order to properly select the correct horizontal beam direction. Remove the jumper that is NOT required:

- Leave in the RIGHT jumper, if the cassette tray or holder requires the collimator to be aimed toward the right side of the room (cable connector down).
- Leave in the LEFT jumper, if the cassette tray or holder requires the collimator to be aimed toward the left side of the room (cable connector up).



2-9 BUCKY WIRING

Wire the Bucky(s) to the logic. (See CABLING DATA and CASSETTE TRAY CONNECTIONS). For the convenience of installation, P2 may be disconnected from the logic board if no upright Bucky is used.

2-10 SID SWITCH INSTALLATION

The SID switches are not supplied with this system. The assembler must install a means of indicating the SID as a closed contact for the logic at the proper SID. One switch is required to indicate the vertical SID of 40" and is connected to W32. If an auxiliary wall Bucky is employed, up to 2 horizontal SID switches may be used which are used for the distances of 40" and 72", and are connected to W33. See SID SWITCHES drawing.

The switches must be a normally open type, rated at 1 amp, 25 VAC. The actuators must be designed and installed so that the appropriate switch is closed only at the one SID intended, plus or minus 0.25 inches on either side of the intended SID. The center of the switch closure range should be located with a maximum inaccuracy of 0.5 percent, i.e., at 40 inches there is a plus or minus 0.2-inch error.

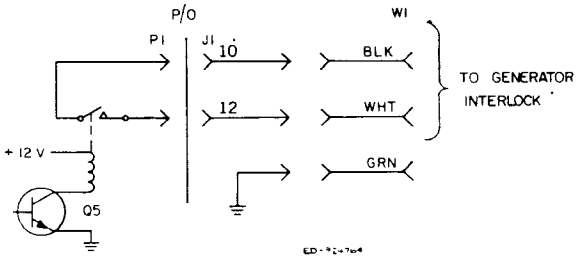
2-11 EXPOSURE INTERLOCK WIRING

Cable W1 is connected to the exposure interlock relay, K1. A contact on K1 is closed when x-ray production is permitted. Connect the cable to the generator interlock input as shown below.

WARNING

THE INTERLOCK MUST BE CONNECTED TO THE X-RAY GENERATOR. DO NOT ATTEMPT TO DEFEAT ITS PURPOSE.

SIMPLIFIED EXPOSURE INTERLOCK WIRING



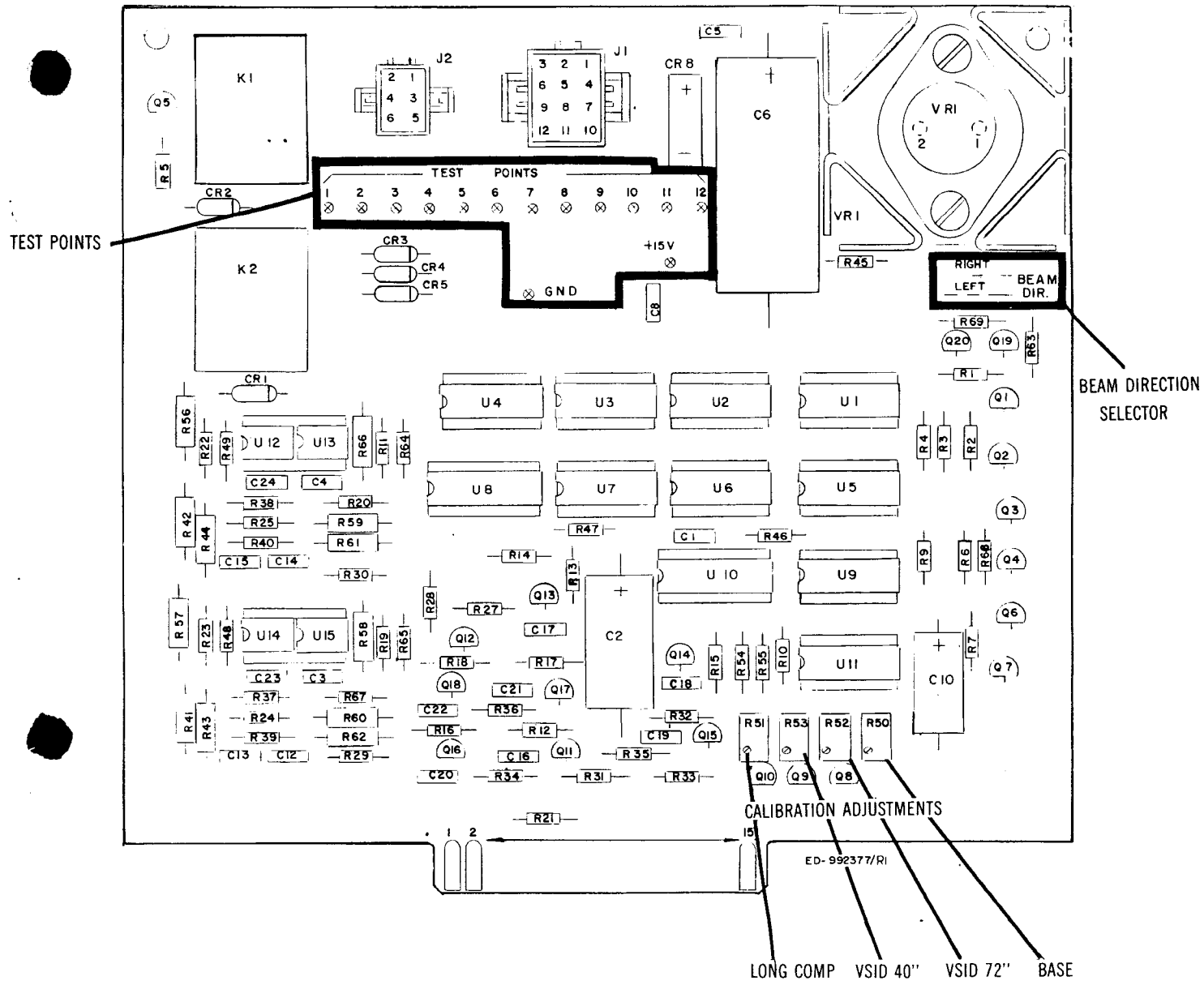
2-12 FINAL INSTALLATION CHECK

STEP	TEST POINT	PROCEDURE	CORRECT INDICATION
1	Keyswitch	Operate keyswitch. Return to original position	Key-operated switch should operate smoothly All interlocks are cleared when generator is ready for exposure, regardless of collimator shutter position.
2	AC power cord of logic chassis	Connect AC power cord into 120 VAC line which is live only with the generator power "on"	None
3		Turn on power (cassette out, collimator not tilted).	MANUAL LAMP LIGHTS. All other indicators should be off
4	LIGHT pushbutton	Press the LIGHT pushbutton.	A light field should be projected but should shut off automatically after about 25 seconds.
5	Film Cassette	Insert film cassette; insert tray in cabinet Repeat for both vertical and horizontal trays.	EXP. HOLD LAMP will light
5A	Place the source at the correct SID		
6	Collimator Shutters	If the OPEN lamp lights, simultaneously open both shutters until the correct indication is obtained.	OPEN lamp goes out; CLOSE lamp lights. *If only one pair of shutters is opened, the correct indication cannot be attained.
7	Collimator Shutters	_____OR_____ If the CLOSE lamp lights, simultaneously close both shutters until the correct indication is obtained.	Both halves of the READY lamp light. Both CLOSE and EXP. HOLD lamp will go out. NOTE: With the READY lamp lighted the x-ray field size can be further reduced without resequencing the logic.

*True only if field size in both orientations is initially smaller than film size.

2-13 INSTALLATION FAILURE

STEP	TEST POINT	PROCEDURE	CORRECT INDICATION
1	Incorrect indication	Check correctness of installation.	All installation instructions had been followed.
2	Equipment Failure	Note all the failure symptoms.	Failure mode defined
3		Check Troubleshooting section of this service manual.	



ELECTRONIC ADJUSTMENTS

3-1 ELECTRONIC SYSTEM ADJUSTMENT PROCEDURES
To ensure that the collimating system performs correctly before following other calibration and alignment sections, the following voltage adjustments must be correct prior to producing radiation exposures for alignment purposes and include:

- adjustment of x-ray field base voltage
- calibration of Horizontal and Vertical Discrete SID Voltages (VSIDC)
- determination of cassette size/voltage accuracy
- collimator potentiometer checkout and adjustment.

The final adjustments to the base and SID voltages are made when x-ray exposures are compared.

The following items are required to complete the ELECTRONIC SYSTEM ADJUSTMENT PROCEDURES:

- digital voltmeter with a minimum display of 3-1/2 digits (1.999 counts), maximum inaccuracy of 0.1% of reading ± 1 digit, and input impedance of 10 megohms (minimum). (Data Technology Model 30 or equivalent)
- electronic pocket calculator to save time in calculation of measured data.
- small (jeweler's) screwdriver

All voltage values are based on the presence of a regulated logic supply voltage of 15.0 VDC. If the output voltage of the regulator (measured at +15v to GND test points on the Logic Board) is other than 15.0 volts, all values must be adjusted by multiplying by the ratio of the actual output voltage to the nominal voltage; e.g. in determining VSIDC.

$$\frac{\text{14.5 VDC (measured)}}{\text{15.00 VDC (nominal)}} \quad \text{x } 6.62 = 6.40 \text{ VDC}$$

for this example, 6.40 volts would be the desired value instead of the nominal 6.62 volts.

Table 3-0 can be used by rounding off all actual regulated supply voltages to those shown in the table to determine the correct calibration voltages.

NOTE

Steps 3-2 through 3-7 are usually NOT required for new installation or periodic recalibration; use these steps only when the x-ray field accuracy is out of tolerance.

X-ray field size adjustments occur during the system accuracy check. Proceed to Section 3-8 unless nominal voltage adjustments are necessary, as determined by performing steps 3-2 through 3-7.

3-2 ADJUSTMENT OF X-RAY FIELD BASE VOLTAGE (VBXF)

1. Set SID TO 40 ± 1/8 inches to achieve a closure of the 40" vertical SID switch.
2. Measure the voltage at TP12 on the logic board with the collimator connected to the logic; this value should be 0.04 volts above ground.
3. If necessary, adjust R50 to obtain this value. No calculations are required.

3-3 CALIBRATION OF 40" VSID VOLTAGES

1. Set the source-image distance to 40 ± 1/8 inches (measured distance) and check that the VSIDC voltage at TP11 is 6.62 volts (nominal). Adjust R53 as required after determining the correct value from table 3-0.
2. Measure the VSIDL (LONG COMPENSATION) voltage at TP6.
3. Adjust R51 as required after determining the correct value from table 3-0.

Table 3-0 CALIBRATION OF VISD VOLTAGES

Measured Supply Voltage @ TP-15	VSIDC 40" @ TP-11	VSIDL LONG COMP. 40" @ TP-6	VSIDC 72" @ TP-11
14.5	6.40	5.67	11.13
14.6	6.44	5.71	11.21
14.7	6.48	5.75	11.28
14.8	6.53	5.79	11.36
14.9	6.57	5.83	11.44
15.0	6.62	5.87	11.52
15.1	6.66	5.91	11.59
15.2	6.70	5.95	11.67
15.3	6.75	5.987	11.75
15.4	6.79	6.02	11.82
15.5	6.84	6.06	11.90

3-4 CALIBRATION OF HORIZONTAL DISCRETE SID VOLTAGES (VSIDC)

1. Set the x-ray beam angulation to a horizontal direction within 2°. Set the image receptor holder (e.g., wall Bucky) to the vertical position within 2°.
2. Set the source-image distance to 40 ± 1/8 inches (measured) and check that the VSIDC voltage at TP11 is as stated above in section 3-3. (If this adjustment was done for the vertical SID of 40 inches in CALIBRATION OF 40" VSID VOLTAGES, disregard this step).
3. Set the source-image distance to 72 inches (measured) and check that the VSIDC voltage at TP11 is 11.52 volts (nominal). Adjust R52 as required per table 3-0.

3-5 TABLE CASSETTE TRAY SIZE/VOLTAGE ACCURACY CHECKOUT (VIR)

Assuming the output of the regulator (VRI) is 15.00 volts, the table cassette tray should produce signal voltages that correspond to the values shown in table 3-1. These must be verified by clamping all cassette sizes, in turn, in the table cassette tray and measuring between TP1 (VIRC) and ground and between TP2 (VIRL) and ground. Calculations are required again if VR1 is not 15.00 volts. If the measurements do not result in VIR voltages within ± .3 volt of the values shown in the table, the tray must be checked and the following procedures followed:

1. If longitudinal error is consistent by 0.1 volt or more, check for a bent sensing arm.
2. If sensing arm is not bent, clamp a 10" x 12" cassette in the tray with the 10" dimension in the LONG direction (side-to-side in the tray).
3. Check the voltages at the points indicated in table 3-1.

Table 3-1 OUTPUT VOLTAGES vs X-RAY CASSETTE SIZES

Conventional X-Ray Film Cassette Size	Output Voltage Based On 15.00 VDC	Metric X-Ray Film Cassette Size (In CM)
5	.9 ± .30	
6	1.95 ± .30	
7	3.15 ± .30	
	3.25 ± .30	18
8	4.20 ± .30	
9	5.25 ± .30	
	5.79 ± .30	24
10	6.45 ± .30	
11	7.50 ± .30	
	8.27 ± .30	30
12	8.70 ± .30	
13	9.75 ± .30	
	10.57 ± .30	35
14	10.80 ± .30	
15	11.85 ± .30	
16	13.05 ± .30	
	14.03 ± .30	43
17	14.10 ± .30	

if the readings obtained do not correspond to the voltages shown in Table 3-1, the mid size 10" x 12" cassette best indicates that the tray potentiometers must be adjusted and should be used below as follows:

a. Consult the LIEBEL-FLARSHEIM instructions supplied with the tray for disassembly details.
b. Remove tray, remove protective cover, and loosen the pot gear set screw for whichever pot is indicated.
c. Reset pot(s) by rotating a small amount.
d. Re-insert tray to recheck voltage. (Several attempts may be necessary.)

NOTE

The Machlett tray Wiring Extender Tool is recommended.

4. Consult the LIEBEL-FLARSHEIM instructions supplied for further adjustment procedures.

3-6 AUXILIARY CASSETTE HOLDER SIZE/VOLTAGE ACCURACY CHECK

1. Repeat the VIR Accuracy Check procedure with the x-ray beam angulated to within 2° of horizontal into the Auxiliary Vertical Cassette holder. Measure at TP1 (VIRC) to ground and TP2 (VIRL) to ground.
2. Check the cassette holder manufacturer's instructions if adjustments are necessary.

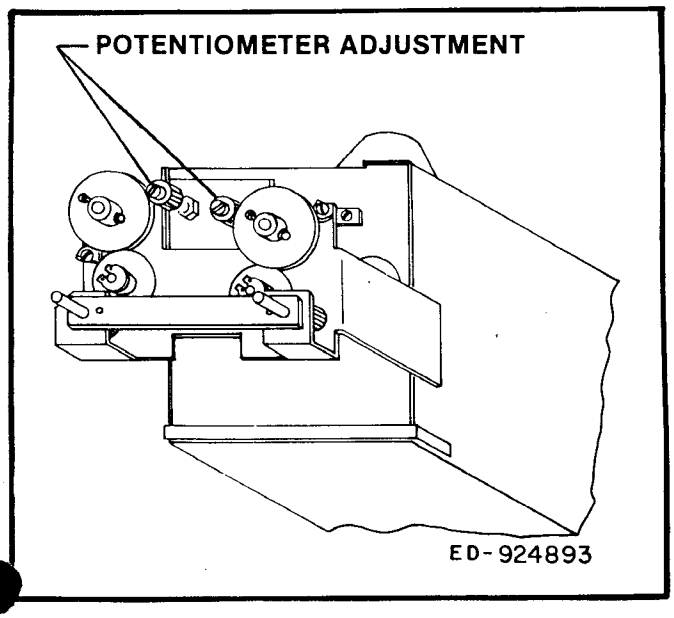
NOTE

Make certain that compatible cassette sizes are used.

3-7 COLLIMATOR POTENTIOMETER CHECKOUT AND ADJUSTMENT (REFER TO DISASSEMBLY)

The collimator potentiometers are factory-adjusted and should not require readjustment in normal use. In the event that the original adjustment is disturbed, or after extended use, the following sequence of steps must be followed for readjustment to the proper settings.

1. Remove line power to the collimator logic.
2. Close both collimator shutters completely.



3. Using an ohmmeter, check the resistance of both the long and cross potentiometers as follows:
   With the long shutter completely closed, the resistance at edge connector P3, across terminals L and 9 should be set to 10 + 5 -0 ohms.

   NOTE

   The terminals are accessible at the edge connector by removing the PC board and turning the edge connector upward or by disconnecting collimator plug P30 and monitoring terminals 14 and 15 and 16 and 15 at collimator.

   With the cross shutter completely closed, the resistance at edge connector P3, across terminals K and 9, should be 10 + 5 -0 ohms.
4. If the potentiometers require adjustment, remove the dial knobs, front panel screws, and front panel. Loosen the potentiometer gear set screws, adjust the potentiometer shafts within the potentiometer gears, and retighten the potentiometer gear set screws. Refer to DISASSEMBLY. Recheck by opening and closing the shutters before and after final set screw tightening to ensure that the pots are properly adjusted.
5. After all adjustments are completed, reassemble the collimator.

3-8 COLLIMATOR ALIGNMENT

Follow these procedures to ensure that the installed collimator meets DHEW alignment requirements.

Complete this entire section and/or all required alignment procedures before operating this collimating system, including:

- identification of light field and x-ray field edges;
- alignment of entry barrier to focal spot;
- verification of light field to x-ray field coincidence;
- verification of shutter dial accuracy;
- verification of x-ray field accuracy;
- centering of cross hair pattern to light field; and
- alignment of Bucky light-line.

These miscellaneous items are required to complete the ALIGNMENT procedures:

- several sheets of white paper;
- pencil, fine stylus, or marker;
- straightedge, measuring tape, or ruler;
- conventional densitometer or a neutral density filter having a density of 1.0 (obtainable from most photographic supply houses);
- large film cassette (preferably 14" x 17");
- coins or lead marking letters;
- Philips head screwdriver and a conventional 1/4 inch wide straight-blade screwdriver;
- masking tape;
- long-nose pliers, 1/4-inch wrench or nut driver;
- 3/32-inch hex wrench with 2 3/4-inch minimum shaft length.

3-9 IDENTIFICATION OF LIGHT FIELD EDGES

CAUTION

THE TUBESTAND AND TABLE MUST REMAIN STATIONARY DURING THESE PROCEDURES.

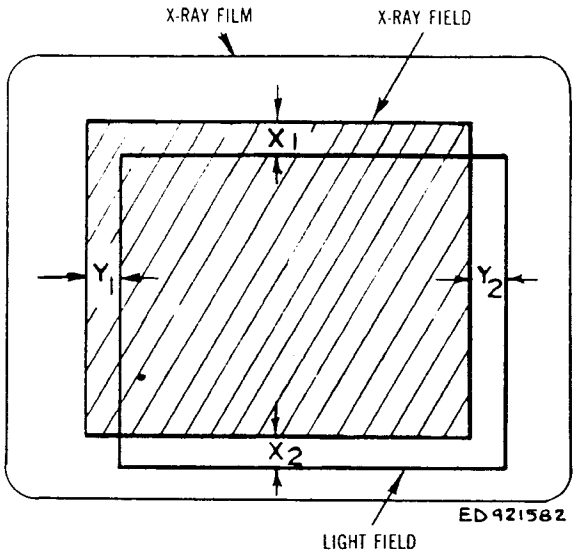
NOTE

Light field alignment is critical and required by DHEW regulations.[1] Alignment must be performed during installation, on a periodic basis (defined in maintenance), and at any point misalignment is suspected.

DEFINITIONS

Light field: area of light projected from collimator lamp that falls on the image receptor plane.

LIGHT FIELD TO X-RAY FIELD ALIGNMENT



1. The sum of X_1 and X_2 shall not be more than 2% of the distance from the focal spot to the film location.
2. The sum of Y_1 and Y_2 shall not be more than 2% of the distance from the focal spot to the film location.

Light field edge: light field whose perimeter is locus of points where illumination is 25% of maximum illumination in the center.

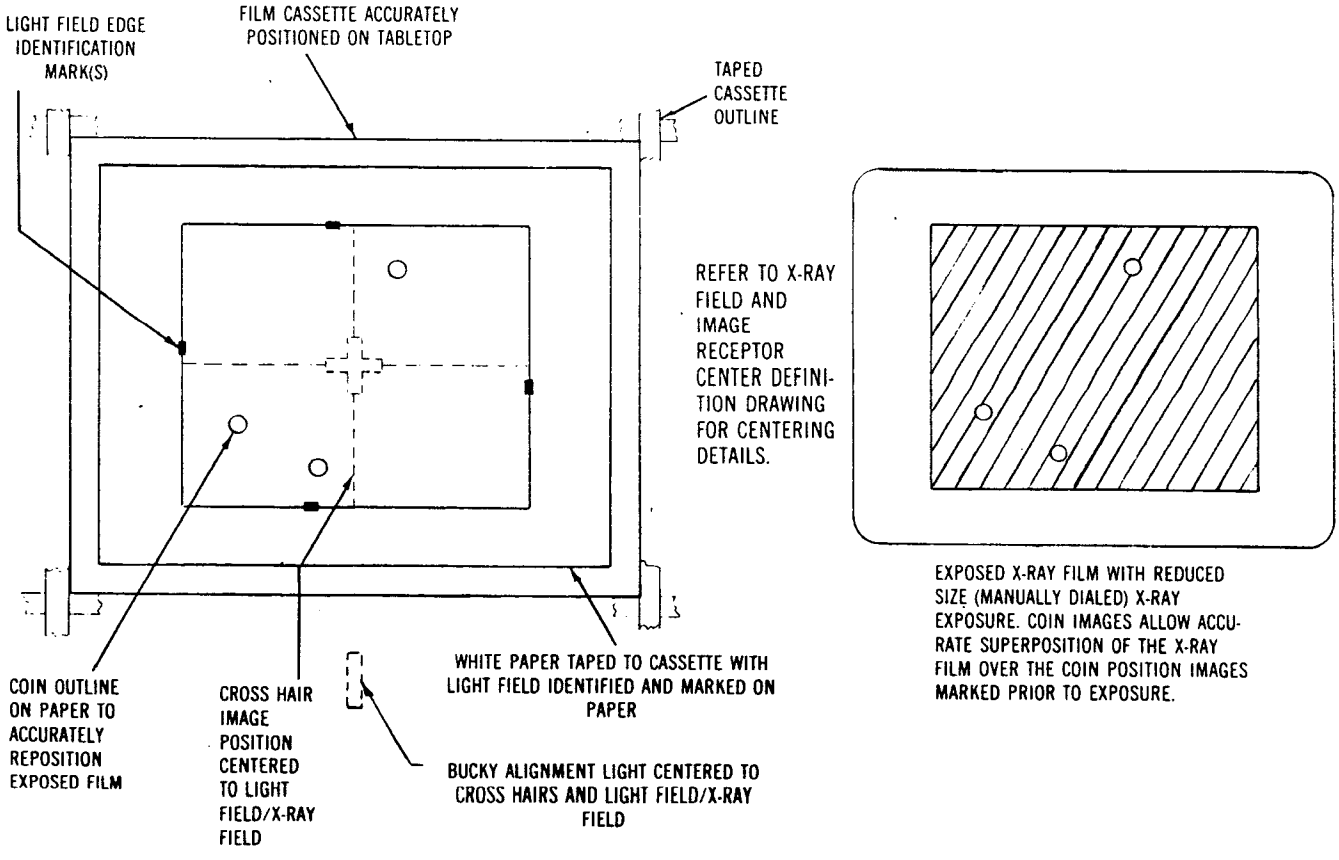
NOTE

These ALIGNMENT procedures define an acceptable, accurate edge identification for calibration purposes. If defined edges are challenged, a light detecting instrument with a 1 mm aperture must be used.

X-ray field: the area of x-ray projected from the x-ray tube unit that falls on the image receptor plane.
X-ray field edge: x-ray field whose perimeter is locus of points where the x-ray density is 25% of maximum x-ray density. This edge is precisely identified by use of a scanning densitometer with a 1 mm aperture and controlled-gamma film.
Light field to x-ray field coincidence: The total misalignment between the light field edges and the respective edges of the x-ray field shall not exceed 2% of the SID in either direction.

1. Subdue or turn off room lights. Locate a sheet of white paper on the tabletop and turn on the collimator field illumination light. Center the paper to the light field.
2. Using the second sheet of white paper as a light detector, square one edge of it up with the right-hand edge of the light field.
3. Proceeding from the unilluminated portion of the tabletop paper, gradually move the second sheet of

LIGHT FIELD, X-RAY FIELD, AND IMAGE RECEPTOR ALIGNMENT CHECKOUT



paper toward the illuminated area.
4. Observe and initially mark the point on the tabletop paper where illumination on the second sheet of white paper first begins to be visible.
5. Make a second mark **3 mm** toward the center of the illuminated field. This mark is to be used as the defined edge for light calibration purposes.

NOTE

The right hand side of the field corresponds to the direction on the observer's right when facing the collimator front panel.

6. Repeat this procedure on the other three sides, measure perpendicular to the edge and make secondary marks **2 mm** toward the center of the illuminated field. These secondary marks are to be used to define the other three light field edges.
7. Use a straightedge and carefully draw lines parallel to the edges of the light field using the secondary marks as reference points. The result should produce a square or rectangle that accurately describes the light field edge.

3-10 IDENTIFICATION OF X-RAY FIELD EDGES

WARNING

RADIATION HAZARD: OBSERVE ALL REQUIRED PRECAUTIONS TO AVOID EXPOSING ANY PART OF THE HUMAN BODY TO DIRECT OR SCATTERED X-RAYS. OBSERVE ALL EQUIPMENT RATINGS.

1. Set the collimator shutter dials to expose an area smaller than the film cassette size.
2. Adjust the x-ray generator exposure factors to produce a film having a density of **1.0.**
3. Check the density using a conventional densitometer or by visual comparison with a "neutral density" filter having a density of **1.0.**
4. Place the developed film on white paper. Place a second piece of white paper on top of the film and parallel to the edge of the image.
5. Slowly move the second piece of paper from the unexposed border toward the exposed x-ray image. Stop just as the increase in density of the film begins to be barely perceptible.
6. Mark this point with a fine stylus. Repeat the preceding for the other three edges.
7. On the edge corresponding to the direction of the x-ray tube cathode, measure and make a second mark **2 mm** toward the center of the image from the first mark. This second mark corresponds to the defined edge for the cathode side only.
8. On the other three edges of the x-ray image, measure and make a second mark **1 mm** toward the image center from the first marks. These second marks correspond to the other three defined edges.

3-11 ENTRY BARRIER TO FOCAL SPOT ALIGNMENT

The focal spot of an x-ray tube may be off-centered to the center of the tube port up to .08 inch (2 mm). In order to verify accurate alignment of the lead entry barrier to the focal spot, an examination of a film, taken with the collimator shutters fully open, should be made to verify that there is no x-ray field cutoff caused by misalignment.

NOTE

This procedure assumes that the correct collimator-to-focal-spot distance is maintained. (see OUTLINE DATA).

1. Set the collimator dials to 17" x 17" on the 40" scale.
2. Locate a 14" x 17" film-cassette at 27" SID. Since the SID is not variable, place the cassette on a cardboard box or inverted plastic waste receptacle to obtain a 27" SID.

WARNING

RADIATION HAZARD: OBSERVE ALL REQUIRED CAUTIONS AND PRECAUTIONS TO AVOID EXPOSING ANY PART OF THE HUMAN BODY TO X-RAYS, DIRECT OR SCATTERED. OBSERVE ALL EQUIPMENT RATINGS.

3. Set the x-ray technique factors to produce a film-exposure of about 1.0 density, expose and develop the film. Examine the film for edge cut-off.

If edge cut-off is observed, the collimator and mount must be removed to adjust the entry barrier. To remove collimator, refer to COLLIMATOR MOUNTING.

1. Loosen the four mounting bolts and slide the inner ring assembly in the direction of the cut-off (blur) as much as the clearance holes in the mount permit.
2. Retighten the bolts, reassemble the collimator, and retest with another film.

3-12 LIGHT FIELD TO X-RAY FIELD COINCIDENCE

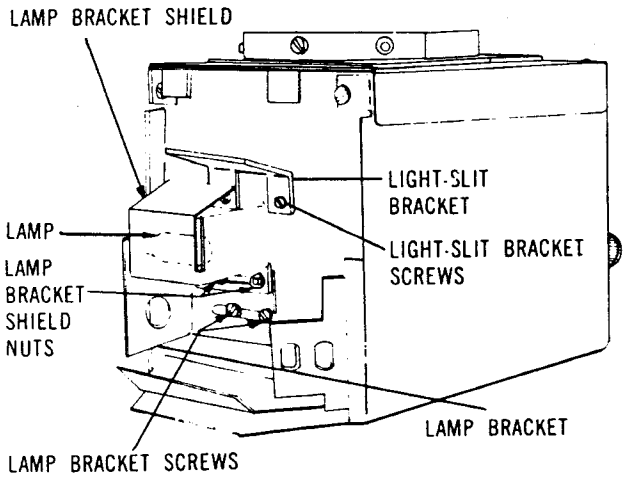
1. Ensure that the x-ray beam is perpendicular to the image receptor.
2. Position the x-ray tube/collimator to **40"** as measured from the focal spot to the table-top.
3. Locate a film cassette on the tabletop and center it to the collimator light field.
4. Use masking tape on the tabletop to "frame" the cassette outline to allow accurate relocation of the cassette each time.
5. Tape a sheet of white bond paper onto the cassette to aid in visualizing and marking the outline of the light field.
6. Adjust the collimator shutters to produce a light field on the bond paper, leaving about a 1-inch unilluminated border.
7. Identify and mark a full outline of the light field as described in IDENTIFICATION OF LIGHT FIELD EDGES.
8. Locate a few randomly placed coins on the paper and trace an outline of each coin to aid in re-orienting film after development.
9. Expose the film with factors that will produce a density of **1.0.**
10. After developing the film identify and mark the edges of the x-ray image as described in IDENTIFICATION OF X-RAY FIELD EDGES.
11. Relocate the cassette in the masking tape frame on the tabletop. Carefully superimpose the film on the paper target by observing the coin images and the coin outlines drawn on the paper.
12. The misalignment of the edges of the x-ray field can now be determined as explained above.
13. If the light field is misaligned to the x-ray field in the cross-table direction, locate the mirror adjustment screw through the hole in the window (Refer to DISASSEMBLY) and adjust the mirror to center the light field by turning the mirror adjusting screw: clockwise to shift the light field forward, counterclockwise to shift it to the rear. Retest for accuracy. See LIGHT FIELD TO X-RAY FIELD ALIGNMENT.

14. If the light field is misaligned in relation to the x-ray field in the longitudinal-table direction, remove the rear cover of the collimator (refer to DISASSEMBLY), losen the lamp bracket screws and move the lamp bracket left or right to center the light field to the x-ray image. Retest with another film. Retighten the screws. See LIGHT FIELD CENTERING ADJUSTMENT.
15. If a dimensional irregularity greater than **2%** SID between the light field and x-ray field size is found, or if there is difficulty aligning the light field with the x-ray field, ascertain that the collimator to focal spot spacing is correct (See OUTLINE DATA). If the spacing is correct, remove the rear cover of the collimator and lamp bracket heat shield if necessary, and check the lamp angulation in the lamp socket. (See LIGHT FIELD CENTERING ADJUSTMENT.) The lamp must be fully inserted into the socket and the main body be fully inserted in the socket and the main body of the lamp must be perpendicular to the socket.

LIGHT FIELD CENTERING ADJUSTMENT

CAUTION

THE LAMP BRACKET GETS VERY HOT AND CAN CAUSE SEVERE BURNS. USE LONG-NOSE PLIERS OR SIMILAR TOOLS TO HOLD BRACKET DURING ADJUSTMENTS. PROTECT EYES FROM THE HIGH INTENSITY LIGHT.



3-13 SHUTTER DIAL ADJUSTMENT

1. Ensure that the x-ray beam is perpendicular to the image receptor.
2. Position the x-ray tube/collimator to **40"** as measured from the focal spot to the x-ray film plane.
3. Locate a film cassette on the tabletop and center it to the collimator light field.
4. Adjust the collimator shutters to an exact dial reading of **10" x 10"** on the **40"** scale, in a closing motion.
5. Locate a few randomly placed coins on the cassette for later re-orientation.
6. Expose the film with factors that will produce a density of **1.0.**
7. After developing the film, identify and mark the edges of the x-ray image as described in IDENTIFICATION OF X-RAY FIELD EDGES.
8. Measure the width and length of the x-ray image and compare this measurement to the dial indications (**10" x 10"** as set in step 4 above).

NOTE

The dial indication must correspond to the x-ray field size to within **2%** of the SID in use. Therefore with **40"** SID and a **10"** dial setting, the cross-table image size must be **10" ± .80" (9.2" -10.8")** and the long-table x-ray image size must be **10" ± .80" (9.2" - 10.8")**. The actual results, however, must be accurate to within ± **.25"** to ensure that all size indications for each SID are accurate.

9. If adjustment is required, loosen the 2 set screws on each knob and turn the knob to the dial indication that corresponds to the x-ray image dimensions on the test film. Retighten screws, making sure that the shutters do not move.
10. Repeat SHUTTER DIAL ADJUSTMENT.

3-14 CROSS-HAIR TO LIGHT FIELD CENTER ALIGNMENT

1. Loosen, by one turn, each of the six accessory track and window screws adjacent to the exit window on the bottom of the collimator. (Refer to OPERATION AND ADJUSTMENT DETAILS).
2. Form a ball (wad) of masking tape (do not use adhesive tape) and press it onto the plastic exit window to assist moving or sliding the window.
3. Activate the collimator field projection light, and center the cross-hair image to the center of the projected light field (the cross-hair must remain squared to the light field edges) to within **0.2** inch of the light field true center.
4. Retighten the six retaining screws.

3-15 BUCKY LIGHT-LINE ALIGNMENT

1. Activate the collimator field projection lamp and by the use of a straightedge, check the centering light-line which is projected forward of and outside of the main light field. It must be in line with the central bar of the cross-table, cross-hair image.
2. If adjustment is required, remove the rear cover. (Refer to DISSASSEMBLY.)

WARNING

THE PROJECTION LAMP BRACKET GETS VERY HOT AND CAN CAUSE SEVERE BURNS. USE LONG-NOSE PLIERS OR SIMILAR TOOLS TO HOLD THE BRACKET DURING ADJUSTMENT PROCEDURES. PROTECT EYES FROM THE HIGH INTENSITY LIGHT.

3. **Loosen the two Bucky light line adjustment screws slightly, (See LIGHT FIELD CENTERING ADJUSTMENT), and move the Bucky light assembly until the light line is centered.**
4. **Check alignment after retightening the screws.**
5. **If the Bucky light line is not projected far enough in front of the Bucky, downward pressure must be applied to the lens/mirror assembly by means of a blunt bar blade inserted between the assembly and top cover.**

CAUTION

USE A BLUNT INSTRUMENT TO AVOID DAMAGE TO THE LEAD SHIELDING.

CAUTION

IF THE LENS/MIRROR ASSEMBLY IS BENT BEYOND THE NECESSARY ANGLE, IT MUST BE REMOVED AND READJUSTED.

3-16 ACCURACY CHECK

This paragraph covers final adjustments to ALIGNMENT. Complete all steps in this paragraph. NOTE, some adjustments may not require changes but completion of this procedure is necessary:

- to verify x-ray field-to-image receptor sizing coincidence; and
- to re-adjust electronic calibration · if necessary.

1. Connect a jumper between P1-10 and P1-12 to bypass the exposure interlock temporarily during initial alignment.

WARNING

THIS JUMPER MUST BE REMOVED IMMEDIATELY FOLLOWING COMPLETION OF THE CALIBRATION PROCEDURES.

NOTE

An alternative to utilizing the aforementioned jumper to permit the use of x-rays during the following test procedures is to temporarily turn the X-ray Field Limitation System Failure keyswitch "off" to facilitate the use of x-rays when required in Step 8 below.

2. Set the x-ray tube/collimator at 40" SID (measured; do not use equipment scales) for vertical (within ± 5°) operation into a horizontal table Bucky.
3. Carefully center the x-ray beam to the cassette tray. Set all equipment locks to retain this alignment.
4. Insert a mid-size test cassette (e.g., 10" x 12") carefully centered and clamped into the table Bucky.
5. Carefully adjust the shutters to achieve a READY indication. Leave equipment set and READY.
6. Identify the edges and center of the light field on the tabletop. Place suitable markers on all four edges of the light field and place a lead number for film identification and orientation in the lower left corner of the light field. This will allow an expedient comparison of light field-to-x-ray field coincidence.
7. Remove the 10" x 12" cassette, and carefully center and clamp a 14" x 17" image recording cassette into the table Bucky with its largest dimension oriented in the same direction as the 10" x 12" cassette. (Do not disturb the cassette to x-ray tube alignment.)

WARNING

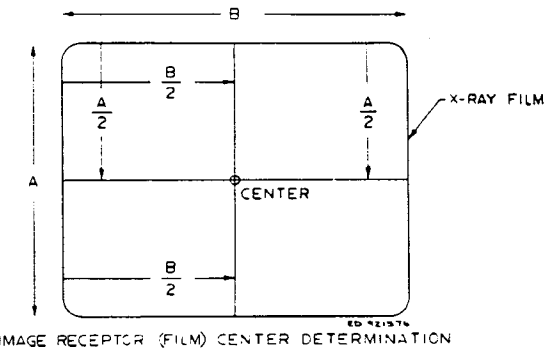
RADIATION HAZARD: OBSERVE ALL REQUIRED CAUTIONS AND PRECAUTIONS TO AVOID EXPOSING ANY PART OF THE HUMAN BODY TO X-RAYS, DIRECT OR SCATTERED. OBSERVE ALL EQUIPMENT RATINGS.

NOTE

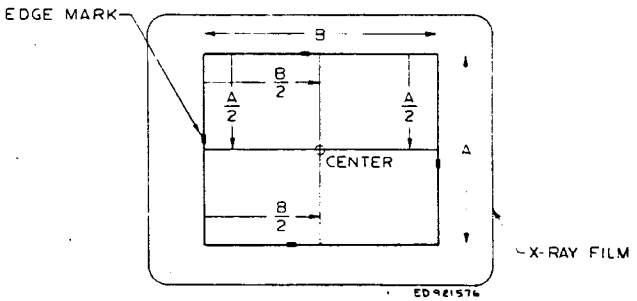
The EXP. HOLD light will be on but the film can be exposed because the exposure hold feature is temporarily bypassed.

8. Set the equipment x-ray exposure technique factors to produce a film density of 1.0 and expose and process the film.
9. Identify the center and edges of the x-ray image (see IDENTIFICATION OF X-RAY FIELD EDGES).

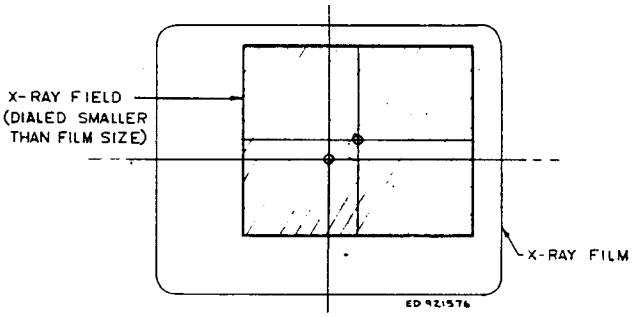
X-RAY FIELD AND IMAGE RECEPTOR CENTER DEFINITION



A. IMAGE RECEPTOR (FILM) CENTER DETERMINATION



B. X-RAY FIELD CENTER DETERMINATION



C. X-RAY FIELD TO IMAGE RECEPTOR (FILM) CENTER COMPARISON

NOTES

LIGHT FIELD TO X-RAY FIELD ALIGNMENT

The total misalignment of the edges of the visually defined field with the respective edges of the X-ray field along either the length or width of the visually defined field shall not exceed 2 percent of the distance from the source to the center of the visually defined field when the surface upon which it appears is perpendicular to the axis of the X-ray beam. [Ref. 21 CFR 1020.31(d)(2).]

X-RAY FIELD LIMITATION AND ALIGNMENT.

The X-ray field size in the plane of the image receptor shall be such that neither the length nor the width of the X-ray field differs from that of the image receptor by greater than 3 percent of the source-to-image distance (SID) and that the sum of the length and width differences without regard to sign be no greater than 4 percent of the SID, when the equipment indicates that the beam axis is perpendicular to the plane of the image receptor. [Ref. 21 CFR 1020.31(e)(2)(ii).]

INDICATION OF X-RAY FIELD SIZE

Means shall be provided on the beam-limiting device to indicate field size in the image receptor plane to within 2 percent of the source-to-image distance (SID). [Ref. 21 CFR 1020.31(e)(1).]

X-RAY FIELD/RECEPTOR CENTER ALIGNMENT

Means shall be provided to align the center of the X-ray field with respect to the image receptor to within 2 percent of the source-to-image distance (SID). [Ref. 21 CFR 1020.31(e)(1).]

10. Repeat this accuracy checkout with a smaller cassette (e.g., 8" x 10") and a larger cassette (e.g. 11" x 14" or 14" x 17") with the larger dimension in the long table direction by repeating steps 4 through 10 in the order described.
11. Repeat this accuracy checkout with the large and small cassettes oriented with the large dimension in the cross table direction by repeating steps 4 through 10 in the order described.

NOTE

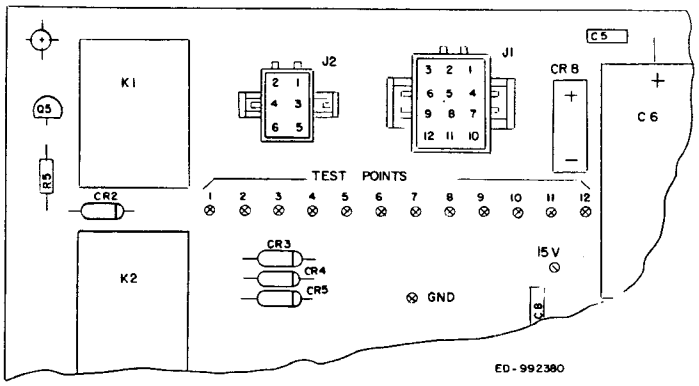
Although all the x-ray field sizes must correspond to the dimensions of the image receptor within 3% of the SID in either orientation, and that the sum of the length and width differences without regard to sign be no greater than 4% of the SID, the actual midrange (10 inch cassette) x-ray field-to-image receptor size error should be adjusted to be less than 1% of the SID (0.4 inch).

12. If the x-ray field sizes are larger or smaller than the image receptor sizes, the 40 inch and/or 72 inch VSID voltage(s) must be adjusted to compensate. Following the adjustments made in step 13 the base voltage and long comp voltages might also have to be adjusted as detailed below. Prior to following step 13, steps 14, 15 and 17 should be read so that the other electronic adjustments can be accomplished before a second series of x-ray exposures is made.
13. If the x-ray field dimensions do not correspond to the image receptor sizes as discussed in the above NOTE at a correct 40 ± 1/8" SID the 40 inch VSID calibration potentiometer (R53) requires adjustment. This adjustment will usually be necessary if the base voltage in step 14 below requires readjustment. The adjustments should be made initially in 0.1 volt increments and be monitored by recording and measuring mid-sized (8" x 10" or 10" x 12") x-ray exposures. Increasing the VSID voltage at TP11 will result in a small PBL x-ray field size. The accuracy checkout with a smaller cassette and a large cassette should be repeated with the cassettes oriented in both positions.
14. If there is an inconsistency in x-ray field-to-image receptor sizing accuracy over the range of shutter aperture sizes, i.e., if the larger x-ray field sizes at 40" SID are oversize relative to the image receptor (film) and the smaller 40" SID field sizes (5, 7, or 8 inch sizes) are undersize relative to the image receptor, the base voltage will require slight readjustment. In this event, decrease the base voltage (R50, TP12) by .01 volt. Conversely, if the larger x-ray field sizes are undersize relative to the image receptor and the smaller x-ray field sizes are oversize, the base voltage should be increased by 0.01 volt. This adjustment will require the VSID adjustment (step 13) to be repeated.
15. If there is a discrepancy between the proportion of LONG and CROSS x-ray field dimensions relative to the long and cross image receptor sizes, the LONG COMPENSATION voltage (R51) at TP6 can be adjusted accordingly. This determination should be made by evaluating all the different sizes of the x-ray test images. Increasing the VSIDL voltage by adjusting R51 will result in decreasing the longitudinal PBL x-ray field size.
16. If an upright Bucky or upright cassette holder is present, steps 4 through 10 should be repeated with cassettes in the upright receptor. Use both 40" SID and 72" SID.
17. If the x-ray field dimensions at the horizontal SID of 72 inches do not coincide with the image receptor dimensions, the 72 inch VSIDC calibration (R52) requires re-adjustment to compensate. The adjustments should be made initially in 0.1 volt increments and be measured as done in step 13 above. Increasing the VSID voltage at TP11 will result in a smaller x-ray field size.

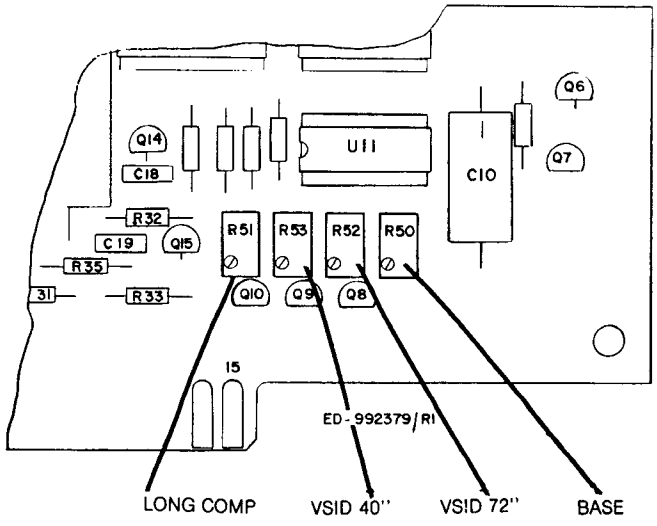
NOTE

Adjustments made to (R51) long comparator voltage affects *both* 40" SID and 72" SID sizing.

LOGIC BOARD TEST POINTS



CALIBRATION ADJUSTMENTS



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THEORY OF OPERATION

4-1 MECHANICAL OPERATION (Manual Mode)

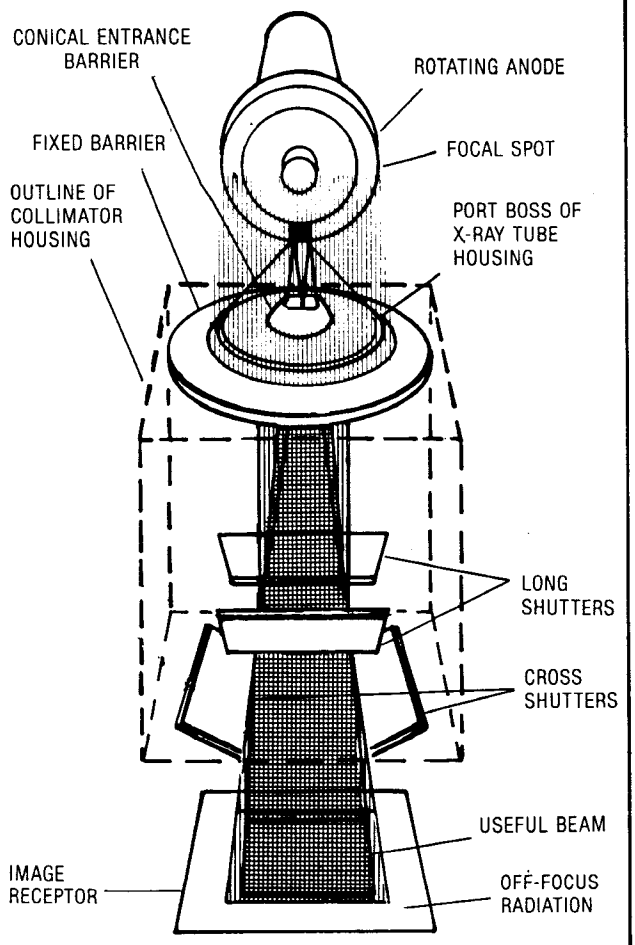
Two pairs of manually controlled lead shutters are contained within the collimator to limit the cone of radiation.

The long shutters control the x-ray beam length, and the cross shutters control the x-ray beam width.

Each pair of shutters is controlled by a dial on the front panel:

The dial marked (||) controls the long shutters
The dial marked (=) controls the cross shutters

SHUTTER OPERATION



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4-2 ELECTRONIC OPERATION

This collimating system uses analog shutter and film size sensing. Potentiometers in the collimator are connected via gears to the shutters. A voltage proportional to the shutter opening is generated at the wipers of these potentiometers. The reference voltage for the head potentiometers is the SID voltage, which is increased in proportion to the distance.

The SID voltage for the long shutters is set at 90% of that for the cross shutters, since the long shutters are closer to the focal spot than the cross shutters. R51, long comp.) provides this adjustment.

The SID voltage is generated when either the 40" or 72" SID switches are closed, and is routed via transistor switch Q9 for 40" or Q8 for 72". This selects R53 or R52. A voltage divider is formed via the selected potentiometer and R10, providing a signal path to the base of Q10, which is connected as an emitter follower, producing the SID voltage. R52 and R53 are adjusted according to the voltages given in table 3-1.

The VBXF voltage is required to account for certain geometrical considerations in the design of the collimator.

4-3 ANALOG COMPARATORS

At a given SID the cross and long collimator output voltages, VXFC and VXFL, are proportional to the projected x-ray field size. These voltages are fed to the two cross comparators U-14 and U-15 and the two long comparators U-12 and U-13. An RC network is connected to the input terminals of each primary comparator (U-14 and U-12) to attenuate noise and limit induced transient voltages. The passive components associated with each comparator set offset voltage, hysteresis, and signal filtering.

The output signals of these comparators are applied to gates that process logic conditions:

- NOR gates are used in conjunction with a gating structure to enable the READY lamp when all conditions are met.
- OR gates (U4) produce a window network inhibiting the recycling signal from U-10 when the shutter is within the undersize and oversize tolerances.

4-4 SID SIGNAL GENERATION AND TILT SWITCH

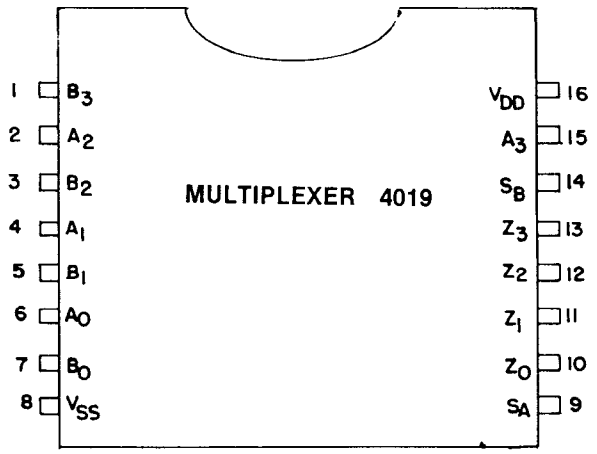
If the collimator head is oriented in the beam vertical direction, the "A" data inputs of U8 (QUAD Z input multiplexer) are selected, disabling the "B" data inputs (wall data). Tilting the collimator into the beam horizontal position drives U8 to select the "B" data inputs and disregard any "A" data.

The 4019 multiplexer provides four multiplexing circuits with common selection inputs; each circuit contains two inputs and one output. It may be used to select four bits of information from one of two sources the "A" data inputs are selected when S_A is high, the "B" data inputs are selected when S_B is high. When S_A and S_B are high, output Z_N is the logical OR of the A_N and B_N inputs (A_N + B_N)

SELECT		INPUTS		OUTPUTS
S_A	S_B	A_N	B_N	Z_N
L	L	X	X	L
H	L	L	X	L
H	L	H	X	H
L	H	X	L	L
L	H	X	H	H
H	H	H	X	H
H	H	X	H	H
H	H	L	L	L

H = high level
L = low level
X = don't care

U8 PIN OUTPUT



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4-5 CASSETTE TRAY

The cassette size is sensed by an analog size sensing tray. The tray is supplied with + 15 volts, VCT. This analog voltage is divided by R41 and R43 for the cross direction and R42 and 44 for the long direction. This technique increases the signal to noise ratio of the signal. C13 and C15 provide added filtering.

Potentiometers in the tray generate voltages proportional to the film cassette size. If a cassette is present in the wall tray the cassette presence switch generates a signal via R28 to the base of transistor Q12. This causes the collector to conduct and ground relay K2, switching the contacts to the wall tray.

4-6 INPUT SWITCHING CIRCUITRY

All input transistors, Q11 through Q18 are connected to operate with an active pull-up resistance. A resistor limits the current at the base of each transistor switch, while a ceramic capacitor across the base limits the transient response of the system. The collector of each transistor is connected to + 15 VDC with a pull-up resistor. When base current is supplied, the collectors conduct, producing a logic Low.

4-7 OPEN LIGHT RESEQUENCING CIRCUIT

Pins 12, 9 and 6 of U6 as well as pin 5 of U5 are connected to the Q output of Flip-Flop U11. The Flip-Flop circuit determines whether the shutters are initially set larger than the Film size. The following events are required to set $\bar{Q}$ to a logic High condition:

- The comparators have logic Low outputs if both shutters are "coned down". By way of U5-C and U9-C, a logic Low is present at the data input of the Flip-Flop. Changing the cassette or SID generates a clock pulse transferring the data to $\bar{Q}$ as a logic High.
- A logic High (CASSETTE PRESENT) and another logic High (SID TRUE) is present at the inputs of NAND gate U5-D, resulting in a logic Low output. In the event a cassette is changed, the CASSETTE PRESENT signal momentarily (while the cassette is out, being changed) reverts to logic LOW, resulting in a logic High output, generating a Trigger pulse from the monostable multivibrator U10-A. Similarly, if the SID is changed the same condition occurs, which may be inhibited by the window logic (U3).

The Q output of U10-A generates an EXP. HOLD condition for one second when trays or SIDs are changed, allowing the RC networks in the comparator circuitry time to settle. The RC network formed by R9 and C10 is designed to filter any noise picked up by the circuitry, and prevent unwanted triggering of U10-A.

A Q output from U10-A triggers U10-B to generate a short (2 ms.) pulse, which triggers U5-A, if, and only if a logic High condition is present at pin 2. Thus U5-A can generate a trigger pulse to the Flip-Flop via U3 if Q is High or if the shutters are sized smaller than the film. If the shutters are sized larger than the film, a logic High is present at the input to the Flip-Flop. A Trigger pulse applied to the Flip-Flop generates a logic Low at the $\bar{Q}$ output if the input is logic High, and similarly generates a logic High at $\bar{Q}$ if the input is logic Low. This pulse may be inhibited by U3 of the window logic.

4-8 COLLIMATOR INDICATOR LAMPS

- Manual Mode
  Manual operation may occur if no cassette is present or if the collimator is tilted more than 10 degrees from vertical or horizontal beam axis.
- Ready Mode
  In order to obtain an exposure under PBL, the shutters must be sized, the flip flop (where applicable) must generate Q = 0, and the monostable stage (where applicable) output Q must be High. The PBL TRUE signal and U10 output are combined in U3-C. This output being High goes to U-2A where it is combined with the sizing signal from U-2B. NOR gate U6A controls the exposure interlock and EXP. HOLD light. The EXP. HOLD light and the interlock relay K1 receive inverted signals. The presence of a MANUAL or PBL READY signal from U2-3 to U-6A causes its output to go Low. U9A inverts the output and drives Q5, the K1 relay driver and Q6, the EXP. HOLD lamp driver.
- Sequence lamps: OPEN, CLOSE, C-READY, L-READY
  Gate U2-D determines that the system is not in MANUAL, and that it is in PBL. This provides one enable input to all the gates of the U1 AND gate.

  The OPEN light is controlled by the flip-flop U-11 when Q goes High.

  When the shutters are opened beyond the film size, Q goes Low, the OPEN light extinguishes, and the CLOSE light illuminates. The close light is on if the PBL enable signal is High. This signal is High if either shutter is opened beyond the film size. When both shutters are closed down properly, the close light extinguishes. This is controlled by U6-B.

  Each READY light is associated with a pair of shutters. When the cross shutters are closed down, the comparator U-14 output goes Low. The output of U6-C goes High. This drives U1-A High driving Q3 and the C-READY light ON.

  Similarly the same sequence occurs with U12, U6-D, U1-B and Q4.

4-9 LAMP TIMER CIRCUIT

Diode D1 (CR1) provides half-wave rectification; diode D2 (CR2) in combination with R1 provides low frequency filtration; and C1 provides noise bypass.

R2 and C3 provide the time constant (time = 1.7 RC) for control of the integrated circuit. During the timing interval, the output (pin 3 of U1) is about 9.5 volts, therefore the relay coil will not be activated. With the contacts relaxed (in a closed position) the triac turns on and actuates the projection lamp.

After applying a negative trigger pulse to Pin 2 (switch closure), a flip-flop in U1 is set. Applying a positive voltage on Pin 4 (switch opening) releases a clamp-transistor in U1 from Pin 7 to 1, removing the short circuit from C3.

While the flip-flop is set and Pin 4 is positive, the output switches to almost Pin 8 voltage level. The relay is deenergized and the triac turns on. With the short circuit removed from C3, the current through R2 starts charging C3. When the voltage on C3 reaches ⅔ of the applied voltage (about 6.33 V), a voltage comparator in U1 resets the flip-flop which switches Pin 3 down to almost Pin 1 potential (relay energizes turning off triac). At the same time, the short circuit is again applied from Pin 7 to Pin 1, discharging C3.

A sustained switch closure (pin 4 to Pin 1) causes the output to remain low (relay energized, triac off) for added safety. The timing cycle may also be interrupted at any time, which will reset the timer for a full-timed cycle.

4-10 RESET INDICATOR CIRCUIT

This circuit (U4A, U4D, U4C) will determine if the CROSS and/or the LONG shutter is adjusted to produce a field size more than 1% SID smaller than the nominal PBL field size for which the electronic system produces a READY mode for each respective shutter. If a shutter is sized smaller than the 1% window tolerance, a small red indicator will light, indicating that if a new cassette of the same size is subsequently reinserted the system will have to be manually recycled. The red indicator also lights with the presence of an OPEN command.

TROUBLESHOOTING

5-1 INTRODUCTION

This section presents two levels of troubleshooting to aid identification of system faults. Once a specific failure is identifed refer to Operation and Theory of Operation. The two levels are:

- Operational Checkout — exercises the system through basic modes of operation.
- Typical Faults - used in troubleshooting common problems on logic board and wiring.

5-2 TEST EQUIPMENT REQUIRED

1. Digital Voltmeter (Data Tech Model 30 or equivalent)
2. screw driver, slotted head (for adjusting SID pots)
3. replaceable electronic parts (CMOS-4000 series IC and voltage comparators, see parts list).

NOTE

Improper removal or replacement of Integrated Circuits (IC) can damage the integrated circuit or other components. Always ensure:

- the IC is properly keyed to the socket and leads are properly aligned before attempting insertion
- the IC is inserted and removed using an EXTRACTOR
- all replacement ICs are exact replacements (function and quality)
- all replacement ICs are stored appropriately
- power is disconnected before removal and replacement.

See CABLING DATA. Verify cabling and inspect plugs to ensure proper fit.

CAUTION

CMOS IC's should be handled with extreme care. They are very susceptible to damage caused by static electricity, even from hands. Antistatic packaging should not be removed until ICs are inserted into the logic board.

5-3 OPERATIONAL CHECKOUT

In the event of system failure requiring use of the X-ray Field limitation System Failure keyswitch, the user is obligated to have the system repaired.

NOTE 1

To simplify these tables, not all front panel lamp operation is included. Refer to OPERATION for information as necessary.

Table 5-1 Verifying Reset Indicator Lamp

Step	Test Point	Procedure	Correct Indication
1	Shutters	Open shutters greater than cassette size.	EXP. HOLD and CLOSE lamps will light once the SID is set and a cassette is in place.
2		"Cone down" the long and cross shutters very carefully. Stop as soon as both halves of READY lamp light.	Both READY lamps light. EXP. HOLD and CLOSE lamps extinguish. RESET lamp should not light.
3	Cassette Tray	Remove cassette tray.	MANUAL light on
4		Reinsert cassette tray.	READY light on
5	Shutters	"Cone down" one or both shutters.	RESET lamp will light.
6	Cassette Tray	Remove cassette tray.	
7		Reinsert cassette tray.	RESET, EXP. HOLD and OPEN lamps light.

NOTE

Checks 5-2a, 5-2b, 5-2c, 5-2d and 5-2e are equally applicable to an upright Bucky or to a cassette holder.

If a fault occurs or if the correct result is not obtained as indicated, then begin circuit checkout at that point.

Table 5-2a — Verifying Manual Control

Step	Test Point	Procedure	Correct Indication
1		Set tubestand to vertical 40" SID.	
2		Position collimator to a vertical position (within ± 10°.	
3	Keyswitch	Check that keyswitch has not been activated.	The switch is in the normal position
4		Insert table Bucky tray into cabinet without a film cassette.	MANUAL LAMP remains lighted.
5	Table Bucky Tray	Remove tray.	
6	Table Bucky Tray	Center an 8" x 10" film cassette into the table Bucky tray and clamp into position.	
7		Insert tray into the Bucky cabinet.	EXP. HOLD lamp and either OPEN or CLOSE lamp lights.
8		Tilt the collimator more than 10° from vertical.	MANUAL LAMP This procedure verifies that manual operation is possible whenever the collimator is more than 10° from vertical or when no film cassette is present.

Table 5-2b — Verifying EXP. HOLD Function

Step	Test Point	Procedure	Correct Indication
1	Cassette Tray	Make sure that no cassette is in the tray.	MANUAL light on
2	= and II Front Panel Dials	Completely close collimator shutters.	

Table 5-2b continued

ep	Test Point	Procedure	Correct Indication
3		Position collimator to a vertical position (within ± 5°).	
		Set tubestand to 40" vertical SID.	40" SID switch contacts are CLOSED. The MANUAL lamp remains lighted.
4	Cassette Tray	Insert an 8" x 10" cassette into the Bucky tray with the 10-inch dimension longitudinal. Insert tray fully into the cabinet.	The EXP. HOLD lamp and the OPEN lamp both should be lighted (beginning of PBL cycle).
5	= and II front panel dials	Open both shutters to a field size larger than the 8" x 10" film.	OPEN lamp extinguishes. CLOSE lamp lights. EXP. HOLD lamp remains lighted.
6	= and II front panel dials	Close both shutters to the 8" x 10" size (or smaller).	CLOSE and EXP. HOLD lamps extinguish; both halves of READY lamp light.
		Move tubestand vertically so that 40" SID switch is open.	READY LAMP extinguishes; only the EXP. HOLD lamp is lighted.

Table 5-2c — Verifying Shutter Positon versus OPEN operational status lamp

Step	Test Point	Procedure	Correct Indication
1	= and II Front Panel Dials	Completely close collimator shutter dials.	MANUAL light on
2		Position collimator to a vertical position (within ± 10°).	
3		Set SID to a switch position other than 40".	
4	Cassette Tray	Insert an 8" x 10" cassette into the Bucky cabinet cassette tray with the 10-inch dimension longitudinal	The EXP. HOLD lamp should light
5	SID Vertical	Set SID to 40".	The EXP. HOLD lamp should remain lighted and the OPEN lamp should light. This procedure verifies that an exposure is prevented when the shutters are closed at the beginning of the PBL cycle and that the operator receives a proper command.

Table 5-2d — Verifying Shutter Position versus CLOSE Operational Status Lamp

Step	Test Point	Procedure	Correct Indication
1	= and II Front Panel Dials	Completely open both collimator shutters.	MANUAL light on
2		Position collimator to a vertical position (within ± 5°).	
3		Set tubestand at the 40" vertical SID position.	
4	Table Bucky Tray	Insert the 8" x 10" cassette into the Bucky cabinet cassette tray with the 10-inch dimension longitudinal.	The EXP. HOLD lamp and the CLOSE lamp will light.
5			This procedure verifies that an exposure is prevented when the x-ray field size exceeds the film size and that the operator receives the proper CLOSE command.

Table 5-2e — Verifying Operation of READY Lamp

Step	Test Point	Procedure	Correct Indication
1	= and II Front Panels Dials	Completely open collimator shutters.	MANUAL light on
2		Position collimator to a vertical position (within ± 5°).	
3		Set tubestand to the 40" vertical position.	
4		Insert the 8" x 10" cassette into the table cassette tray.	The EXP. HOLD and the CLOSE lamp will light.

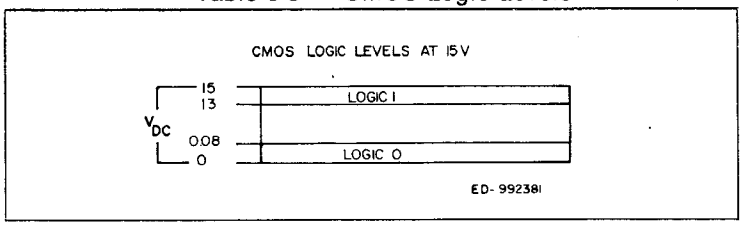
Table 5-2e continued

Step	Test Point	Procedure	Correct Indication
5	= CROSS Dial	Slowly close the CROSS shutter until correct size indication is attained.	The CROSS half of the READY lamp will light.
6	= LONG Dial	Slowly close the LONG shutter until correct indication is attained.	The LONG half of the READY lamp lights. The CROSS half of the READY light remains lit. The CLOSE lamp extinguishes. No other lamp should be lighted.
7	Shutter Dials	Observe settings of the dial indicators.	On the 40" SID scale, the dial indicators show the size of the film placed in the cassette.

Repeat the OPERATIONAL CHECKOUT for all acceptable cassette sizes for both vertical (BEAM DOWN) and horizontal (BEAM LEFT or BEAM RIGHT). Note that the jumper position on the logic board configures the logic for auxiliary cassette tray use.

For a basic understanding of logic levels refer to table 5-3

Table 5-3 — CMOS Logic Levels



TERMINOLOGY
Transistor ON - Base voltage of approximately 0.75 VDC
SID - source (focal spot) to image receptor (film) distance in inches unless otherwise specified)
VXFC - Voltage representing the dimension corresponding to the collimator cross shutters
VXFL - Voltage representing the dimension corresponding to the collimator long shutters.

5-4 TYPICAL FAULTS
The following charts give examples of typical faults and solutions. Refer to Charts 1-7 first when there is a system failure.

Problem
NO Collimator lamps LIGHT
Conditions
Collimator: beam vertical; no cassette in Upright Bucky; no cassette in table; no SID set.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to +15 V test point (on LOGIC BOARD). Voltmeter should read 15 V ± 0.5 VDC.
2. If correct reading is obtained, check for a bad connection to collimator lamps at P30; or a bad transistor at the lamp drivers (for example, MANUAL, Q7).
3. If voltage reading was NOT obtained in Step 1, measure voltage across pins 1 and 2 of P1 for 18 VAC. If no voltage is present, check fuses F1, F2, F3 and F4 (input power).

Problem
System does NOT go into MANUAL.
Conditions
Collimator: beam vertical; no cassette in Upright Bucky; no cassette in table; no SID set.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to TEST POINT 8. Voltmeter should indicate a logic LOW.
2. If a logic LOW is NOT measured, check Q11 for a base to collector short; or a collector to emitter short. Q11 should be OFF. If not check for a cassette presence switch stuck closed or shorted.

Problem
System does NOT go into EXP HOLD.
Conditions
Collimator: beam vertical, cassette inserted into table tray; collimator shutters are open larger than film size.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to TEST POINT 9 first then to TEST POINT 8.
2. Both TP8 and TP9 should measure a LOGIC HIGH. If either or both are not HIGH, refer to LOGIC CHART. Proceed backwards thru the LOGIC CHART until the problem is located (such as Q11 and Q14 defective).
3. If TP8 and TP9 measure a LOGIC HIGH, continue thru the LOGIC CHART until the problem is found.

Problem
System does NOT issue a CLOSE or OPEN command when EXP HOLD lamp is ON.
Conditions
Collimator: beam vertical, cassette inserted into table tray; and a 40" vertical SID is set.
1. Connect digital voltmeter: negative to GND test point and positive to TEST POINT 9 first, then to TEST POINTS 8 and 10.
2. TP8, TP9, and TP10 should measure a Logic HIGH. If either or both are not HIGH, refer to LOGIC CHART until the problem is located (Q11, Q14, Q16 should be ON).
3. If Q11, Q14, Q16 are not ON, check external wires and verify voltage is present on base, then check transistors for a collector to emitter short.
4. If TP8, TP9, and TP10 measure a Logic HIGH, proceed thru the LOGIC CHART until the problem is located.

LOGIC CHART

MODE

TEST POINT	MANUAL NO FILM NO SID BEAM VERT.	FILM EXP. HOLD NO SID	EXP. HOLD **OPEN** COMMAND	EXP. HOLD **CLOSE** COMMAND	READY CYCLE COMPLETE	READY
TP9	H	H	H	H	H	H
TP8	L	H	H	H	H	H
TP10	L	L	H	H	H	H
U3-3	L	L	H	H	H	H
U3-4	L	L	H	H	H	H
U2-11	L	L	H	H	H	H
U2-3	L	L	L	L	H	H
U11-2	—	—	H	L	L	L
U2-4	—	—	L	L	H	H
U6-4	—	—	L	H	L	L
U6-10	—	—	L	L	H	H
U6-11	—	—	L	L	H	H
U4-11	—	—	—	L	L	H
U4-3	—	—	—	L	L	H
U4-10	—	—	—	L	L	H
U3-11	—	—	—	L	L	⎍
U2-8	—	—	H	L	L	H
L.E.D	—	—	ON	OFF	OFF	ON
U12-7	—	—	L	H	L	L
U14-7	—	—	L	H	L	L
U13-7	—	—	H	L	L	H
U15-7	—	—	H	L	L	H
Q1	OFF	OFF	ON	OFF	OFF	OFF
Q2	OFF	OFF	OFF	ON	OFF	OFF
Q3	OFF	OFF	OFF	OFF	ON	ON
Q4	OFF	OFF	OFF	OFF	ON	ON
Q5	ON	OFF	OFF	OFF	ON	ON
Q6	OFF	ON	ON	ON	OFF	OFF
Q7	ON	OFF	OFF	OFF	OFF	OFF
U8-6	L	L	L	L	L	L
U8-4	H	L	L	L	L	L
U8-2	H	H	L	L	L	L
U8-7	H	H	H	H	H	H
U8-5	H	H	H	H	H	H
U8-3	H	H	H	H	H	H
U8-1	H	H	H	H	H	H
U8-14	L	L	L	L	L	L
U8-9	H	H	H	H	H	H

Problem
Cross shutter circuitry okay (READY Lamp LIGHTS), long shutter circuitry NOT functioning properly (READY lamp does NOT LIGHT). Remember: READY lamp is split into Cross and Long - see OPERATION.
Conditions
Collimator: beam vertical, cassette inserted into table tray; and a 40" vertical SID is set.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to TEST POINT 7.
2. Open the long shutter dial to a size larger than the film size. The voltmeter should read a logic HIGH. If not, measure voltage at TP4 (and record) then measure voltage at TP2 (and record).
3. When voltage at TP4 is greater than the voltage at TP2, TP7 should be HIGH; when the voltage at TP4 is less than OR equal to the voltage at TP2 the output TP7 should be LOW.
4. If the voltage relations in STEP 3 are NOT obtained, replace the comparator - U12.
5. If voltages on the input of U12 (TP2, TP4) are not present:
   - check calibration of the tray for voltages at TP2 or
   - calibration of the SID for the voltage at TP4.
6. If voltages in STEP 3 are obtained, proceed backwards thru the LOGIC CHART until the problem is found.

Problem
Long shutter circuitry okay (READY lamp LIGHTS), cross shutter circuitry NOT functioning properly (READY lamp DOES NOT LIGHT). Remember: READY lamp is split into Cross and Long — see OPERATION.
Conditions
Collimator: beam vertical, cassette inserted into table tray; and a 40" vertical SID is set.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to TEST POINT 5.
2. Open the Cross shutter dial to a size larger than the film size. The voltmeter should read a logic HIGH. If not, measure voltage at TP1 (and record) then measure voltage at TP3 (and record).
3. When voltage at TP3 is greater than the voltage at TP1, TP5 should be HIGH; when the voltage at TP3 is less than OR equal to the voltage at TP1 the output TP5 should be LOW.
4. If the voltage relations in STEP 3 are NOT obtained, replace the comparator - U14.
5. If voltages on the input of U14 (TP3, TP1) are not present:
   - Check calibration of the tray for voltages at TP1 or
   - calibration of the SID for the voltage at TP2.
6. If voltages in STEP 3 are obtained proceed backwards thru the LOGIC CHART until the problem is found.

Problem
System will recycle when same size film is used and shutters are collimated to within the window tolerance (approximately 1% of the SID).
Conditions
Collimator: beam vertical, cassette inserted into table tray; and collimator shutters are manually set to within the film size within 1% of the SID, e.g. ± 0.4 @ 40"; and both cross and long READY lamps LIGHT.
Procedure
1. Connect digital voltmeter: negative to GND test point and positive to U4 pin 10.
2. A logic LOW should be present. If a HIGH is obtained, measure output of U13 and U15 pin 7 for a LOW. If either comparator is HIGH, measure comparator inputs (pins 2 and 3) and record.
3. If the voltage at pin 2 is greater than pin 3 then the voltage at pin 7 should be HIGH or when pin 2 is less than or equal to pin 3 then the output voltage at pin 7 should be LOW.
4. If the input voltages are correct and output voltages are NOT correct replace the comparator.

NOTE

To facilitate proper operation of RESET feature, cassettes should be accurately centered in the cassette tray.

5-5 INPUT SIGNALS CHECKOUT

P30-20 (Ground)	P30-11	+ 13 volts (collimator ± 10° from vertical)
P30-20	P30-12	+ 13 volts (collimator 80° to 90° Beam Right
P30-20	P30-13	+ 13 volts (collimator 80° to 90° Beam left
P30-20	P30-9 (TP-11)	6.6 volts @ 40" SID, 11.5 volts @ 72" SID
P30-20	P30-10 (TP-6)	5.9 volts @ 40" SID 10.4 volts @ 72" SID
P30-20	P30-16	see Table 3-0
P30-20	P30-14	see Table 3-0
P30-20	P30-15 (TP-12)	.04 volts

TABLE CASSETTE TRAY CHECKOUT

P3-3 (GND)	P3-1	+ 15 volts
P3-3	P3-A	variable (see Table 3-1)
P3-3	P3-B	variable (see Table 3-1)
P3-3	P3-2	0 volts
P3-3	P3-C	+ 15 volts (cassette IN), 0 volts (cassette OUT)

UPRIGHT CASSETTE TRAY CHECKOUT

P2-5 (GND)	P2-6	+ 15 volts
P2-5	P2-1	variable (see Table 3-1)
P2-5	P2-2	variable (see Table 3-1)
P2-5	P2-3	0 volts
P2-5	P2-4	+ 15 volts (cassette IN), 0 volts (cassette OUT)

5-6 POWER SUPPLY TROUBLESHOOTING

The voltage regulator circuit contains current-limiting protection, therefore, a short circuit on the 15-volt distribution circuit will automatically drop the output voltage to a low value or to zero volts in order to protect the regulator from burn-out.

The following sequence provides correct troubleshooting of the power supply in the event of a short circuit or overload.

Symptom: 15 volt and 13.2 volt lines measure 0 to 5 volts

1. If the 15 volt regulator (VR1) heat sink is cool, check the 3.0 Amp line fuses (F3 and F4) on the end panel and the 0.75 Amp fuses (F1 and F2) inside the logic unit.
2. If 18.0 VAC is present at the output side of F1 and F2, measure across C6 or C5; the value should be approximately 24.5 VDC. If this is not so, VR1 should be replaced.
3. If the heat sink of VR1 is hot, VR1 is probably in a current-limiting condition, indicating a short-circuit on the load side.
4. Disconnect all loads in turn, starting with the SID switches, the tray wiring, and the collimator. If the voltage returns, the last load removed is the cause.
5. In order to verify the cause of the short, the most expedient measure is to lightly touch each transistor or chip supplied by the 15 VDC source, being careful to keep one's hands away from any high voltage present in the chassis. Once the most likely cause of the short is located, conventional troubleshooting with an ohmmeter should be commenced after removing all AC power from the unit.

5-7 TROUBLESHOOTING THE TIMER CIRCUIT

Due to line losses, power supply regulation, and triac voltage drop (1 volt), the voltage measured at the lamp socket (with lamp ON) must be 20-24 VAC true rms.

1. Remove the gate lead from G on the circuit board.
2. Apply power; the lamp must remain OFF. If it remains ON, and all wiring is OK, replace the triac. (Refer to DISASSEMBLY diagram.)
3. Measure the voltage across R1, it must be from 6 to 8 volts, indicating that all normal loads are OK.
   If the voltage exceeds 8 volts, U1 is probably internally shorted (continue testing).
4. Measure the voltage across C2; it must be 9.25 to 10.8 volts.
   If the voltage is less than 9.25 volts, a short circuited component is again indicated, confirming step 3 (continue testing).
5. Measure the voltage across R3; it must be from 3.5 to 5 volts (between timing intervals).
   If the voltage is more than 5 volts, K1 coil or D4 (CR3) is the shorted component.
   If the voltage is less than 3.5 volts and if the voltage in step 3 is more than 8 volts, replace M1.
6. If steps 3, 4 and 5 are OK, measure the voltage across R2 by connecting a voltmeter from C2 (+) and C3 (+). Prior to a timing interval, the voltage will read about 8 to 9.5 volts.
   Activate the time-start switch; ensure that the switch is indeed operating by reading across R4; 9.25 to 10.8V = switch closed.

During the timed interval, the reading across R2 will slowly drop to about 3.5 and snap back to its former value of 8 to 9.5 volts. With a 10 megohm meter the time will be (1.7 RC).

If the reading starts dropping but stops at some mid-value and holds, capacitor C3 is leaking and can either be replaced or exchanged with C2.

If the voltage does drop slowly to about 3.5 and snaps back to its former value, all timing circuits have now been checked as OK.

7. Finally, check the triac turn-on as follows:
   - First connect ohmmeter from G to T2 on the circuit board; it must indicate an open circuit prior to a timing interval, and 100 ohms during a timing interval. If not, replace K1 (or R5);
   - Second, use a 100 ohm test resistor and momentarily contact the gate lead (which must be attached to the triac) to T2 on the triac or T2 on the circuit board. During the resistor contact, the lamp must be on. If the lamp does not turn on, replace the triac. (Refer to LAMP TIMER WIRING).

CAUTION

DO NOT DIRECTLY CONTACT THE GATE LEAD TO T2. THIS COULD DAMAGE THE TRIAC.

8. Reconnect the gate lead to G on the circuit board.

5-8 SYSTEM EXPECTED USEFUL LIFE AND MAINTENANCE

Periodic preventive maintenance including collimator and tray lubrication, cleaning, electrical and mechanical adjustments are to be performed once every twelve months or 10,000 films when the collimator is readjusted, whichever occurs first, unless otherwise specified. The periodic maintenance schedule is required to maintain the collimator system in proper and accurate condition throughout the system's useful life and to extend the useful life of the system.

The minimum useful life with periodic maintenance of the PBL-II system including the collimator and electronic module is five years or 50,000 films or collimator readjusting cycles. With the specified preventive and corrective maintenance, the collimator and logic module should last beyond the specified minimum life. Corrective maintenance consists of repair or replacement of randomly failed components as soon as a failure is detected and assuring that the collimator exit window mirror and projection lamp are properly maintained and/or replaced when required.

The standard tray should last through the minimum specified lifetime of the system contingent on reasonable and careful usage.

5-9 COLLIMATOR CHECKOUT, LUBRICATION AND CLEANING

Perform the following collimator lubrication and mechanical inspection every twelve months or 10,000 films (when the collimator is readjusted), whichever occurs first. This procedure requires the removal of the collimator body cover, inspection of all moving parts, lubrication of all friction points, and careful assembly and cleaning of all critical components. The collimator rear cover and body cover must be removed. Refer to DISASSEMBLY.

5-10 MECHANICAL INSPECTION AND SERVICE

Inspect all front drive gears (behind the front panel) for correct mesh while cycling the collimator through its maximum range. There should be no significant slack between the meshed gear teeth where the backlash springs are not used. Check the right-angle bevel gears on the cross shutter drive shaft (above the left shutter control knob). If the beveled gear pair or the two large spur gear pairs are not meshed properly the front panel will have to be removed. This is accomplished by removing the two dial knobs, two front panel screws and two small top front cover screws.

CAUTION

Support the front panel with a length of cord or wire; DO NOT ALLOW IT TO HANG BY THE ELECTRICAL WIRES.

If the spur gear pair(s) is (are) loose, the idler (middle gear) can be adjusted for a better mesh by slightly loosening the idler gear lock nut on the reverse side of the front drive bracket and pushing the idler gear into better mesh with the large shutter shaft gear (upper) and the lower dial knob pinion gear. Retighten lock nut firmly after adjusting the gears just enough to allow smooth, even mesh. Relubricate as required. Refer to COLLIMATOR LUBRICATION.

If the bevel gears on the cross shutter drive shaft are not correctly meshed, loosen the set screw on the inside collar on the shaft and, if necessary, loosen the set screw on the large shutter shaft gear. Push on the outer end of the shaft while holding the collar forward against the brass bushing and tighten the collar set screw. Tighten the large shutter shaft gear and test for smooth, even operation.

If the gears inside the collimator chassis are not correctly meshed, or if the shutters or shutter control arms are loose, the collimator must be returned to the factory for corrective repair and a complete mechanical re-alignment.

NOTE

Whenever the collimator gearing is adjusted, the collimator potentiometer calibration must be repeated. Anytime the front panel is removed and/or the collimator gearing is adjusted, the dial accuracy check must be repeated. Refer to COLLIMATOR POTENTIOMETER CHECKOUT AND ADJUSTMENT, and SHUTTER DIAL ADJUSTMENT.

5-11 COLLIMATOR LUBRICATION

Apply a small amount of grease (Lubriplate 630-AA or equivalent) to the meshed teeth of all collimator gears. Wipe off all excess grease after cycling the collimator a few times.

NOTE

Protect the mirror, do not allow grease to contact the reflective surface.

Apply one drop of a medium weight, #20, oil (do not use lightweight household oils) to all shafts and gear pivots at the points of friction. Wipe off all excess oil after cycling the collimator a few times.

NOTE

Protect the mirror, do not allow oil to contact the reflective surface.

Inspect the remainder of the collimator for loose or missing parts and the wires for damaged insulation.

5-12 COLLIMATOR CLEANING

The cleaning functions detailed below are necessary to maintain the collimator within required specifications for light output and edge contrast.

After completing the collimator checkout and lubrication, check the mirror for dust and grease. Clean the mirror only with surgical cotton and alcohol. Be sure that all oily or dirty film is washed free from the mirror.

Clean the plastic window inside and out with a soft damp cloth and any common mild glass cleaner. Wipe away any dirt residue or film with a slightly dampened lens paper or tissue. Ascertain that the inside of the window is clean before assembling the collimator body cover onto the collimator.

5-13 PARTS REPLACEMENT

If the mirror or plastic exit window are cracked, broken, or damaged (stained) they should be replaced immediately. Refer to PERIODIC RECALIBRATION.

If the projection lamp has not been replaced during the past 12 months or after 10,000 exposures have been made, it is recommended that it be replaced during the periodic maintenance procedure.

5-14 TRAY LUBRICATION AND MAINTENANCE

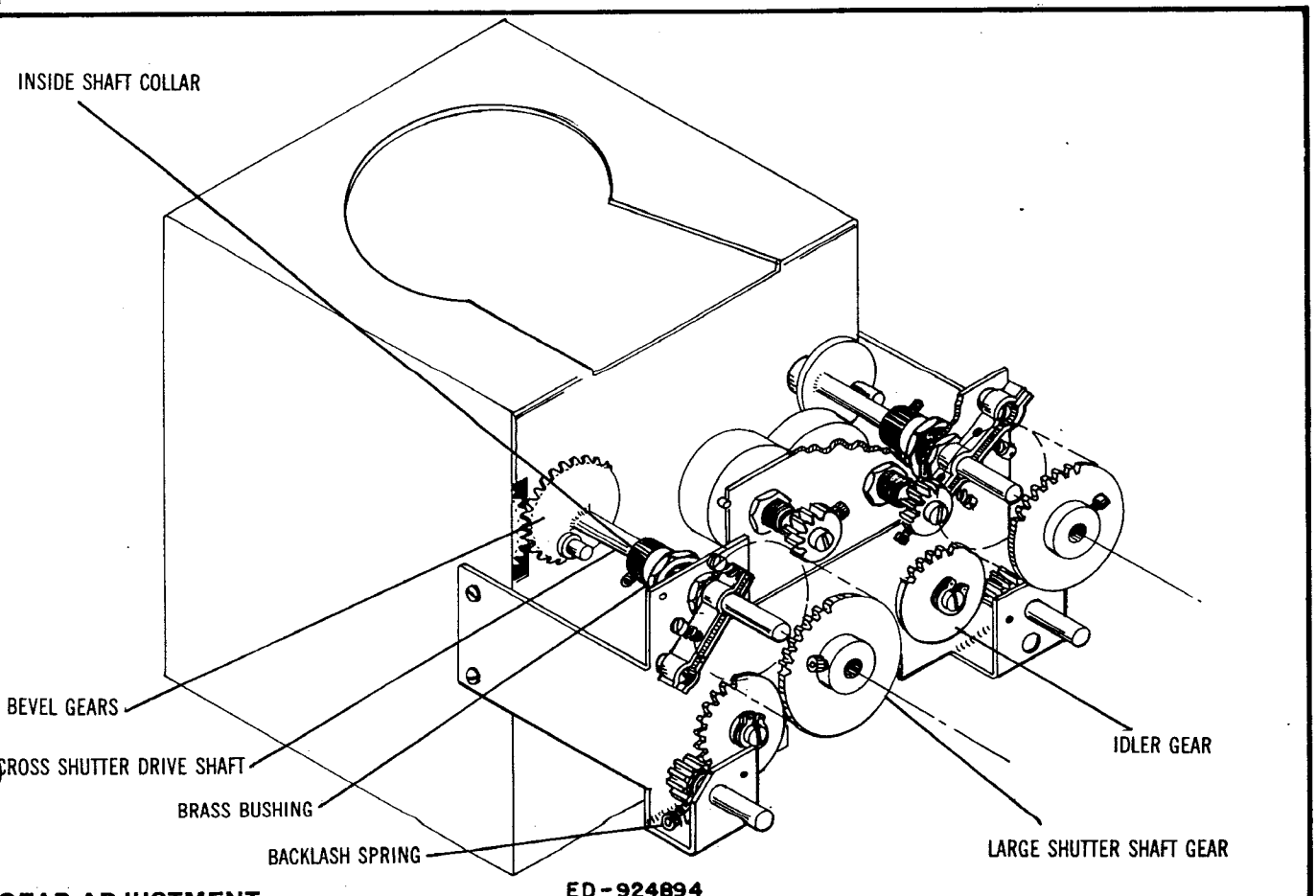
The lubrication schedule listed in the cassette tray operating and service instruction booklet must be followed. Every 10,000 films the tray connector is to be lubricated as described with the proper lubricant. Perform other cleaning and adjusting operations as also prescribed. Refer to TABLE CASSETTE TRAY SIZE/VOLTAGE ACCURACY CHECKOUT procedure if cassette tray calibration is to be checked or if faulty tray operation is suspected.

5-15 PERIODIC RECALIBRATION

Perform the following alignment procedures: SHUTTER DIAL ADJUSTMENT, LIGHT FIELD TO X-RAY FIELD COINCIDENCE, CROSS-HAIR TO LIGHT FIELD CENTER ALIGNMENT, BUCKY LIGHT-LINE ALIGNMENT, and ACCURACY CHECKOUT once every twelve months or 10,000 films (whichever occurs first), or any time the collimator is removed from the x-ray tube (even if reinstalled on the same housing).

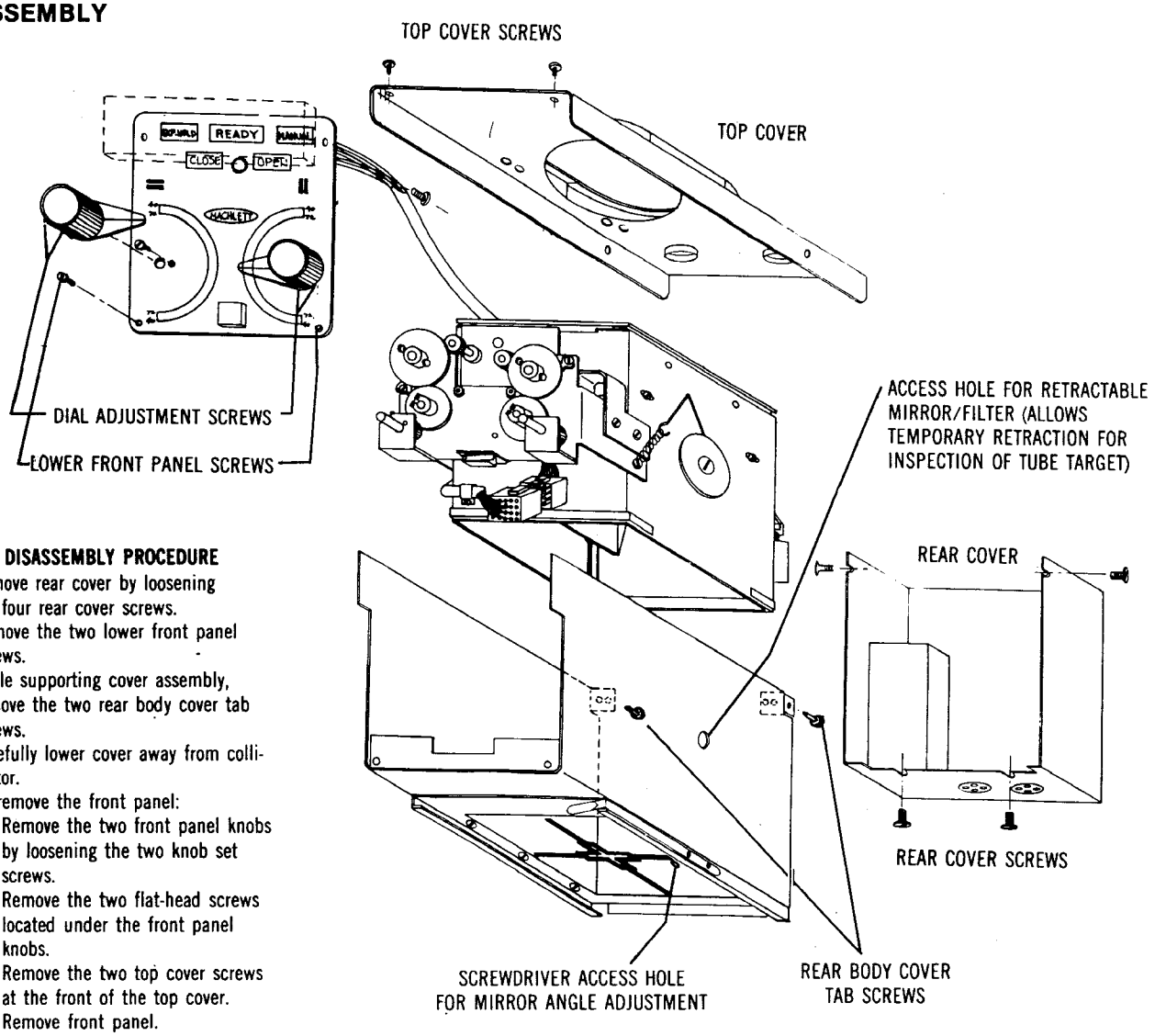
If the accuracy checkout procedure indicates that the system be recalibrated, perform all necessary calibration steps, including tray calibration if this is suspected. Refer to TABLE CASSETTE TRAY SIZE/VOLTAGE ACCURACY CHECKOUT.

If, during replacement of the projection lamp, the lamp is placed correctly in the lamp socket as described in LIGHT FIELD TO X-RAY FIELD COINCIDENCE, and if the old lamp was correctly placed in the socket, the light field may not require readjustment. Refer to LIGHT FIELD TO X-RAY FIELD ALIGNMENT, CROSS-HAIR TO LIGHT FIELD CENTER ALIGNMENT, and BUCKY LIGHT-LINE ALIGNMENT.



GEAR ADJUSTMENT

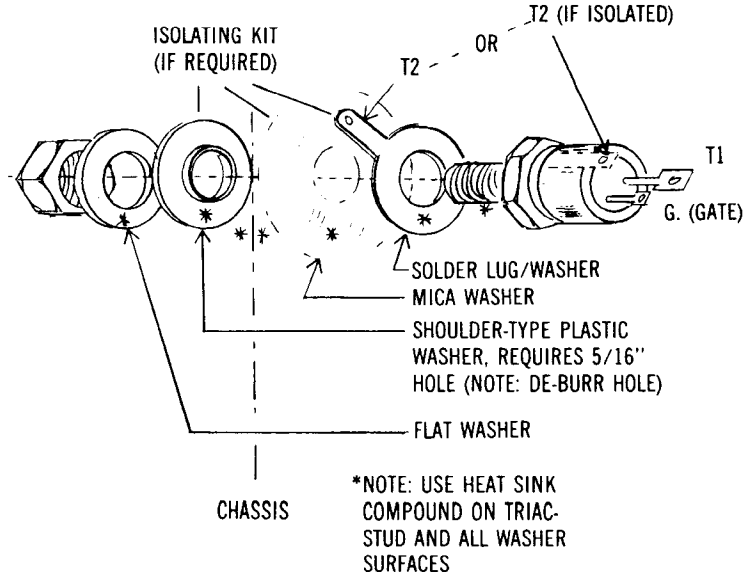
DISASSEMBLY



DISASSEMBLY PROCEDURE

- Remove rear cover by loosening the four rear cover screws.
- Remove the two lower front panel screws.
- While supporting cover assembly, remove the two rear body cover tab screws.
- Carefully lower cover away from collimator.
- To remove the front panel:
  1. Remove the two front panel knobs by loosening the two knob set screws.
  2. Remove the two flat-head screws located under the front panel knobs.
  3. Remove the two top cover screws at the front of the top cover.
  4. Remove front panel.

TRIAC REPLACEMENT



COLLIMATOR FUNCTION CHECK LIST

All steps on this checklist must be performed by the assembler upon installation and/or x-ray tube change. Items marked with an asterisk (*) must be performed at required intervals (Ref. TM ST-3620, PBL-II 150 semi-automatic collimating system).

These functions must be verified prior to verifying compliance with 21 CFR, Sub-Chapter J, Part 1020, Performance Standards.

Location _____ ASSEMBLER _____

Function	Acceptance Requirement	Reference Manual	Initials	Date
Mechanical Security*	check for damaged and loose fasteners, missing parts, etc.	para. 2-1, -4, -5, -6, -7.		
* Generator must be locked out with mirror/filter OUT above 50 kVp. With System Failure Override Keyswitch engaged, exposures are inhibited. (50/150 versions only).	exposures prevented when KV higher than 50 with filter OUT.	SEE SEPARATE PKV INTERLOCK MANUAL ST-2882-5.		
Check that actual SID* settings are correct, and check SID switch actuation for reliability, repeatability, and ease of setting by operator.	"ON" distance of ⅜"-½" and centered to actual SID to within 0.2 at 40" and 0.3 at 72".	para. 2-10		
Light field to x-ray* field alignment	within 2% SID	para. 3-12		
Bucky Light Line* alignment	within ± 1% SID	para. 3-15		
X-ray field to image receptor alignment* for table tray and wall tray or cassette holder	within 2% SID	para. 3-16		
Shutter Dial accuracy test and alignment*	length/width Tolerance 10" 0.25 5" 0.80 17" 0.80	para. 3-13 3-16		
PBL operation and return to PBL mode*	exposure hold when not at SID, exposure hold until dials adjusted. Exposure hold upon cassette change until dials adjusted if reset lamp is on.	"Operation" page 3.		
Accuracy Test* A. Vertical SID size B. Field size proportionality C. Horizontal SID field size	All sizes within 2% SID	para. 3-16		

Function	Acceptance Requirement	Reference Manual	Initials	Date
Table cassette tray: VIR size signals	within ± 0.3 VDC	para. 3-7, Table 3-1		
Cassette size restrictions	all sizes from 5" to 17"	para. 2-7		
Cassette presence indication	with x-ray beam axis perpendicular to table, when cassette is removed from tray MANUAL light will go "on". When cassette is inserted into tray, MANUAL light will go "out" and Exposure Hold light will come "on".			
Wall cassette holder: VIR size signals	within ± 0.3 VDC	para. 3-6 Table 3-1.		
Cassette size restrictions	all sizes 5" to 17", unless restricted by tray construction.	para. 3-6.		
cassette presence indication	check for logic low at U8, pin 5. with x-ray beam axis perpendicular to wall, follow procedure described above.	para. 3-6 Table 5-3.		
Focal spot-to-collimator spacing	3.00" −0 + ⅛	page 3		
Exposure and equipment Interlocks wiring	must inhibit exposures in Exposure Hold mode	para. 2-7, 2-11.		
X-ray field base voltage check	within ± .01 VDC	para. 3-1, 3-2		
Calibration of 40" VSID Voltage	within ± .02 VDC or as finally calibrated in subsequent tests.	para. 3-3		
Calibration of Horizontal Discrete SID Voltages	within ± .02 VDC	para. 3-4		
Collimator Lamp Voltage	21-24 VAC	para. 2-6		

SYSTEM COMPLIANCE CHECKLIST

It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, of the Performance Standards.

For each compliance item there may be a variety of test methods described. Which method is used will depend on the tester's experience, availability of equipment, time, or requirements of the collimating system. Any references to tolerances on compliance items are referenced directly from the performance standards. They do not take into account inaccuracies brought about by the test equipment, instrumentation, or the human element. These factors must be considered when these tests are performed.

This checklist is to be used by the assembler to assure that all points of compliance are covered. A regular schedule of compliance testing, along with a schedule of functional testing (as detailed in the separate "COLLIMATOR FUNCTION CHECKLIST" should be established as part of a routine quality control monitoring and maintenance program.

LOCATION _____ ASSEMBLER _____

REQUIREMENTS	APPLICABLE PARAGRAPH			COMPLIANCE VERIFIED			
	21 CFR 1020	MANUAL	NEMA*	DATE	INITIALS	DATE	INITIALS
Beam Quality, (Half-value layer-HVL)	.30(m)	Specification Pg. 3	2.09				
Exposure Lockout with Variable Filtration	.30(m)	change notice 9-5-84	2.10				
Actual vs. Indicated SID	.31(e)(1)		2.13				
Visual Definition of X-ray Field Size	.31(d)(2)	16-14 Pg. 12	2.14				
Intensity of Light Field Illumination	.31(d)(2)(ii)	2-6 Pg. 5	2.15				
Minimum Field Size	.31(d)(1)	Specification Pg. 2	2.16				
X-ray Field/Receptor Center Alignment	.31(e)(1)	3-16 Pg. 14	2.17				
Indication of X-ray Field Size	.31(e)(1)	3-16 Pg. 15	2.18				
Positive Beam Limitation (PBL)	.31(e)(2)	Operation (foldout)	2.19				
X-ray Field Limitation and Alignment	.31(e)(2)(ii)	3-16 Pg. 14	2.20				
Return to PBL with Image Receptor Change	.31(e)(2)(iii)		2.21				
Key Lock PBL Override	.31(e)(2)(v)		2.22				

*NEMA Standards Publication No. XR 8-1979

Changed 4/1/85

PARTS LIST

This manual, ST-3620, covers the PBL-II 150 collimator starting with serial No. 14-05-0-2000 and all subsequent units.

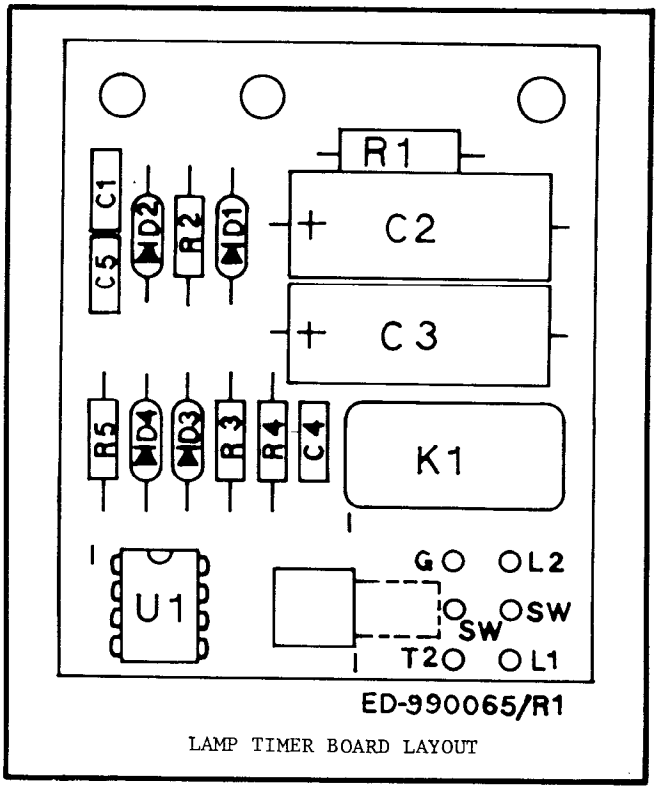
REF DES	MACHLETT PART #	DESCRIPTION
	LOGIC UNIT ASSEMBLY	
	D-992007	Logic Unit (Complete)
	F-991997	Cover, Logic Unit
	P-992069	Transformer, power
	P-750133	Fuseholder, dual
F1,F2	P-754659-18	Fuse, 3AG, .75 Amp, 125 V
	P-753689	Fuse retainer (2)
F3,F4	P-754659-30	Fuse, MDX, S.B. 3 Amp, 250 V
	P-921729	Keyswitch, rotary
	P-754564	Triac, 30 Amp
	AA-992020	Harness, main, with P30 plug and Cable #30
Cable #30	AA-992011	Cable, 30-Conductor
Cable #31	A-924738	Cable, 6-Conductor
Cable #32	A-924739	Cable, 2-Conductor
Cable #33	A-924740	Cable, 4-Conductor
P2 Harness	A-924741	Cable, 6-Conductor
P1 Harness	A-924743	Cable, 4-Conductor
Cable #1	A-924745	Cable, 3-Conductor
Cable #4	A-924747	Cable, 3-Conductor
	*LOGIC BOARD ASSEMBLY	
	D-991062	Logic board, tested
C1,C8,C11-C24	P-754529-12	Capacitor, 0.1 uF, 100 V
C2	P-754528-5	Capacitor, 50 uF, 25 V
C3,C4	P-754529-9	Capacitor, .01 uF, 100 V
C5	P-754529-21	Capacitor, 0.33 uF, 50 V
C6	P-754528-10	Capacitor, 500 uF, 50 V
C10	P-754528-2	Capacitor, 10 uF, 50 V
CR1-CR5	P-754506-4	Diode, 1N4004
CR6,CR7	Not Used	
CR8	P-754510-2	Rectifier, bridge, SBMB1
K1,K2	P-754770-2	Relay, 12 V, 2-PDT
Q1-Q7, Q19,Q20	P-754590	Transistor, MPSA12
Q8-Q18	P-754509-1	Transistor, 2N2222A
R1-R7 R14-R18, R21,R29-R38, R54,R55, R68,R69	P-754500-44	Resistor, 10 K, 1/4 W, 10%
R9, R10, R28,R45	P-754500-32	Resistor, 1 K, 1/4 W, 10%
R11,R19, R22,R23	P-754533-84	Resistor, 7.5 K, 1/4 W, 10%
R12,R13	P-754500-36	Resistor, 2.2 K, 1/4 W, 10%
R20,R24, R25,R67	P-754534-81	Resistor, 22 M, 1/4 W, 5%

*For logic board layout see Electronic Adjustments.

REF DES	MACHLETT PART #	DESCRIPTION
R26	Not Used	
R27	P-754500-40	Resistor, 4.7K, 1/4 W, 10%
R39,R40	P-754500-56	Resistor, 100 K, 1/4 W, 10%
R41,R42 R61,R62	P-754807-8	Resistor, 100 K, 1/4 W, 0.5%
R43,R44, R59,R60	P-754807-4	Resistor, 16.2 K, 1/4 W, 0.5%
R46,R47	P-754500-49	Resistor, 27 K, 1/4 W, 10%
R48,R49, R64,R65	P-754533-58	Resistor, 620 Ohm, 1/4 W, 5%
R50	P-754605-2	Potentiometer, trimmer, 10 ohm, 10-turn
R50 (Alt.)	P-754580-1	Potentiometer, trimmer, 10 ohm, 3-turn
R51	P-754605-6	Potentiometer, trimmer, 200 ohm, 10-turn
R51 (Alt.)	P-754580-5	Potentiometer, trimmer, 200 ohm, 3-turn
R52	P-754605-11	Potentiometer, trimmer, 20 K, 10-turn
R52 (Alt.)	P-754580-11	Potentiometer, trimmer, 20 K, 3-turn
R53	P-754605-1	Potentiometer, trimmer, 10 K, 10-turn
R53 (Alt.)	P-754580-10	Potentiometer, trimmer, 10 K, 3-turn
R56,R57	P-754807-10	Resistor, 243 K, 1/4 W, 0.5%
R58,R66	P-754807-11	Resistor, 270 K, 1/4 W, 0.5%
R63	P-754533-60	Resistor, 750 ohm, 1/4 W, 5%
U1-U3	P-754545-14	Quad 2-input AND gate, 4081
U4	P-754545-13	Quad 2-input OR gate, 4071
U5	P-754545-2	Quad 2-input NAND gate, 4011
U6	P-754545-1	Quad 2-input NOR gate, 4001
U7	P-754545-16	Hex inverter, 4069
U8	P-754545-12	Quad 2-input multiplexer, 4019
U9	P-754545-19	Hex inverter Schmitt trigger, 4014
U10	P-754545-15	Dual retriggerable monostable multivibrator, 4528
U11	P-754545-9	Dual "D" flip-flop, 4013
U12-U15	P-754579-2	Voltage comparator, LM-311
VR1	P-754569-5	Voltage regulator, LM-340K-15

REF DES	MACHLETT PART #	DESCRIPTION
		LAMP TIMER ASSEMBLY
	F-543726	Lamp timer board, tested
C1,C4	P-754529-12	Capacitor, 0.1 uF, 100 V, ± 10%
C2,C3	P-750107	Capacitor, 150 uF, 15 V
C5	P-754529-9	Capacitor, .01 uF, 100 V, ± 10%
D1,D3 D4	P-754506-4	Diode 1N4004
D2	P-754567-20	Diode, Zener, 1N5240B, 10 V
K1	P-754578-2	Relay, Dry Reed
R1	P-754535-49	Resistor, 270 ohm, 0.50 W, 5%
R2	P-754534-25	Resistor, 100 K ohm, 0.25 W, 5%
R3	P-754533-49	Resistor, 270 ohm, 0.25 W, 5%
R4	P-754534-1	Resistor, 10 K ohm, 0.25 W, 5%
R5	P-754533-39	Resistor, 100 ohm, 0.25 W, 5%
U1	P-754514	IC NE555 V Timer
		COLLIMATOR
	C-924792	Head assembly, (PBL-II 150) adjustable mount
	C-924793	Head assembly, (PBL-II 150) swivel mount
	C-924797	Head assembly, (PBL-II 150-LF) adjustable mount
	C-924798	Head assembly, (PBL-II 150-LF) swivel mount
	AA-924802	Inner ring assembly, adjustable mount
	AA-924813	Inner ring assembly, swivel mount
	AA-924803	Outer ring assembly, adjustable mount
	AA-924814	Outer ring assembly, swivel mount
	P-924250	Plastic window
	P-924249	Frame, window
	P-921862	Rails, extension
	P-924248	Adapter, locking spring
	F-924809	Panel,front (rayproofed)
	P-544385-1	Lamp, red,"Exposure Hold"
	P-544385-2	Lamp, amber, "Manual"
	P-544384	Lamp, green, "Ready"
	P-752601-1	Lamp, white, "Open"
	P-752601-2	Lamp, white, "Close"
	P-754731-1	"Light" switch
	P-754731-3	Lens, "Light" switch
	P-754682-1	LED, red
	P-924202	Cover, lamp display
	A-543703	Knob, dial assembly(2)
	C-924419	Cover, rear
	AA-924819	Harness, wiring and plug
	P-751743	Switch, tilt
	P-541814-2	Potentiometer, 1,000 ohm, (2)
	A-544343	Mirror/filter switch assembly
	P-543715	Lamp, projection, Norelco type FCS
	P-543746	Base, Lamp, GE type QCS

	MACHLETT PART #	DESCRIPTION
		MISCELLANEOUS
	B-543700	Kit, mounting (with spacers)
	P-539200	Spacer, 1/4 - inch
	P-540202	Spacer, 1/16 - inch
	P-924487	Tray, Cassette, Liebel-Flarsheim (Economy)
	P-751638	Tray, Cassette, Liebel-Flarsheim (Heavy-Duty)*
	P-544393	Kit, Installation, Bucky (for above trays)
	A-990148	Tray, Cassette, 14 x 36, Midwest (Economy)*
	A-990147	Tray, Cassette, 14 x 36, Midwest (Heavy Duty)*
	A-990097	Kit, Installation, Bucky (for above trays) *
	F-750036	Tape, Measuring *
		Optional



LAMP TIMER BOARD LAYOUT

Machlett

A **Raytheon** Company

CHANGE NOTICE

February 4, 1985

Refer to PARTS LIST, Logic Board Assembly

The following components have been changed:

For systems manufactured in January, 1984 and all subsequent (identified by system serial numbers starting with 14-01-4-5625 on the collimator head):

REF DES	MACHLETT PART#	DESCRIPTION
C2	P-754528-5	capacitor, 50 uF.,
	has been changed to:	
C2	P-754555-5	capacitor, 1.0 uF.
R47	P-754500-49	resistor, 27K, 1/4 W., 10%
	has been changed to:	
R47	P-754576-17	resistor, 499K, 1/4 W., 1%

For systems manufactured in February, 1985 and all subsequent (identified by system serial numbers starting with 14-02-5-0001 on the collimator head):

U10	P-754545-15	dual retriggerable monostable multivibrator, 4528
	has been changed to:	
U10	P-754545-31	dual retriggerable monostable multivibrator, 4538

For all systems, the manufacturer's part number, 40014, shown for U9, a Hex Schmitt trigger (Machlett part no. P-754549-19) should be 40106.

Add the following specifications:

Filtration interlock (PKV Interlock module, PBL-II 50/150 only)	
filter in:	PKV interlock bypassed (normal PBL)
filter out:	PKV interlock prevents exposures at 50 kVp and above
Interlock circuit:	isolated form C contacts rated at 2 amps @ 120 VAC (resistive load)
Proportioning kVp signal (from generator):	can accept any one of 5 voltage ranges (AC or DC) from a minimum of 0.1 to a maximum of 120 volts, adjustable setpoint corresponding to 50 kVp within each range
Power requirements for PKV interlock (from generator):	120 VAC, 50/60 Hz at less than 0.1 amp

Ref. "OPERATION" (page 9):

Add the following caption:

"IN/OUT mirror/filter knob (On 50/150 version) works with PKV interlock. In IN position, the projection lamp may be used, in OUT position projection lamp is blocked out.

- for 50/150 version:
  IN: exposures can be made at all kVp ranges.
  OUT: exposures can be made only below 50 kVp.

- for 150 version:
  IN: exposures can be made (normal mode).
  OUT: exposures cannot be made. (Spring-loaded to remain IN.)"

Ref. page 28, "PARTS LIST"

Change the following

FROM: "This manual (ST-3620) covers the PBL-II Collimator starting with Serial No. 14-05-0-2000 and all subsequent units".

TO: "This manual, ST-3620, covers the PBL-II with system serial numbers as noted starting with 0001 and all subsequent units. The first two digits of the serial number on the collimator are denoted by a product code number as follows:

14 PBL-II 150
25 PBL-II 50/150
15 PBL-II 150 LF

The second pair of digits and the third digit denote the date (month and year):

01 - Jan.
12 - Dec.
0 - 1980
1 - 1981
2 - 1982

For example, a complete serial number could be:

15-05-2-0623

Thus, this particular unit would be a PBL-II 150 LF manufactured in May 1982 containing a collimator head bearing Serial Number 0623.

The System Serial Number is located on the left-hand side of the collimator head.

The Logic Serial Nubmer is located on a foil strip on the front apron of the Logic Unit.

Ref. page 29 "PARTS LIST"
Add to collimator parts list:

MACHLETT PART #	DESCRIPTION
	Head assembly (PBL-II 50/150) adjustable mount
	Head assembly (PBL-II 50/150) swivel mount
P-539278	switch, lever-actuated
P-543693	knob, mirror/filter
AA-G176615	cordset, filter switch

Machlett
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CHANGE NOTICE

February 4, 1986

The externally accessible mirror/filter driver, which controls the position of the mirror/filter, has been changed with regard to the method of operation: On units manufactured prior to January 1986, a flat-bladed screwdriver is used; on units manufactured during and after January 1986, a 3/32" hex wrench is used. This new design provides a more positive means of flipping the mirror/filter into or out of the beam.

The 3/32" hex wrench included is used to change the position of the mirror/filter shaft. This same wrench can also be used to adjust the Center Adjustment Setscrews for the Non-Swivel Mount Collimator mounting ring. Refer to Section 2-2 of technical manual.

NOTE

This document must be used in conjunction with ST-3620, "TECHNICAL MANUAL - PBL-II semi-automatic collimating system". The references below are to changes required in ST-3620 due to the addition of a 50/150 version.

Ref. page 1:

Change the following

FROM: "Two versions of this collimator are available: PBL-II 150 ..., PBL-II 150 LF ...,"

TO: "Three versions of this collimator are available: PBL-II 150 ..., PBL-II 150 LF ... and ,

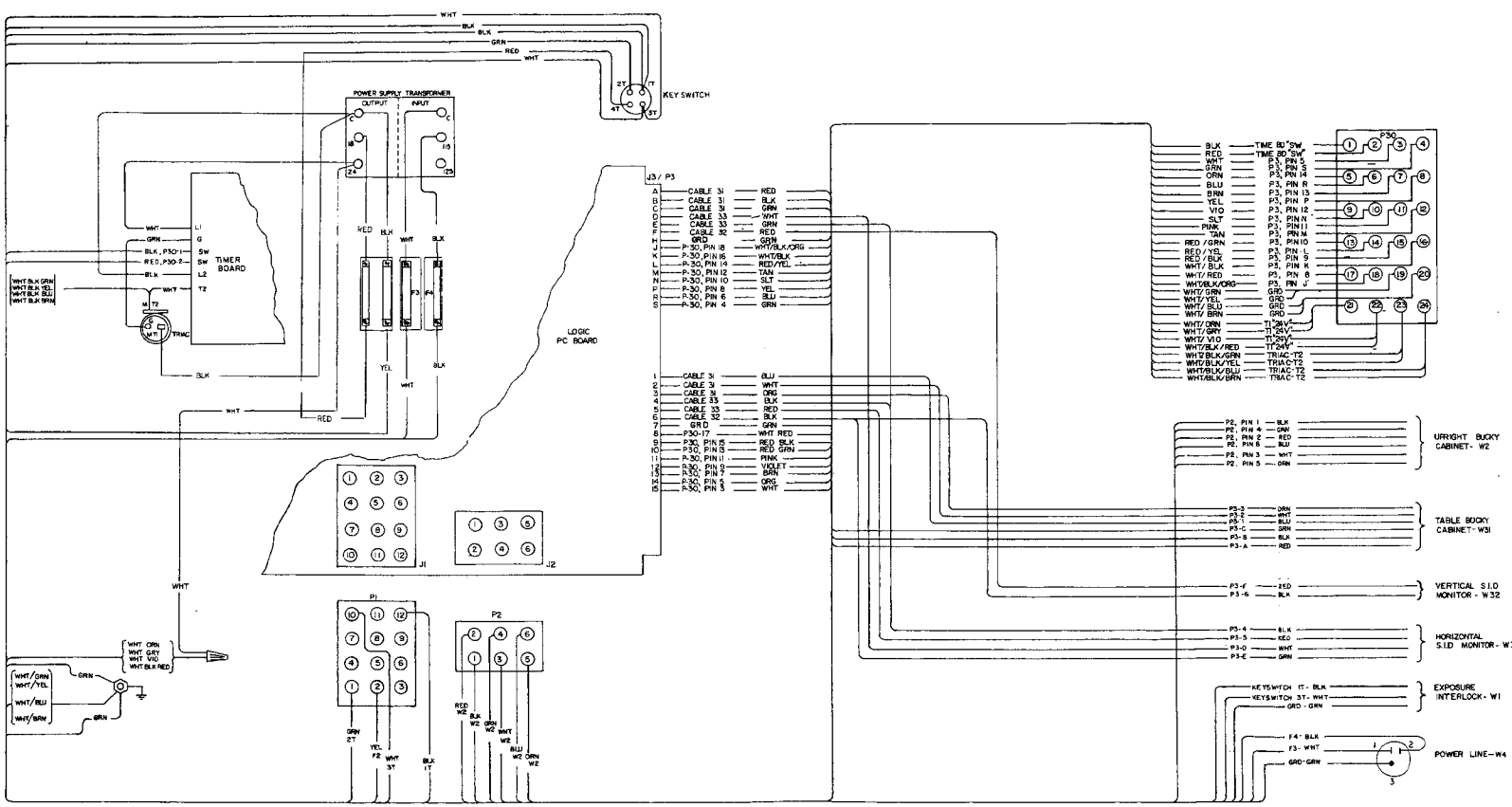
- PBL-II 50/150 - used for soft tissue studies such as mammography and other techniques through 150 kVp."

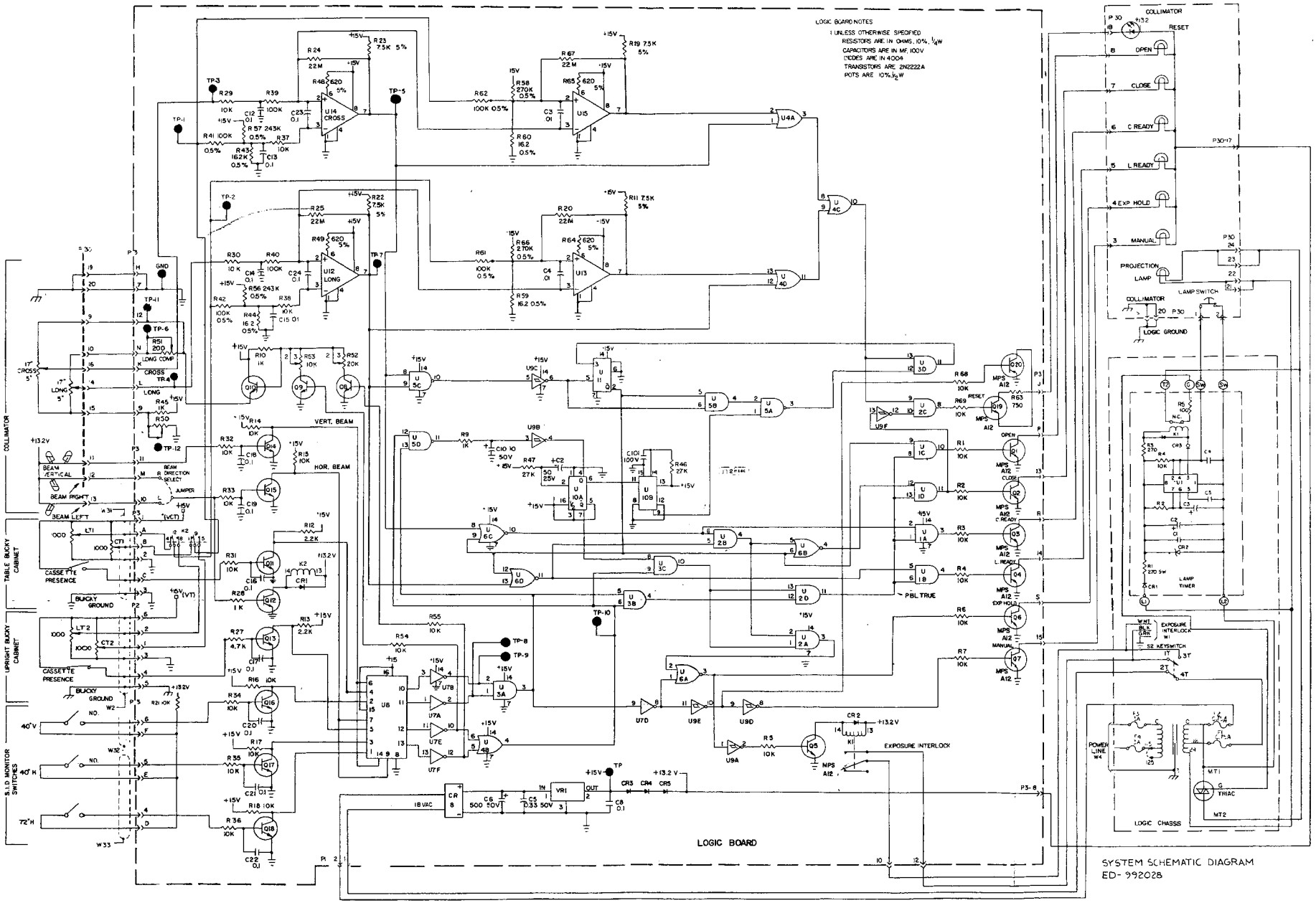
FROM: "A unique wedge-shaped filter, part of a retractable mirror/filter assembly, provides uniform filtration. To allow inspection of the x-ray tube target, this assembly can be quickly flipped out of the beam by means of a screwdriver inserted into an externally accessible slot, eliminating the necessity of disassembling or removing the collimator.

TO: "A unique wedge-shaped filter, part of a retractable mirror/filter assembly, provides uniform filtration. To allow inspection of the x-ray tube target, this mirror/filter assembly can be quickly flipped out of the beam by means of an external knob - eliminating the necessity of disassembling or removing the collimator. On the PBL-II 50/150, the mirror/filter can be removed from the x-ray beam to lower the inherent filtration for techniques under 50 kVp. A PKV interlock monitors the generator output and prevents exposures if the filter is not re-inserted at levels of 50 kVp and above."

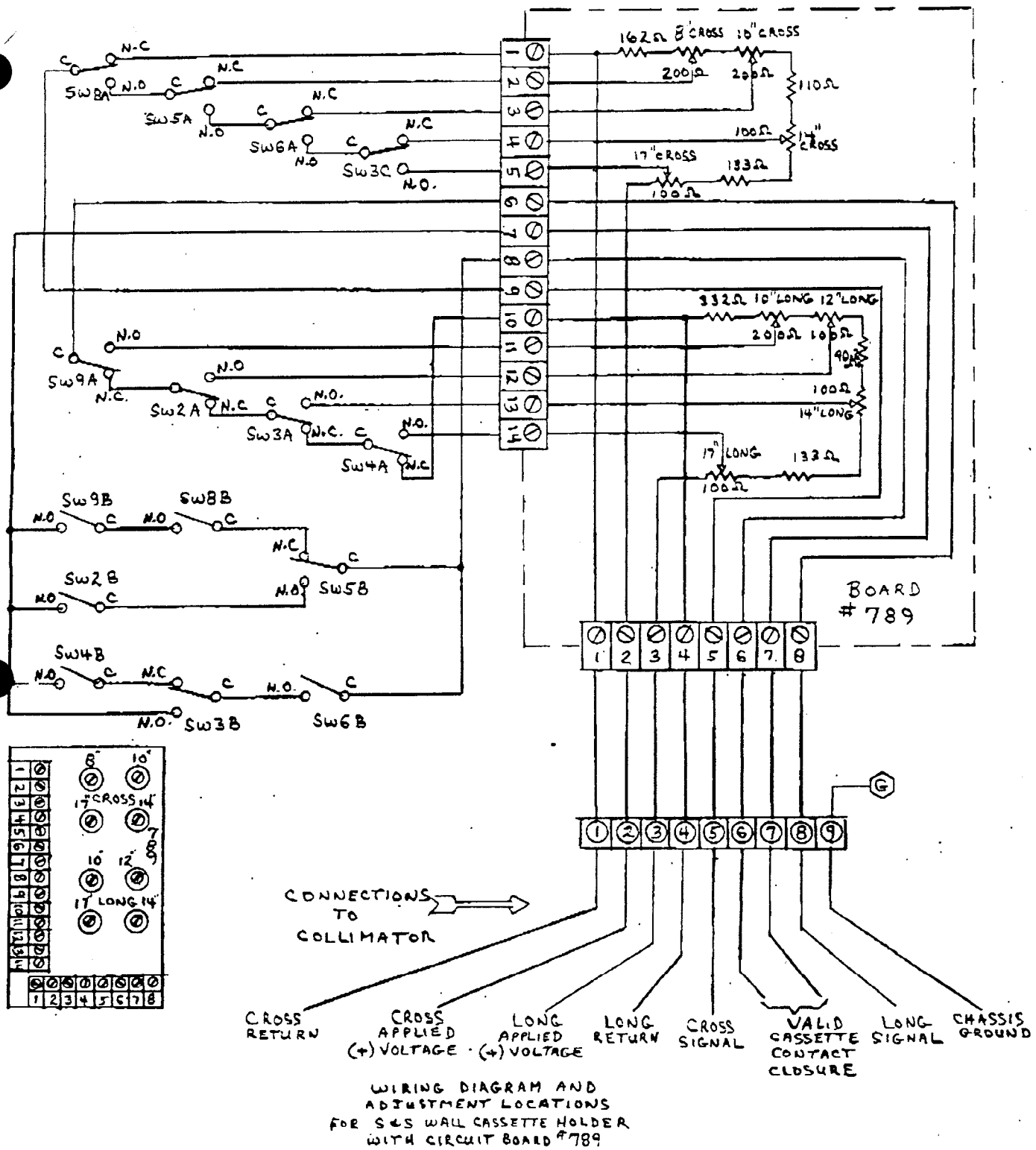
WIRING DIAGRAM PBL II-150 COLLIMATOR

ED-992340




LOGIC BOARD NOTES
1 UNLESS OTHERWISE SPECIFIED
RESISTORS ARE IN OHMS, 10%, 1/4W
CAPACITORS ARE IN MF, 100V
DIODES ARE IN 4004
TRANSISTORS ARE 2N2222A
POTS ARE 10%, 1/2 W
COLLIMATOR
RESET
OPEN
CLOSE
C READY
L READY
EXP HOLD
MANUAL
PROJECTION LAMP
LAMP SWITCH
LOGIC GROUND
LAMP TIMER
EXPOSURE INTERLOCK
KEYSWITCH
POWER LINE
TRIAC
LOGIC CHASSS
LOGIC BOARD
TABLE BUCKY CABINET
UPRIGHT BUCKY CABINET
S.I.D MONITOR SWITCHES
VERT. BEAM
HOR. BEAM
BEAM VERTICAL
BEAM RIGHT
BEAM LEFT
CASSETTE PRESENCE
BUCKY GROUND
LONG COMP
CROSS
LONG
PBL TRUE
EXPOSURE INTERLOCK
SYSTEM SCHEMATIC DIAGRAM
ED- 992028

S+S Wall Cassette Holder



WIRING DIAGRAM AND ADJUSTMENT LOCATIONS FOR S&S WALL CASSETTE HOLDER WITH CIRCUIT BOARD #789

FIG. 2

Switch 5A, 6A } Burgess MCAS-97 V24T7-GP } 3 total
A, 8B, 5B, 6B }

A, B, C = Cherry MCAS-96 - 1 total

there = Micro - MCAS-95 - 6 total