Eureka X-Ray Tube

3250 W. Carroll Avenue
Chicago, Illinois 60641

312 545 3126
FAX 312-227-3632

INSTALLATION ADVISORY

TO: INSTALLERS, SERVICE PERSONNEL, AND USERS OF X-RAY SYSTEMS

Linear Collimator Mounting Information

In order to insure a safe and secure mounting of this collimator to the x-ray tube housing, the following installation guidelines should be followed:

1. Two different lengths of screws are provided in the cloth bag containing the spacers. Determine the correct length of screw to use taking into account the collimator spacing requirements and/or peculiarities of the tube housing boss.

2. Clean the screws and housing port boss with alcohol and if necessary, remove any debris which may be present in the tube housing mounting holes.

3. Securely fasten the upper mounting ring and spacers to the collimator mounting surface. As a precaution, a medium strength thread locking compound, such as Loctite #242, should be applied to the screws before fastening the collimator mounting ring to the tube housing. The use of Nylok or vibration resistant screws is also recommended.

   Verify that the collimator mounting screws engage the housing by at least five (5) threads when used with any required collimator spacer plate(s).

4. Carefully support the collimator in place and re-attach the clamping ring. The hinge of the clamping ring must line up with the pin in the lower mounting ring. Securely fasten the 6-32 soc. HD screw holding the clamping ring.

5. After mounting the collimator and/or performing any service to it or the tube housing, inspect the fit of the collimator and tube housing. Grasp and attempt to move the collimator and then the tube housing assemby while inspecting for loose joints or gaps between the tube/collimator assembly as well as other tube mounting areas.

6. It is recommended that a periodic inspection at least every 12 months be made to insure mounting integrity.

WARNING!

Failure to adhere to the above guidelines may result in loosening, damaged screws or mount failure which could result in heavy components falling during use. Incidents of loose system components should be reported immediately to x-ray service personnel for repair.

Eureka X-Ray Tube

3250 N. Kostner Ave.
Chicago, Illinois 60641
312 545 3126
TWX 910 221 5632
FAX 312 545 2668

PLEASE READ!

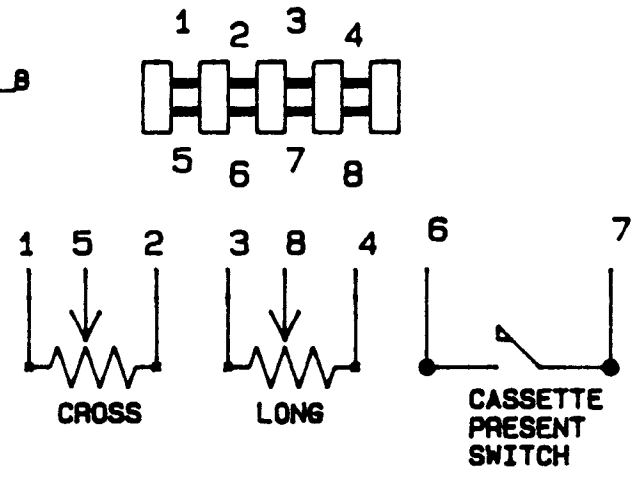
THE EUREKA COLLIMATORS HAVE BEEN 100% TESTED AND CALIBRATED AT THE FACTORY. OUR INTENTION IS THAT YOU WILL ONLY HAVE TO CONFIRM OPERATION, THEN RE-ADJUST SID VOLTAGES TO MATCH THE COLLIMATOR AND THE IMAGE RECEPTOR (CASSETTE TRAY) AFTER THE UNIT IS INSTALLED.

SECTION 3.0 OF THE MANUAL (OPERATION CHECK-OUT) WALKS YOU THROUGH THE PROGRAM USING INTERNAL GENERATED CASSETTE SIZE SIGNALS (5" AND 14"), BY SELECTING APPROPRIATE SWITCHES LOCATED ON THE LOGIC P.C.B.

THERE IS ONE FACTORY SET ADJUSTMENT THAT SHOULD NO BE ALTERED. IT IS R25 ON THE LINEAR I & II AND R29 ON THE LINEAR III. THIS POTENTIOMETER SETS THE VOLTAGE TO THE COLLIMATOR FEEDBACK POTENTIOMETERS (VCPL). THIS VOLTAGE CONTROLS THE "TRACKING" OF THE COLLIMATOR CLOSED TO OPEN AND IS EXTREMELY CRITICAL. PLEASE NOTE, IF IT REQUIRES A RE-ADJUSTMENT, YOU CAN MEASURE THIS VOLTAGE AT TP-2. THE FACTORY SET VALUE IS RECORDED ON THE SIDE OPPOSITE THE LOGIC P.C.B. R26 (LINEAR I & II) AND R30 (LINEAR III) CONTROLS THE VOLTAGE TO THE CROSS FEEDBACK POTENTIOMETER AND IS USED TO "BALANCE" CROSS TO LONG AFTER THE CORRECT X-RAY FIELD SIZE HAS BEEN SET.

WE HAVE CALIBRATED THE COLLIMATOR AROUND A CASSETTE TRAY THAT IS CALIBRATED AT 500 OHMS FOR AN 11" (12-1/8" OUTSIDE) CASSETTE. THE 11" DIMENSION RE-PRESENTS EXACTLY ONE-HALF EXCURSION OF THE 1K OHM CASSETTE TRAY POTENTIOMETER. WE SUGGEST THAT YOU CHECK, AND ADJUST, IF NECESSARY, YOUR CASSETTE TRAYS. HERE IS THE SIZE VERSUS OHMS CHART:

CASSETTE FILM/SIZE	OHMS @ PINS 1 & 5, AND 4 & 8
5"	60 OHMS
7"	207 OHMS
8"	280 OHMS
10"	427 OHMS
11"	500 OHMS
12"	573 OHMS
14"	720 OHMS
17"	940 OHMS



SHOULD YOU HAVE ANY QUESTIONS, PLEASE CALL EUREKA X-RAY FIELD APPLICATIONS AT:

FACTORY OR,

CENTRAL REGION	1-800-545-3126	312-545-3126
EASTERN REGION	1-800-426-8236	
SOUTHERN REGION	1-800-227-8645	
WESTERN REGION		714-250-3151

LINEAR II

INSTALLATION MANUAL

REVISED ISSUE 10/2/87

TABLE OF CONTENTS

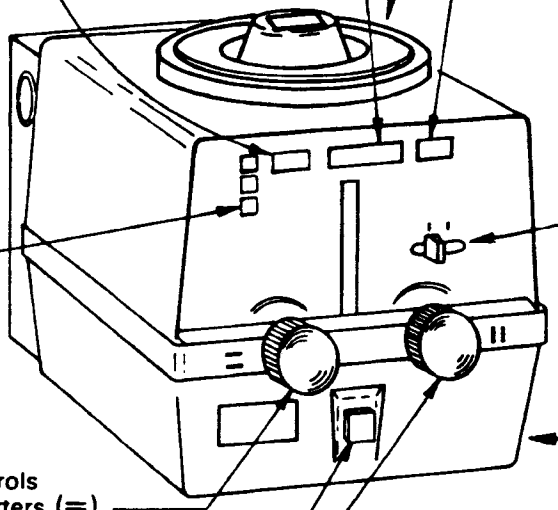
TABLE OF CONTENTS

TABLES, CHARTS, FIGURES, and ILLUSTRATIONS

SECTION 1.0

INTRODUCTION

FRONT PANEL INDICATORS & COLLIMATOR OPERATION



READY INDICATORS:
Dual lamps indicate when each shutter is properly positioned.

TEST SWITCH – Pushbutton located on rear panel. Pressing test switch applies a voltage to drive motors and **ALL** indicator lamps for "TEST".

MANUAL INDICATOR:
Indicates when:
- Collimator is tilted greater than ±10°
- Table is tilted 10° from vertical or horizontal
- Cassette is not located in cassette tray
- Cassette tray is not fully inserted
- External stereo/tomo command is supplied.

EXPOSURE HOLD INDICATOR:
Indicates when:
- Shutters are not properly positioned
- When vertical SID is not positioned at 40" SID
- When horizontal SID is not positioned at standard SID's.

40" & 72" HORIZONTAL SID INDICATORS:
Indicator lamps correspond to horizontal SID's.

HORIZONTAL SID SCALE
Position Knob:
Sliding knob positions the scale at 40" or 72" with detents. Indication representing field coverage at these SID's.

MIRROR RETRACTOR
Located next to cone track for x-ray tube inspection.

This dial controls the cross shutters (=)

Pushbutton to start timed light field display.

This dial controls the long shutters. (||)

PBL OPERATION

- Insert cassette into cassette tray
- Press "lamp" pushbutton to activate light field and bucky centering light line. Properly center bucky/cassette
- Indicators will go from MANUAL to EXP. HOLD while collimator shutters are moving, and then to READY when shutters are properly aligned.
- At this point you may reduce the x-ray field size if desired.

MANUAL OPERATION

- Press the "lamp" pushbutton to activate the light field. Adjust the shutters (both long and cross) to a size not larger than the film to be used.
- Center light field over cassette or anatomical area to be exposed.

Figure 1.1

1.0 INTRODUCTION

This manual contains information for the assembly, installation, adjustment, testing and maintenance of the LINEAR™ series of radiographic collimators manufactured by EUREKA X-RAY TUBE COMPANY.

1.1 YOU HAVE LEGAL OBLIGATIONS

The manufacturers of beam limiting devices are required to provide instructions for assembly, installation, adjustment and testing adequate to assure compliance with applicable provisions of DHHS Performance Standards 21 CFR Sub-Chapter J, Part 1020.

Those who assemble or service beam limiting devices must follow the instructions of the original manufacturer and process the FD-2579 Assemblers Report where applicable.

The responsibility for compliance of this product is assumed by failing to follow the original manufacturer's instructions or by modifying any component which affects radiation safety.

The FDA (BRH) requires that manufacturers must include a specific requirement that the assembler perform all applicable tests at the time of installation. A thorough explanation of the equipment required and step by step instructions must be provided by the manufacturer. The instructions include a requirement to record key data to demonstrate at a later time that all tests were performed and that the equipment was left in full compliance with the standards.

As an assembler, you must perform these tests for the applicable requirements at the time of installation and following any repairs which could alter the performance.

A Compliance Data Log is provided in this manual to record the results of the tests.

1.2 BACKGROUND

An x-ray collimator functions as an apparatus for regulating the cross-sectional size and shape of a beam of radiation which emerges from an x-ray tube.

The source of radiation is virtually a point-source and, due to the tube housing design, emerges from the port as a solid diverging cone of radiation. The finite angle of the anode surface limits the x-ray beam on the anode side (heel-effect) forming a "D" shaped x-ray field, limiting the useful coverage.

In "collimating" a beam to a given size and shape, a geared-pair of lead (Pb) plates (shutters) are moved symetrically into the beam to absorb the unwanted portion of the emerging beam. A second geared-pair of shutters are positioned at right angles to the first pair, and again are moved symetrically into the beam. In this manner a continuously variable square/rectangular beam is formed.

The landing area of the beam will contain a radiographic image receptor located in a plane perpendicular to the beam at pre-determined distances from the radiation source (focal spot).

The size and shape of the image receptor will determine the maximum useful cross-sectional size and shape of the beam in the plane of the image receptor. The source to image receptor distance (SID) determines the actual shutter opening required to regulate the beam size and shape in the plane of the image receptor.

"Positive" beam-limiting (PBL) devices incorporate means to prevent x-ray production until the beam limitation meets the applicable provisions of the Performance Standards.

Automatic PBL devices incorporate motors that regulate the shutter opening as required while manual PBL devices require the operator to adjust the shutters by the use of knobs, levers, etc.

The primary objective of the electronic logic circuitry is to limit the beam to the size of the image receptor and to provide other standardized operations consistent with the DHHS Performance Standards 21 CFR Sub-Chapter J. This is accomplished by electrically measuring the size of the image receptor and the distance (SID) involved. The resultant signal is then compared to a signal which represents the collimator shutter opening to form a means of limiting the beam.

The second objective is to provide convenience featues such as status indicator lights to aid and guide the operator in the use of the collimator, particularly with a manual PBL device.

1.3 LINEAR™ SERIES COLLIMATOR FEATURES

1.3.1 SERVICEABILITY:

The Linear™ series collimator logic provides a third objective not included with other similar products — serviceability. This new dimension is incorporated in a manner which allows a single positioning of the collimator above a table top for the diagnostic trouble-shooting of the logic and collimator functions. All calibrations are then done by observing the light-field projected onto a test pattern provided with each collimator.

The test pattern, in conjunction with the indicators and miniature programming switches located on the logic circuit board, virtually eliminates the requirement for a digital voltmeter for calibrating the collimator. Instrumentation as a rule will only be required to pinpoint a fault identified by the indicators and programming switches and for external circuitry. Also, locating the logic board on the collimator allows troubleshooting and adjustment from a central location while observing the results. As always, confirming radiation exposures are made only with all parties located in a radiation-protected area.

After confirming that the logic board and collimator are functional and calibrated, external signals can be selectively applied to check for correct operation. After all external signal sources are confirmed, the programming switches are then set to the "OFF" position with the collimating system returned to the normal operating condition.

1.3.2 MIRROR RETRACTION FEATURE:

When the need arises to visually inspect the port of the x-ray tube, the mirror may be retracted from the exposure position. Release of the mirror actuator restores the original position of the mirror.

1.4 STANDARD FEATURES (Model Linear II)

The Linear II™ automatic PBL collimation systems from EUREKA include all features required for diagnostic excellence . . .

. . . Rated for operation to 150 kVp.

. . . Full manual operation for table-top radiography.

. . . Automatic PBL operation upon insertion of a cassette into the bucky tray.

. . . Manual field size reduction after automatic PBL cycle.

. . . Color coded lights to indicate modes of operation.

. . . Bright 150 Watt light-field illumination operated by an internal timer.

. . . Square or rectangular pattern continuously variable from 17" x 17" at 36" SID to fully closed.

. . . Continuous size sensing capability for all metric and inch size cassettes.

. . . Compatible with Liebel-Flarsheim or Eureka MCT II cassette size sensing bucky and tray.

. . . Cone track provided for accessories.

. . . Swivel mount for angulated positioning.

1.5 ADVANCED FEATURES

The Linear™ collimation systems also incorporate features required for diagnostic convenience . . .

. . . Illuminated SID front panel indicators.

. . . Selectable field size scales to avoid confusion.

. . . Bright centering light-line which extends from the front of the extended cassette tray across the table-top to beyond the center of the patient, completely eliminates the need for mechanical "pointers".

1.6 TECHNICALLY ADVANCED FEATURES

The Linear™ collimation systems incorporate features for diagnostic down-time reduction . . .

. . . Push button for indicator lamp test function.

. . . Digital logic circuitry located on the side of the collimator for table-side troubleshooting convenience without x-ray exposures.

. . . Programming switches and indicators on the logic board permits simulation of cassette size signals and all SID functions. A built-in "logic probe" allows troubleshooting from a central location at table-side. After confirming that the logic board and collimator are fully functional, external signals can be selectively applied to check for correct external signals.

. . . Most electronic components are standardized types available at major electronic suppliers. Use of standardized staight-forward logic allows troubleshooting and repair with general electronic experience.

. . . An indicator lamp in the "light" switch will indicate when the field projector bulb requires replacement. A spare lamp is provided inside the lamp housing and is easily replaced by the owner/operator.

1.7 SPECIFICATIONS (Model Linear II)

Operation:	Automatic (PBL) within 2 seconds, and manual.
SID's for PBL:	Vertical SID at 40", 40" and 72" horizontal.
SID Indicators:	Horizontal SID indicators at 40" and 72".
Radiation Shielding:	Rated for 150 kVp. Less than 50 mR/Hr/mA at one meter.
Film Coverage:	Continuously variable from 17" x 17" to 5" x 5" in PBL mode at all listed distances, 17" x 17" to closed in Manual mode.
Light Field:	More than 160 LUX (15 footcandles) with a minimum edge contrast ratio of 4:1 at one meter. Controlled by internal timer.
Accuracy:	2% of SID in use.
X-ray Field Accuracy:	Within 2% of SID in use in length and width. (Sum less than 4%).
Bucky Light Line:	Bright center line extending from center of field to withdrawn tray.
PBL By-Pass:	Accepts by-pass signal from control for stereographic and tomographic operation.
Mirror/Filter Retraction:	Mirror retraction for port viewing.
Inherent Filtration:	2.0mm (min.) aluminum equivalent at 100 kVp and above.
Power Requirement:	115-125 VAC, 50/60 Hz, 2 Amp, 3 Wire, 1 Phase.
Light-Field Lamp:	Type DZE, 24 VAC, 150 WATT (GE).
Weight:	19 lbs. (collimator head only).

(Note: Specifications subject to change without notice.)

1.8 RADIATION AND MECHANICAL/ELECTRICAL WARNING (from NEMA Standards Publication/No. XR8-1979)

Radiation Warning for Diagnostic X-Ray Systems

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, *"Diagnostic X-ray Systems and their Major Components"*, and the National Council on Radiation Protection (NCRP) No. 33, *"Medical X-Ray and Gamma-Ray protection for energies up to 10 MeV-Equipment Design and Use"*, as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.

Mechanical-Electrical Warning for Diagnostic X-ray Systems

All of the movable assemblies and parts of x-ray equipment should be operated with care.

Only properly trained and qualified personnel should be permitted access to any internal parts. Live electrical teminals are deadly; be sure line disconnect switches are opened and other appropriate precautions are taken before opening access doors, removing enclosure panels, or attaching accessories.

Do not remove the flexible high tension cables from the x-ray tube housing or high tension generator or the access covers from the generator until the main and auxiliary power supplies have been disconnected.

When disconnecting high-voltage cables, they must be grounded immediately in order to dissipate any electrical charge that may remain on the cables or the tube.

Failure to comply with the foregoing may result in serious or potentially fatal bodily injuries to the operator or those in the area.

1.9 COMPATIBILITY

The Linear™ series collimators are compatible and can be adapted for use with x-ray tube/housing assemblies that meet all of the following factors:

1. Focal Distance of X-ray Tube:

   The focal spot to collimator mounting flange distance must be 2.44 inches, ±0.031 inches (1/32"). Four (4) spacers are supplied for adaption:

   1 – 1/4 inch (0.25") spacer

   3 – 1/16 inch (0.06") spacer

   Use any combination to achieve the requirements.Refer to Section 8.0, Appendix, Table 1 for additional information.

2. Leakage Radiation:

   Maximum leakage radiation from the x-ray tube/housing assembly must not exceed 50 mR/hr at 100 cm (40 inches) at specified leakage technic factors.

3. Inherent Filtration and Half-Value Layer:

   The EUREKA Linear™ series collimators have a minimum value of 2.0mm aluminum equivalence at 100 kVp. This value plus any tube inherent filtration plus any added filtration must meet the minimum requirements of 21 CFR Sub-Chapter J, part 1020.30 (m)(1) Table 1 on beam quality (e.g., minimum HVL at 100 kVp must be 2.7mm Al).

4. Application:

   The intended application is for general purpose radiographic equipment including tomographic and chest applications. Maximum tube rating must be 150 kVp or less.

5. Installation:

   Must be made with supplied hardware including mounting flange, spacers (as required), and four (4), 1/4" x 20 bolts equally spaced on a 3.62" diameter bolt center.

1.10 MAINTENANCE

The collimator system must be properly maintained to assure both compliance with the BRH regulations and useful life.

Preventive maintenance is to be performed once every twelve months. This includes inspection and lubrication of both the cassette tray(s) and collimator mechanism.

Checkout should also occur if any of the following conditions occur:

- Lamp replacement
- Premature electronic component failure
- When collimator is removed from tube/housing assembly
- When collimator and/or cassette tray have been subjected to external damage.

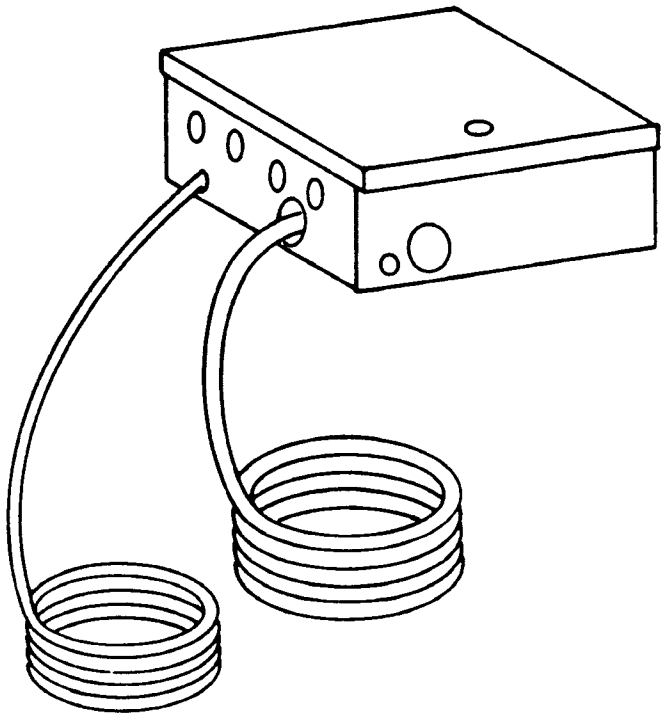
Refer to Section 3.0 for collimator CHECK-OUT procedure, and refer to the cassette tray manual for tray maintenance.

1.11 COMPLIANCE REQUIREMENTS

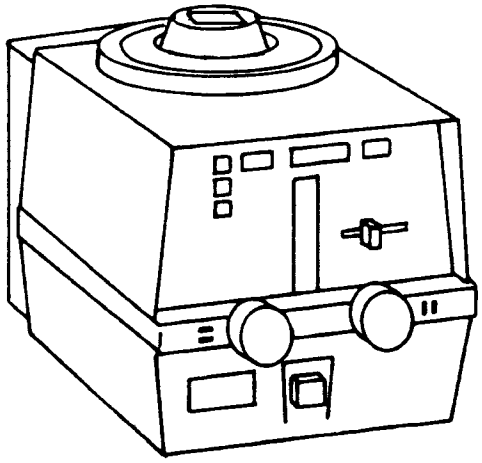
It is necessary for the assembler to verify compliance. A series of tests, when performed at the time of installation, will indicate compliance with 21CFR, Sub-Chapter J, Part 1020, Performance Standards. These tests which are described in Section 6, "Compliance Verification", must be performed before releasing the collimator for use. A record sheet is provided at the end of Section 6 and should be completed by the installer. In order to avoid wasted effort the installation, checkout and adjustment procedures descibed in Sections 2 through 5 should be completed prior to performing the compliance tests.

SECTION 2.0

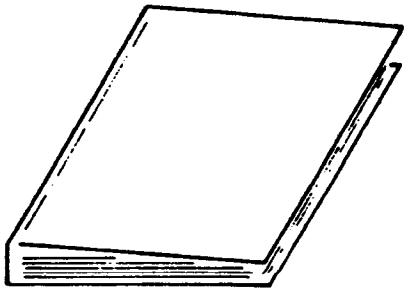
INSTALLATION



INTERCONNECT AND
POWER SUPPLY UNIT



COLLIMATOR



MANUAL

MOUNTING HARDWARE
AND SPACERS

COMPONENT IDENTIFICATION
FIGURE 2.1

2.0 INSTALLATION

2.1 Unpacking

Carefully unpack the equipment and check for damage incurred during shipment. Any damage should be referred to the agency that delivered the product.

2.2 Equipment Supplied

Refer to figure 2.1 for component identification.

- Linear II Collimator
- Spacers and Mounting Hardware
- Interconnect and Power Supply Unit
- Packet containing Instruction Manual, Assembler's Report FD-f2579, etc.

2.3 Collimator Mounting

Determine the collimator mounting surface to focal spot distance from the data supplied with the x-ray tube (do not rely on an inscribed mark on the tube housing).

NOTE: The collimator will not perform properly unless the focal spot to upper swivel ring distance is 2 7/16" (2.44 inches, 62 mm.) ± 1/32" (.031 inches, 1 mm.). Be sure to include any permanent mounting plates in the focal spot to port boss distance stated in the tube manufacturer's data.

NOTE: The Linear II is designed to be used with a lead diaphragm or cone in the plastic port of the x-ray tube.

If it is found that lead diaphragms or cones require removal or modification, consult the factory.

Determine the total thickness of the supplied spacers(s) that must be added between the upper swivel ring of the collimator mounting surface, to obtain a focal spot to upper swivel ring distance of 2 7/16" (2.44 inches, 62 mm.) ± 1/32" (.031 inches, 1 mm.). Refer to Figure 2.2.

Remove the upper swivel ring from the collimator by removing the 6-32 socket head cap screw and opening the clamping ring.

Securely fasten the upper mounting ring and spacers to the collimator mounting surface.

Carefully support the collimator in place and re-attach the clamping ring. The hinge of the clamping ring must line up with the pin in the lower mounting ring.

2.4 Power Chassis Mounting

The power chassis is a standard NEMA enclosure intended to be mounted on a wall or in an equipment cabinet. There are knock-outs on the sides and bottom of the enclosure for cable entry. Locate the power chassis in an area that will permit:

1. Cable Bend Radius
2. Convection Cooling
3. Clearance for Door Opening

All external connections to the system are made in this chassis. They include:

1. AC Power Input
2. Table Image Receptor Input
3. Wall Image Receptor Input
4. Horizontal SID Input
5. 40" Vertical SID Input
6. Table Tilt Monitor
7. Generator Exposure Interlock
8. Tomo/Stereo By-Pass Input

Refer to the Power Chassis outline drawing for mounting dimensions. (Figure 2.3)

2.5 Interconnect Wiring

(Refer to Cabling Outline Figure 2.4)

CAUTION: You will be wiring 120 VAC into the power chassis. Be sure that the x-ray generator is off before proceeding.

All connections are located inside the power chassis (Refer to terminal strip layout – Figure 2.5-a, b, c and Schematic 70-08009).

2.5.1 120 VAC Input

Connect the three-wire cable supplied to the 120 VAC source as follows:

Black – Hot
White – Neutral
Green – Ground

2.5.2 Exposure Interlock

Connect the supplied cable to the exposure interlock circuit of the generator (refer to the generator manual). The collimator "Exposure Hold" is a set of normally open contacts that remain open in the "Hold" condition (Refer to Figure 2.6). The contacts are Form C with the normally closed contacts available.

2.5.3 Tomo/Stereo Input

If the x-ray system is equipped with either Tomo or Stereo shift capability it will be necessary to connect a signal to the collimator Tomo/Stereo by-pass input. This circuit accommodates a variety of signals. Determine the signal level available from the Generator Installation Manual. Connect as indicated in Figure 2.7.

2.5.4 Table Image Receptor Input

The Linear collimator systems are designed to operate with input characteristics as listed below.

Refer to the Cassette Tray Installation Manual and the appropriate Bucky Manual to assure proper operation of these devices.

Connect the table image receptor input as indicated in Figure 2.8.

ELECTRICAL SPECIFICATIONS:

- Impedance – 1000 OHMS, ±5% total resistance
- Resistance Linearity – within 1.5%
- Output Voltage vs. Cassette Size with +15.00 volts applied between SUPPLY and COMMON Terminals is shown in the center column on the following page.
- Operating Output Voltage vs. Cassette Size with +7.02 volts applied at 40" SID is shown in the right-hand column in the table on the following page.

Cassette/Film Size		DC Output Voltage ±0.2V (15.00 volts input)		DC Output Voltage 40" SID (7.02 volts input)	
INCH	CM (metric)				
5		0.90		2.30	
6		1.95		2.65	
7		3.15		3.05	
	18		3.25		3.08
8		4.20		3.40	
9		5.25		3.75	
	24		5.79		3.93
10		6.45		4.16	
11		7.50	<–Reference Point	4.51	
	30		8.27		4.77
12		8.70		4.91	
	35		10.57		5.54
14		10.80		5.61	
	43		14.03		6.69
17		14.10		6.72	

2.5.5 Auxiliary Wall Cassette Tray Installation

When an auxiliary wall cassette or size-sensing wall cassette holder is installed in the system, connect the inputs to the power chassis as indicated in Figure 2.8.

Identify the location of the auxiliary cassette tray or holder with respect to the collimator. Remove the bottom collimator cover as shown in Figure 3.0. Set the appropriate switch located on the collimator Logic P.C.B.:

A. Wall Cassette Right – Set SW2-5 "ON"
B. Wall Cassette Left – Set SW3-5 "ON"
(Refer to Figure 3.2)

NOTE: Only one of these switches is to be placed in the "ON" position at any time.

2.5.6 Discrete Vertical SID Installation (40" Only)

If the system is to be mounted on a variable SID tubestand, it is necessary to install a switch to be activated at the 40" vertical SID position as shown in Figure 2.5(a).

The switch must be installed to activate within ±0.2 inches of the 40 inch SID position.

Connect the Normally Open contacts to TS1-17 and TS1-19.

If the collimator is mounted at a permanent vertical SID position, connect a jumper wire between TS1-17 and TS1-19.

2.5.7 Horizontal SID Installation

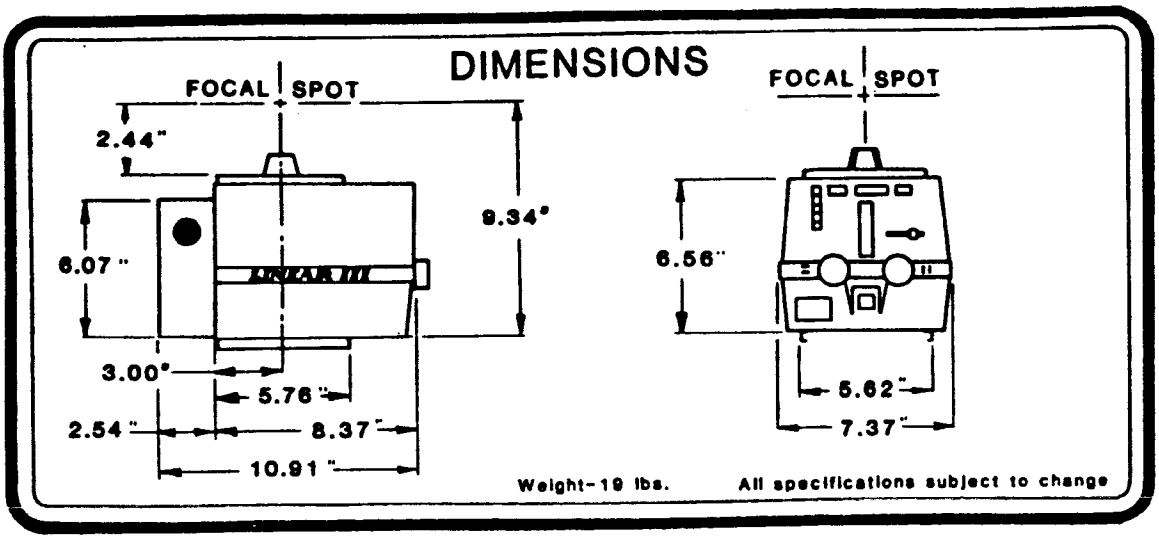
A switched signal is required at the horizontal SID positions to be used. Only one switched signal is to be present at any one time. Position each of the switches to close within ±0.2 inches of their respective SIDs.

Connect the switches to the Power Chassis as indicated in Figure 2.9(a) for Non-Tilt Tables and 2.9(b) for Tilting Tables.

2.5.8 Table Tilt Monitor

If a tilting table is installed as part of the system, it is necessary to mount the table tilt monitor to transfer angular position information to the collimator. Proper orientation of the monitor is shown in Figure 2.10.

Remove the jumper between TS2-5 and TS2-10. Connect the table tilt monitor as in Figure 2.11.



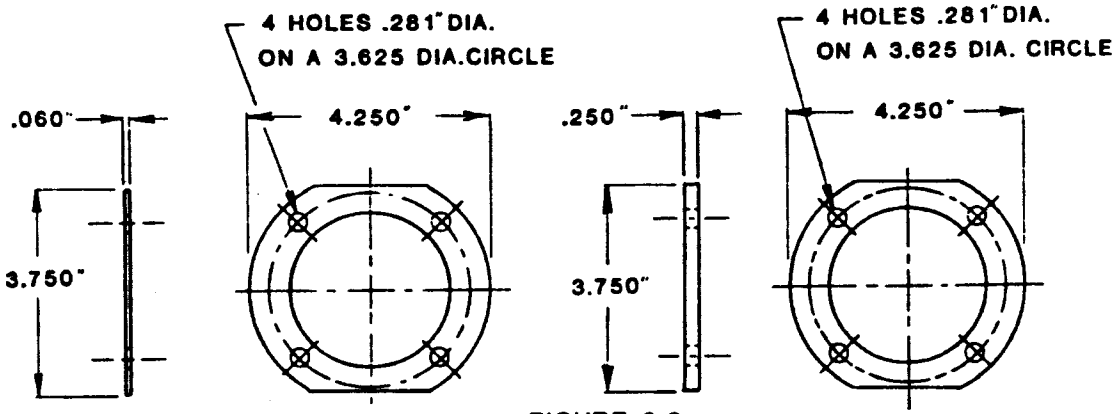


FIGURE 2.2

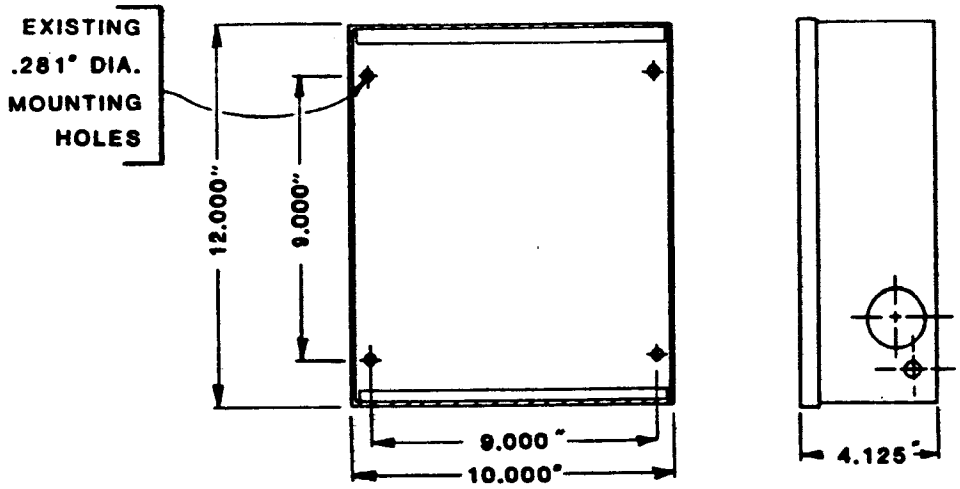
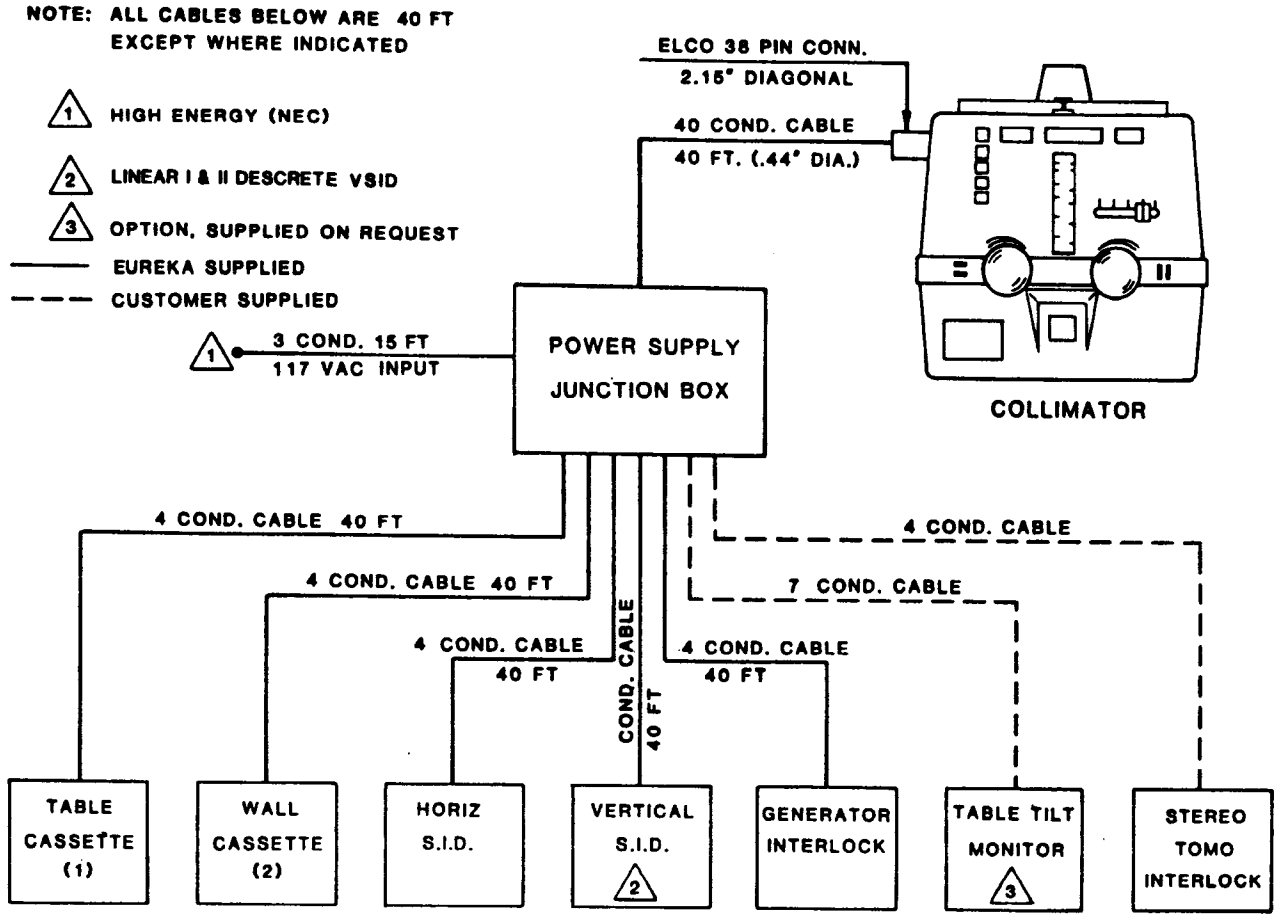
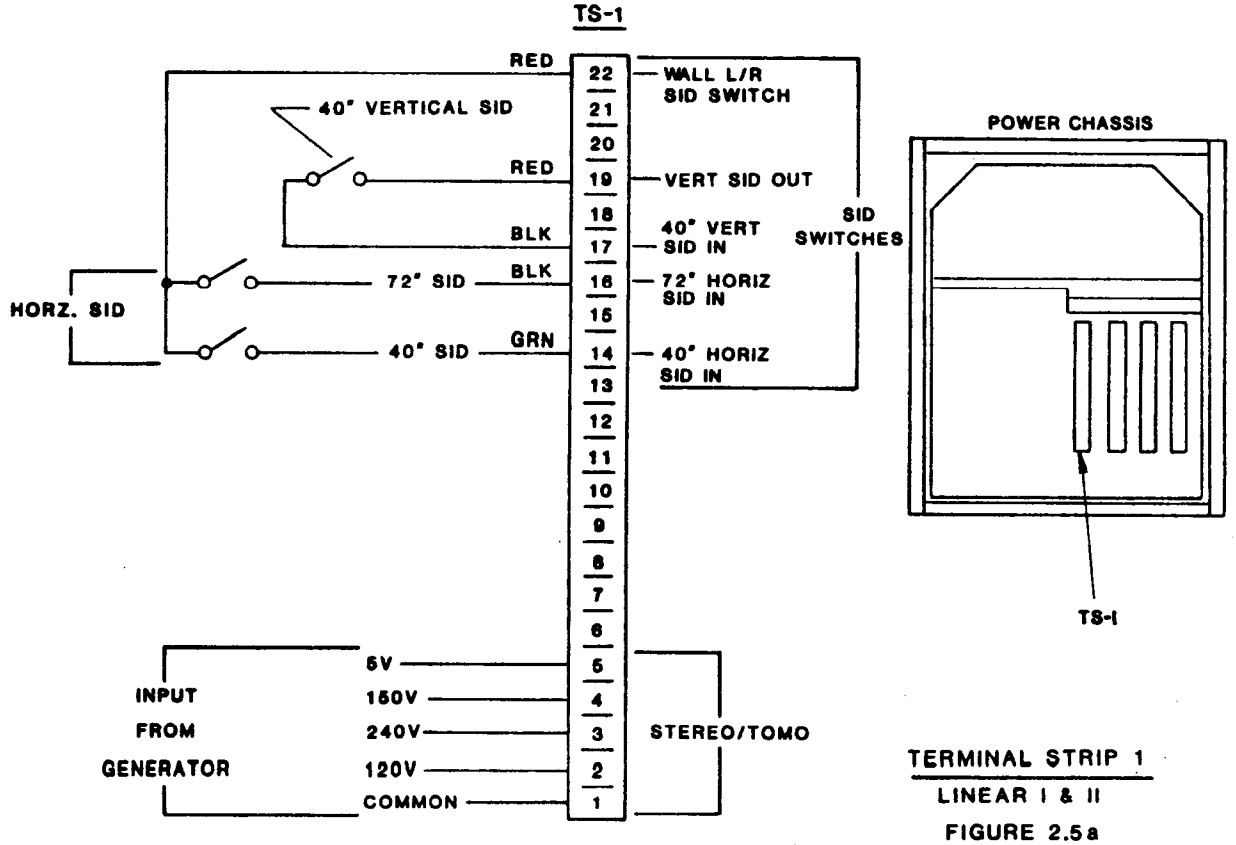


FIGURE 2.3



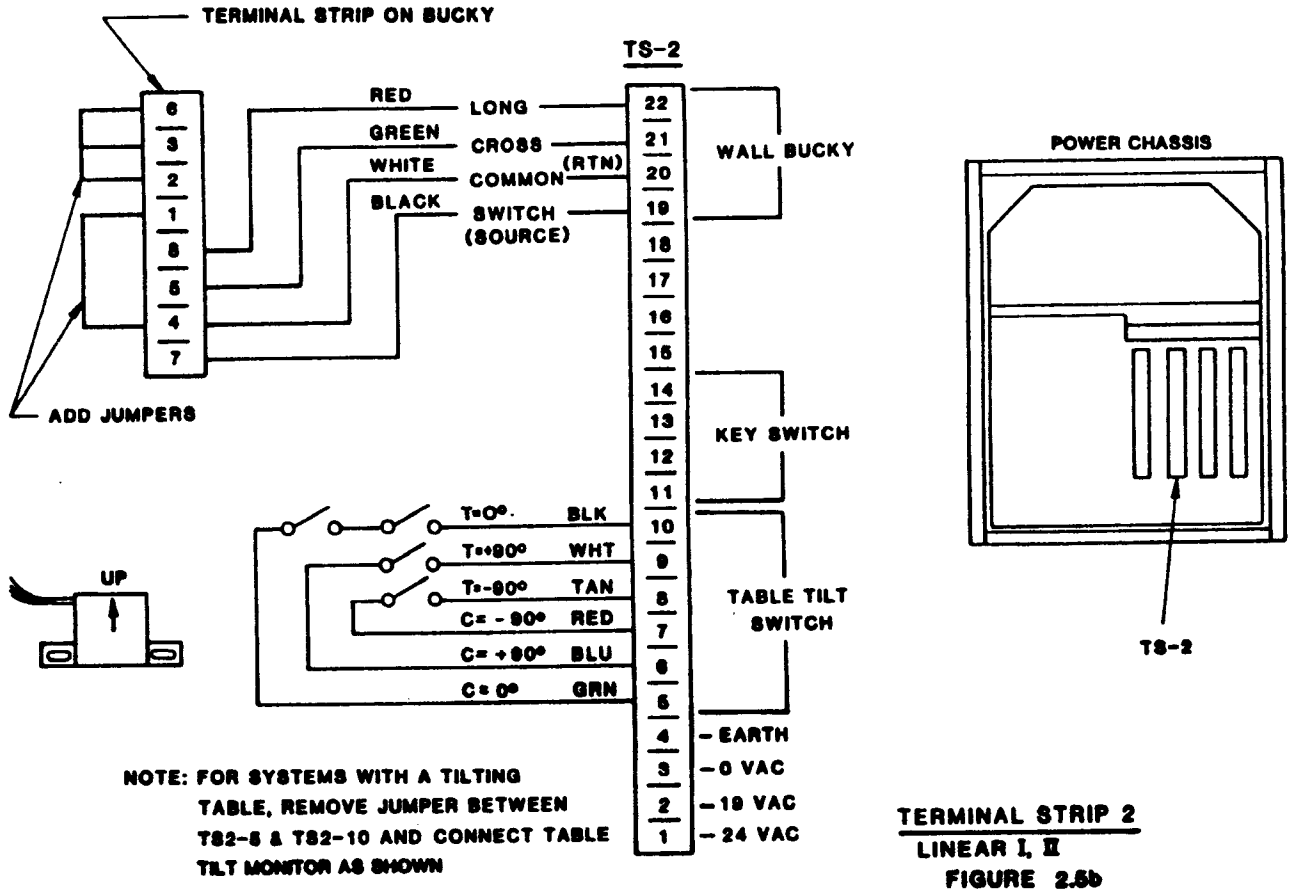
CABLE CONFIGURATION FOR #70-40000 LINEAR II

FIGURE 2.4

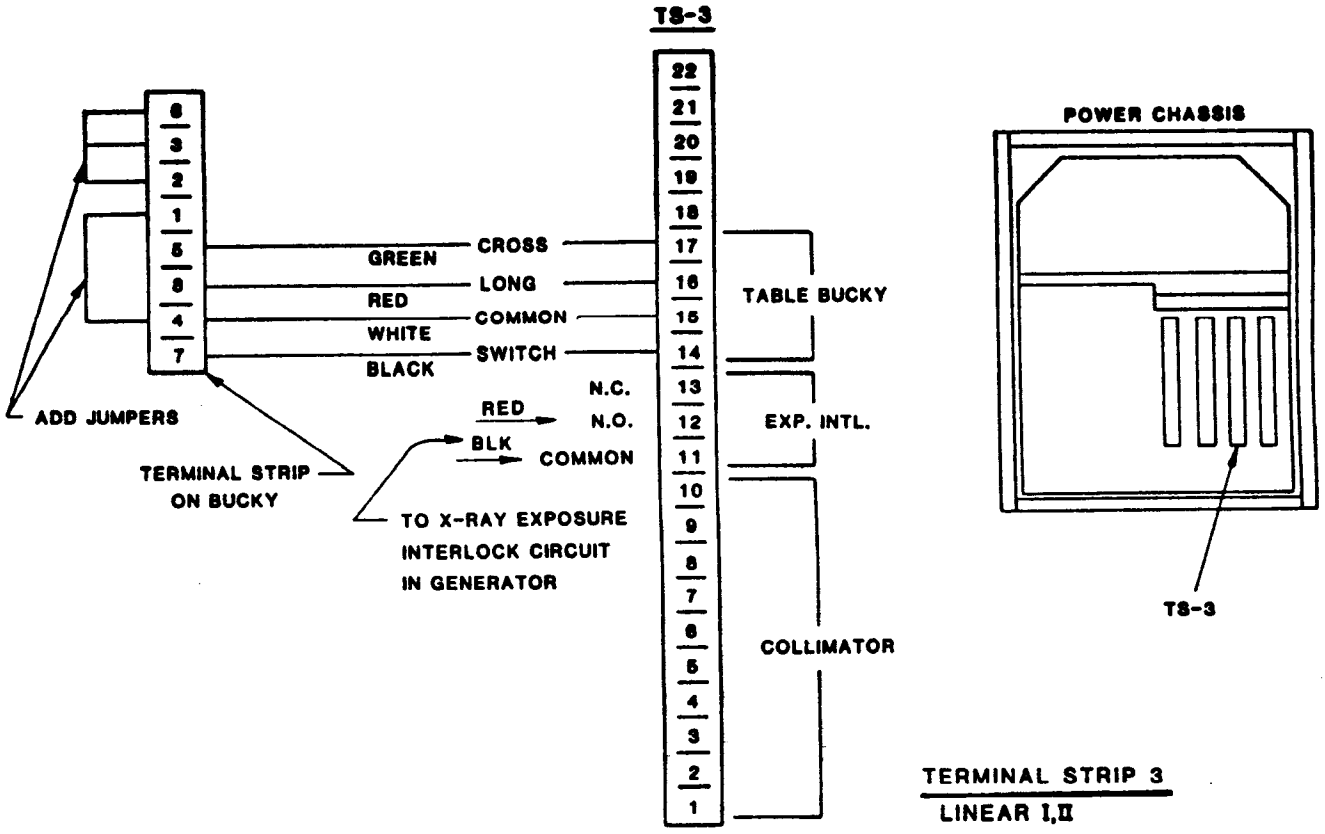


TERMINAL STRIP 1
LINEAR I & II

FIGURE 2.5a



TERMINAL STRIP 2
LINEAR I, II
FIGURE 2.5b



TERMINAL STRIP 3
LINEAR I,II
FIGURE 2.5c

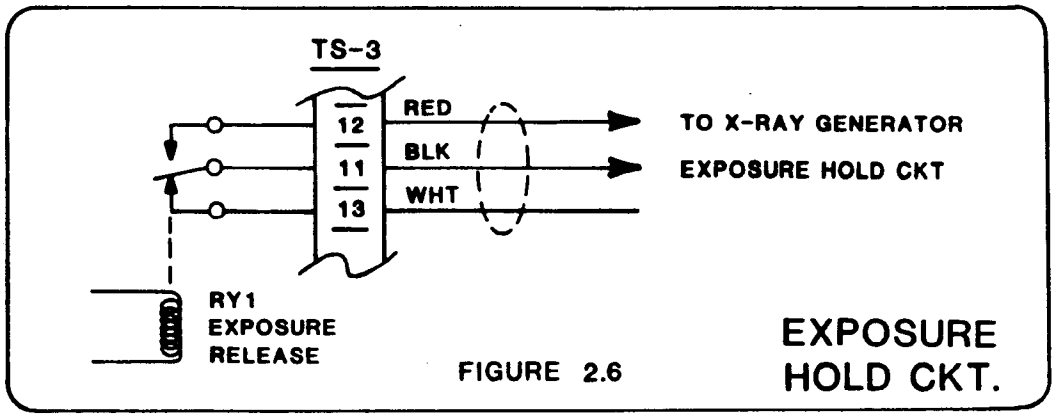


FIGURE 2.6

EXPOSURE HOLD CKT.

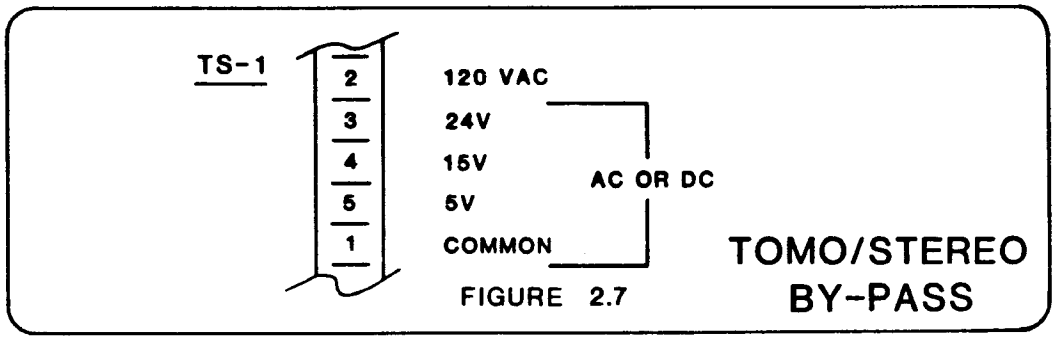


FIGURE 2.7

TOMO/STEREO BY-PASS

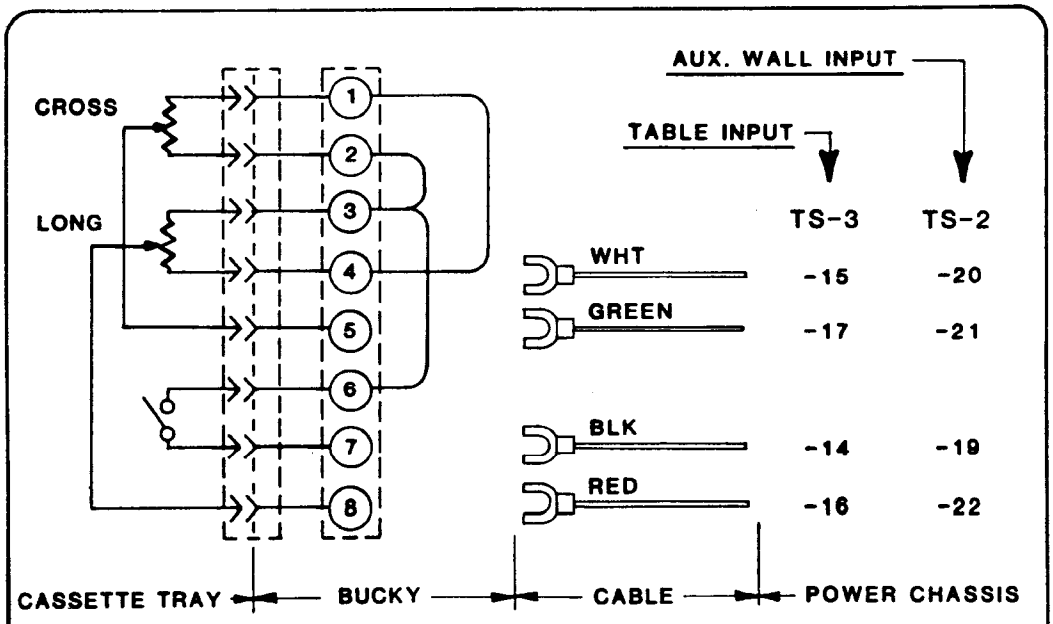


FIGURE 2.8

CASSETTE TRAY CKT.

SECTION 3.0

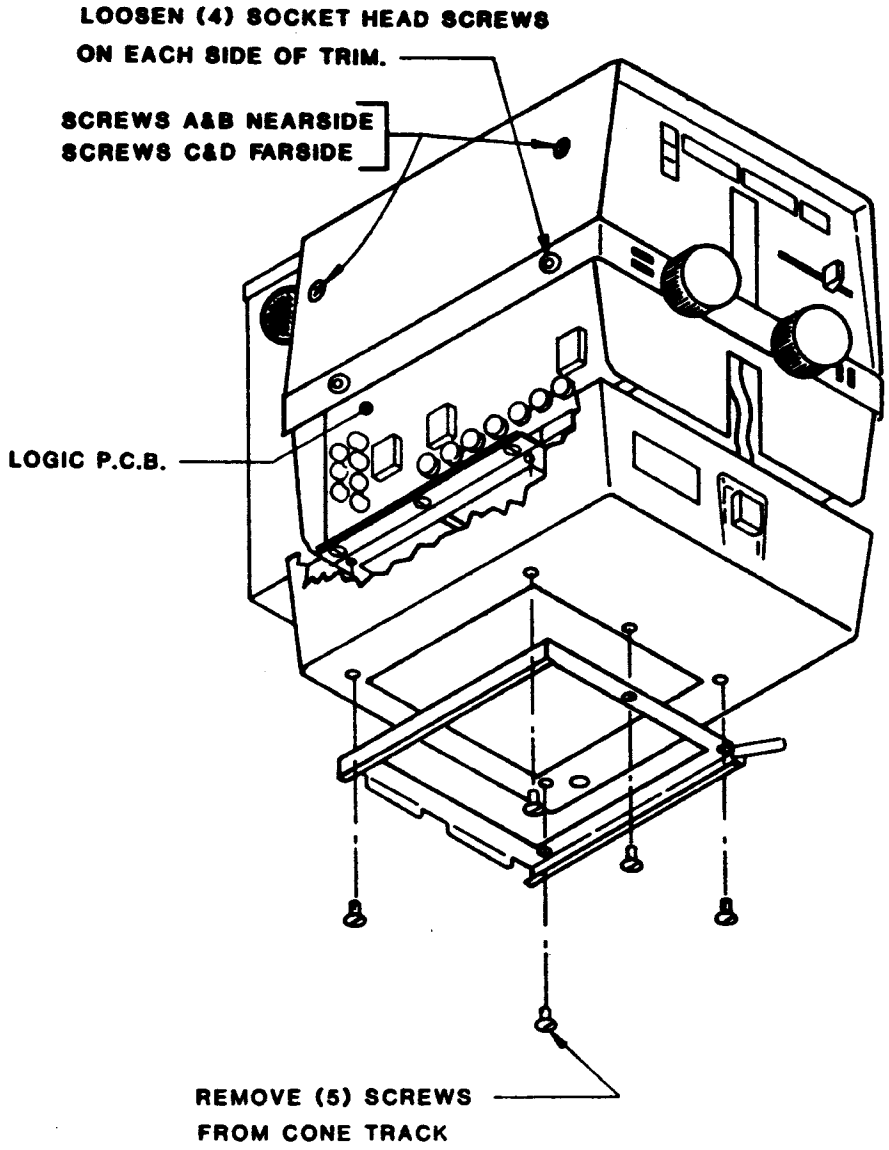
OPERATIONAL CHECK OUT PROCEDURE

TOP COVER REMOVAL

(TO GAIN ACCESS TO TOP HALF OF LOGIC P.C.B. AND LAMP DRIVER P.C.B. BEHIND FRONT PANEL)

1. LOOSEN, DO NOT REMOVE, THE 4 SCREWS ON THE TRIM BAND
2. REMOVE SCREWS A, B, C AND D
3. LIFT TOP COVER AND PULL FORWARD

COVER REMOVAL



BOTTOM COVER REMOVAL

1. LOOSEN, DO NOT REMOVE, THE 4 SCREWS ON THE TRIM BAND, 2 EACH SIDE
2. REMOVE THE CONE TRACK
3. LAMP SWITCH MAY BE REMOVED FROM COVER AND RE-CONNECTED

FIGURE 3.0

3.0 OPERATIONAL CHECKOUT PROCEDURES – MODEL LINEAR II

The following procedures form a means to check operation of the collimating system and must be performed at the time of installation.

These procedures also form a key troubleshooting aid by using internal SID and IR signals to check for correct Logic PCB and collimator response, followed by use of external signals to check the wiring.

Although some signals are internally simulated, external wiring or component defects can prevent proper operation by producing false input signals. An external short circuit to ground for example, on the 40" SID switch will prevent the 40" indicator from coming ON. During any of the following tests, an incorrect indication or operation must be identified and corrected before continuing with the tests.

These procedures are written in a specific sequence; altering the sequence will result in misjudgement and a waste of time.

YOU HAVE LEGAL OBLIGATIONS

PRIOR TO RELEASE OF THE SYSTEM TO THE USER, THE RESULTS OF EACH STEP MUST BE AS DEFINED.

ENTER THE APPROPRIATE DATA IN THE SPACES PROVIDED IN THE COMPLIANCE DATA-LOG AND RETAIN FOR YOUR RECORDS AS PROOF THAT THESE TESTS WERE SUCCESSFULLY PERFORMED.

EQUIPMENT REQUIRED:

A. The x-ray tube support and the table must include angulation indicators in order to comply with Part 1020.31 (d)(2)(i) and 1020.31 (e)(1)(ii). These indicators are to be used for the following tests.

B. The x-ray tube support device also must include SID indicating means in order to comply with 1020.31 (e)(1)(i).

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

3.1 REMOVE COLLIMATOR COVER AS SHOWN IN FIGURE 3.0

Set the switches on the logic PCB shown in Figure 3.2 as follows:

SW2-1	OFF	SW3-1	OFF
SW2-2	OFF	SW3-2	OFF
SW2-3	OFF	SW3-3	OFF
SW2-4	OFF	SW3-4	OFF
SW2-5	OFF	SW3-5	OFF

3.2 COLLIMATOR TILT SWITCH CHECKOUT

Position the tilt switch at 0°, horizontal. Angulate the collimator to a 0° beam-down position. Slowly angulate the collimator +20° toward a beam-left position and back to −20° toward a beam-right position.

LED-4, Figure 3.1, must be on at 0° and remain on for +11° and −11° angulations.

3.2.1 Angulate the collimator to a +90° beam-left position and slowly angulate it to 20° down below horizontal (+70° from vertical).

LED-1 must be on at +90° and remain on for 11° below horizontal (+79°).

3.2.2 Angulate the collimator to a −90° beam-right position and slowly angulate it to 20° down below horizontal (−70° from vertical).

LED-5 must be on at −90° and remain on for 11° below horizontal (−79°).

IF COLLIMATOR TILT SWITCH DOES NOT CHECK OUT, REFER TO MASTER BOARD SCHEMATIC 70-08009

3.3 TABLE TILT SWITCH CHECKOUT (FOR TILTING TABLES ONLY)

Remove the jumper between TS2-5 and TS2-10. Angulate the collimator to 0° beam-down. Angulate the table to 0° horizontal and slowly tilt it to +20° and then −20°.

LED-4, Figure 3.1, must be on with the table at 0° and remain on for +11° and −11° from horizontal.

3.3.1 Position the table at +90° upright (usually about an actual +85°) and angulate the collimator to a +90° (LED-1 "ON") beam-left position. Slowly tilt the table 20° down from the maximum upright position (+70°).

LED-7, Figure 3.1, must be ON at a maximum upright and remain ON until the table is angulated down to +79°. (LED-1 will also be ON).

3.3.2 Angulate the table to −90° trendellenberg and angulate the collimator to −90° beam-right (LED-5 ON). Slowly tilt the table 20° down from the maximum trendellenberg position.

LED-6, Figure 3.1, must be ON and remain ON until the table is angulated down to −79°. (LED-5 will also be "ON").

3.3.3 The tilt monitors must meet the above requirements in order to comply with Part 1020.31 (d)(2)(i) and 1020.31 (e)(1)(ii) of the Performance Standards.

If the tilt monitors do not pass each requirement listed, corrective action must be taken. DO NOT PROCEED with the testing until all requirements are met. Refer to Section 2.5.8, Figure 2.10 and 2.11 and Schematic 70-08009.

3.4 LOGIC AND COLLIMATOR OPERATION CHECKOUT –(Using Internal Signals)

NOTE: Cassette tray must be removed for the following procedures.

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

Angulate the table to 0° horizontal and the collimator to 0° beam-down position. LED-4 on the Logic P.C.B. must be ON.

Using a steel measuring rule, measure the distance from the center of the plastic exit window to the center of the cassette tray (Image Receptor). Set this distance to 30⅝" ± 1/16" in order to achieve 40" focal spot to table top distance.

A. The ON and MANUAL indicators on the collimator front panel should be ON.

B. LED-2, Figure 3.1, on the Logic P.C.B. should be ON.

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

A. LED-2 (IR TRUE) should switch OFF.

B. The MANUAL indicator should switch OFF.

C. The HOLD indicator should switch ON.

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

A. The 40" indicator should switch ON.

B. The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

3.2.2 Angulate the collimator to a −90° beam-right position and slowly angulate it to 20° down below horizontal (−70° from vertical).

LED-5 must be on at −90° and remain on for 11° below horizontal (−79°).

IF COLLIMATOR TILT SWITCH DOES NOT CHECK OUT, REFER TO MASTER BOARD SCHEMATIC 70-08009

3.3 TABLE TILT SWITCH CHECKOUT (FOR TILTING TABLES ONLY)

Remove the jumper between TS2-5 and TS2-10. Angulate the collimator to 0° beam-down. Angulate the table to 0° horizontal and slowly tilt it to +20° and then −20°.

LED-4, Figure 3.1, must be on with the table at 0° and remain on for +11° and −11° from horizontal.

3.3.1 Position the table at +90° upright (usually about an actual +85°) and angulate the collimator to a +90° (LED-1 "ON") beam-left position. Slowly tilt the table 20° down from the maximum upright position (+70°).

LED-7, Figure 3.1, must be ON at a maximum upright and remain ON until the table is angulated down to +79°. (LED-1 will also be ON).

3.3.2 Angulate the table to −90° trendellenberg and angulate the collimator to −90° beam-right (LED-5 ON). Slowly tilt the table 20° down from the maximum trendellenberg position.

LED-6, Figure 3.1, must be ON and remain ON until the table is angulated down to −79°. (LED-5 will also be "ON").

3.3.3 The tilt monitors must meet the above requirements in order to comply with Part 1020.31 (d)(2)(i) and 1020.31 (e)(1)(ii) of the Performance Standards.

If the tilt monitors do not pass each requirement listed, corrective action must be taken. DO NOT PROCEED with the testing until all requirements are met. Refer to Section 2.5.8, Figure 2.10 and 2.11 and Schematic 70-08009.

3.4 LOGIC AND COLLIMATOR OPERATION CHECKOUT –(Using Internal Signals)

NOTE: Cassette tray must be removed for the following procedures.

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

Angulate the table to 0° horizontal and the collimator to 0° beam-down position. LED-4 on the Logic P.C.B. must be ON.

Using a steel measuring rule, measure the distance from the center of the plastic exit window to the center of the cassette tray (Image Receptor). Set this distance to 30⅝" ± 1/16" in order to achieve 40" focal spot to table top distance.

A. The ON and MANUAL indicators on the collimator front panel should be ON.

B. LED-2, Figure 3.1, on the Logic P.C.B. should be ON.

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

A. LED-2 (IR TRUE) should switch OFF.

B. The MANUAL indicator should switch OFF.

C. The HOLD indicator should switch ON.

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

A. The 40" indicator should switch ON.

B. The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

C. The HOLD indicator should switch OFF.

D. The READY indicators should switch ON.

E. The light field size on the table top (40") should be about 14" x 14". Use test pattern 70-09015 supplied with this manual.

3.4.3 Set SW3-2 "OFF" (opening of 40" SID switch).

A. The 40" indicators should switch OFF.

B. The READY indicators should switch OFF.

C. The HOLD indicator should switch ON.

3.4.4 Set SW3-3 "ON" to simulate 72" SID switch closure.

Move the front panel sliding SID scale knob to the 72" detented position.

A. The 72" indicator should switch ON.

B. The collimator field size indicators (front panel) should rapidly adjust to about 14" x 14" and stop.

C. The HOLD indicator should switch OFF.

D. The READY indicators should switch ON.

E. The light field size on the table top (40") should be about 7.8" x 7.8" (14" x 14" at 72" with a .56 reduction due to 40" positioning). Use test pattern 70-09015 supplied with this manual.

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

A. The 72" SID indicator should switch OFF.

B. The READY indicators should switch OFF.

C. The HOLD indicator should switch ON.

3.5 EXTERNAL SID SIGNAL CHECKOUT (HORIZONTAL)

Angulate the collimator to 90° with the x-ray beam at the wall mounted cassette holder. Angulate the table to 0° horizontal.

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

A. LED-1 on the Logic P.C.B. must be ON. (Figure 3.1).

B. Set SW3-5 "ON" on the Logic P.C.B. to select left-wall operation (Figure 3.2).

3.5.2 If the cassette holder is on the wall adjacent to the foot-end of the table, this requires the collimator to be at −90° beam-right.

A. LED-5 on the Logic P.C.B. must be ON (Figure 3.1).

B. Set SW2-5 "ON" on the Logic P.C.B. to select right-wall operation (Figure 3.2).

NOTE: If the wall mounted cassette holder is on the wall adjacent to the head end of the table, leave SW3-5 ON and SW2-5 OFF.

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

3.5.3 Move the collimator horizontally until the distance from the source (focal spot) to image receptor (film in cassette) is at a 72" SID . Slowly move the collimator to a greater and then to a lesser SID while measuring the actual SID.

The 72" indicator on the collimator must be ON at a measured 72" SID and must switch OFF at a maximum of 72.75" and OFF again at a minimum of 71.25" SID.

3.5.4 Move the collimator horizontally to a 40" SID, and slowly move the collimator to a greater and then to a lesser SID.

The 40" indicator on the collimator must be ON at a measured 40" SID and must switch OFF at a maximum of 40.40" and OFF again at a minimum of 39.60" SID.

3.6 TILTING TABLE RECEPTOR SID SIGNAL CHECKOUT – (FOR TILTING TABLES ONLY)

Angulate the table to a full upright position. Angulate the collimator beam-left to aim the x-ray beam at the upright table cassette tray. LED-7 on the logic P.C.B. must be ON (Figure 3.1).

3.6.1 Move the collimator horizontally to a 40" SID, and slowly move the collimator to a greater and then to a lesser SID.

The 40" indicator on the collimator must be ON at a measured 40" SID and must switch OFF at a maximum of 40.40" and OFF again at a minimum of 39.60" SID.

3.7 EXTERNAL IR SIGNALS CHECKOUT (TILTING OR NON-TILTING TABLES

Set the switches on the logic PCB shown in Figure 3.2 as follows:

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

Angulate the collimator 0° beam-down direction with a measured SID of 40" measured to the bucky. For tilting tables, angulate the table to 0° horizontal.

A. The MANUAL indicator should be ON.
B. LED-2 on the Logic P.C.B. should be ON. (Figure 3.1)
C. The 40" indicator should be ON.

3.7.1 Locate a cassette in the table cassette holder and fully insert the tray into the bucky.

A. The MANUAL indicator should switch OFF.
B. The HOLD indicator switch ON.
C. LED-2 on the Logic P.C.B. should switch OFF. (Figure 3.2)
D. The collimator field size indicators (front panel) should rapidly adjust and stop.
E. The HOLD indicator should switch OFF.
F. The READY indicators should switch ON.
G. The light field size on the table-top should be about the same size as the cassette inserted into the cassette tray. (Do not remove the cassette at this time).

3.7.2 Angulate the collimator to properly aim at the wall cassette holder with the Horizontal SID at about 50".

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

3.7.3 Fully insert a cassette into the wall cassette holder.

A. LED-2 on the Logic P.C.B. should switch OFF.
B. The MANUAL indicator should switch OFF.
C. The HOLD indicator should switch ON.
D. All SID indicators should be OFF.

3.7.4 Move the collimator horizontally to each of the available SID's (i.e. 40" or 72").

A. An SID indicator should switch ON.
B. The collimator field size indicators (front panel) should rapidly adjust and stop.
C. The HOLD indicator should switch OFF.
D. The READY indicators should switch ON.
E. The light field size should be about the same size as the cassette in the wall cassette holder.

3.7.5 Remove the cassette from the table cassette tray. The removal of the cassette from the table cassette tray should not produce a response.

3.8 FOR TILTING TABLES

Tilt the table to full upright. At +79°, and without a cassette in the table bucky, the following should occur:

A. LED-2 on the Logic P.C.B. should switch ON.
B. The READY indicators should switch OFF.
C. The MANUAL indicator should switch ON.

3.8.1 Angulate the collimator to +90° beam-left position. Insert a cassette into the cassette tray and fully insert the tray into the table bucky.

A. LED-2 on the Logic P.C.B. should switch OFF.
B. The HOLD indicator should switch ON.
C. The MANUAL indicator should switch OFF.

3.8.2 Move the collimator horizontally to each of the available SID's to the tilted table (i.e., 40" or 72").

A. An SID indicator should switch ON.
B. The collimator field size indicators (front panel) should rapidly adjust and stop.
C. The HOLD indicator switch OFF.
D. The READY indicators should switch ON.
E. The light field size should be about the same size as the cassette inserted into the table cassette tray.

3.8.3 Repeat steps 3.8.1 through 3.8.2 with the table and collimator tilted to −90° beam-right position.

3.9 STEREO/TOMO BYPASS SIGNAL CHECKOUT

Angulate the collimator 0° beam-down direction with a measured SID of 40" measured to the bucky. For tilting tables, angulate the table to 0° horizontal.

A. The MANUAL indicator should be ON.
B. LED-2 on the Logic P.C.B. should be ON. (Figure 3.1)

3.9.1 Locate a cassette in the table cassette holder and fully insert the tray into the bucky.

A. The MANUAL indicator should switch OFF.
B. The HOLD indicator should switch ON.
C. LED-2 on the Logic P.C.B. should switch OFF. (Figure 3.2)
D. The collimator should rapidly adjust and stop.
E. The HOLD indicator should switch OFF.
F. The READY indicators should switch ON.
G. The light field size on the table-top should be about the same size as the cassette inserted into the cassette tray. (Do not remove the cassette at this time).

3.9.2 Activate the Stereo/Tomo switch on the generator.

A. The READY indicators should switch OFF.

B. The MANUAL indicator should switch ON.

3.9.3 Deactivate the Stereo/Tomo switch. The collimator should return to the state as indicated in step 3.9.1.

3.10 INPUT SIGNAL VERIFICATION CHART

The charts located at the end of this section are keyed to the preceding steps and to the signal name appearing on the Logic P.C.B. Schematic 70-08002.

A "logic indicator" is located on the Logic P.C.B. Attach a miniature test lead clip on TP-1 and, by the use of a pointed probe, the logic status can be checked when necessary. A logic "HIGH" will illuminate LED-3 and a logic "LOW" will not illuminate LED-3.

3.11 FINAL TEST SWITCH SETTINGS

At the end of this test procedure, be sure to set the test switches as follows:

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

(VIRC, IR, TRUE, VISID OUT, VSID IN and VIRL signals are analog and cannot be expressed in "Logic" terms)

SIGNALS (paragraph ref.)	3.2	3. 2.1	3. 2.2	3.3	3. 3.1	3. 3.2	3.4	3. 4.1	3. 4.2	3. 4.4	3. 4.6	3. 4.8	3.5	3. 5.2
VIRC (TS4-7), VIRL (TS4-5)														
$\overline{\text{STEREO/TOMO}}$ (TS4-11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{C = 0°, T = 0°}}$ (TS3-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0
$\overline{\text{C = +90°}}$ (TS3-6)	1	0	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°}}$ (TS3-7)	1	1	0	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{C = +90°, T = +90°}}$ (TS3-9)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°, T = −90°}}$ (TS3-8)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
IR TRUE														
$\overline{\text{40" SID}}$ (TS4-14)	1	1	1	1	1	1	1	1	0	1	1	1	1	1
$\overline{\text{72" SID}}$ (TS4-9)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
EXP. REL. RY (TS4-8)	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\overline{\text{TABLE LEFT SIDs}}$ (TS4-17)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{TABLE RIGHT SIDs}}$ (TS4-15)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{WALL L/R SIDs}}$ (TS4-19)	1	0	0	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{VERT SIDs}}$ (TS4-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0

LINEAR II Logic Chart

"X" – Don't Care

"1" – Logic High (+15 v)

"0" – Logic Low (0 v)

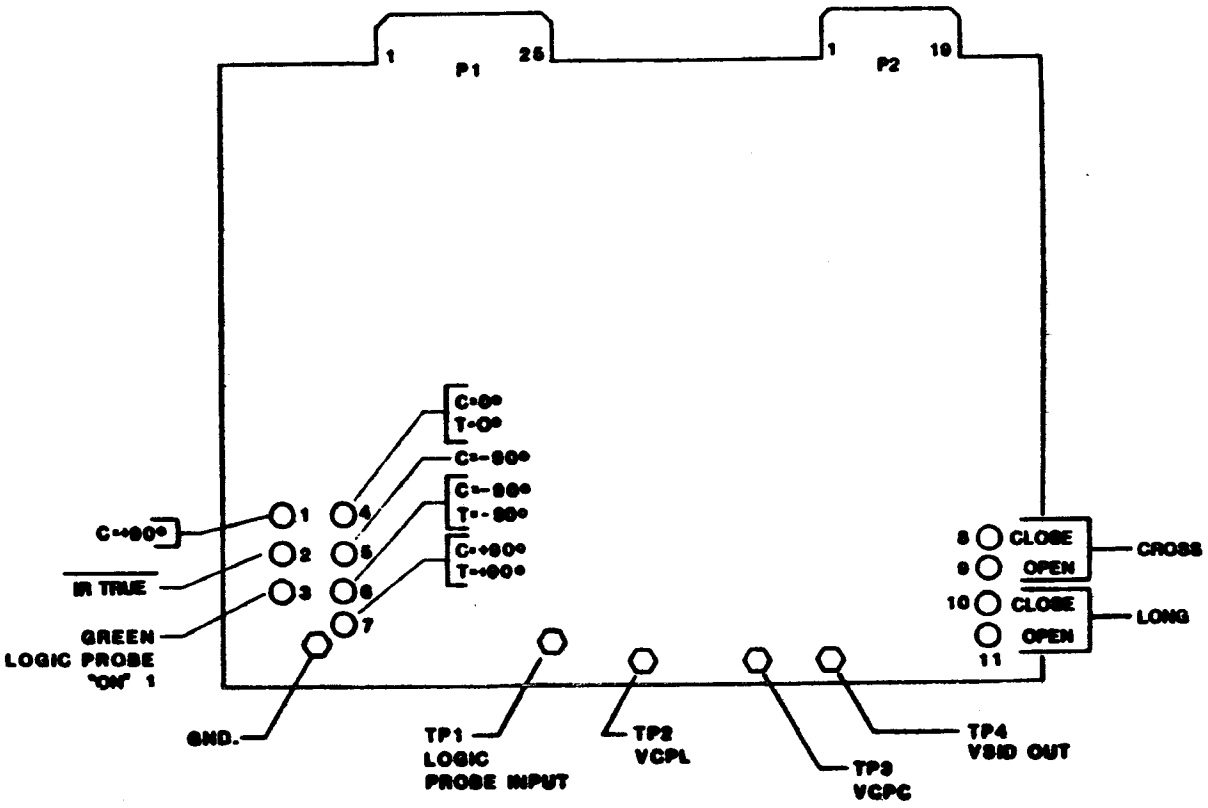


FIGURE 3.1

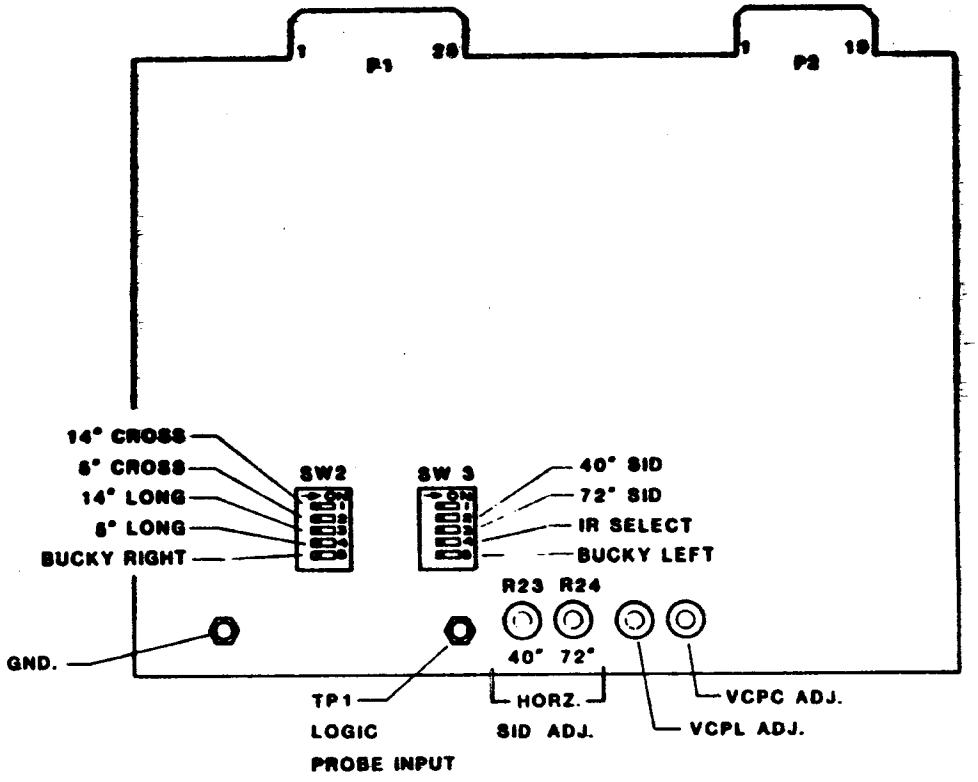


FIGURE 3.2

SECTION 4.0

ADJUSTMENT PROCEDURES

4.0 ADJUSTMENT PROCEDURES

The following adjustment procedures are performed with the collimator located in a single fixed position above a test pattern located on the table top.

The adjustments are made while observing the light field edges, therefore, it is necessary to confirm that the light field accurately represents the x-ray field. By establishing a defined light field and exposing a film to produce a density of 1.0, the x-ray field (image) can be compared to the light field.

The Performance Standards 1020.30 (b)(22) and (45) define the edges of the light field as the locus of points at which the illumination is one-fourth of the maximum and the edges of the x-ray field as the locus of points at which the exposure rate is one-fourth of the maximum.

The x-ray field should be determined by exposing a film to a density of 1.0 on the developed image, and observing the points at which the density is just visibly increased above the base fog background of the film.

In a similar manner, the light field edges should be determined by observing the light field on a white background. By observing the points at which the light field is just visibly increased over the background illumination, and comparing this to the x-ray field (and to the tolerance marks on the pattern), comparisons may be made.

PLEASE NOTE

Eureka Collimators have been 100% tested and calibrated at the factory. Our intention is that you will only have to confirm operation, then readjust the SID voltages to match the collimator and the Image Receptor (cassette tray) after the unit is installed.

Section 3 of the Manual (Operational Checkout) walks you through the procedure using internally generated cassette size signals (5" and 14") by selecting appropriate switches located on the logic P.C.B.

There are FACTORY SET adjustments that should NOT be altered. They are R25 (VCPL) and R26 (VCPC) located on the Linear I, II Logic P.C.B. (70-08002). These potentiometers set the voltages to the collimator feedback potentiometers. The voltages control the "Tracking" of the collimator, closed to open, and are extremely critical. If, in the unlikely event that they require adjustment, you can measure VCPL at TP-2 and VCPC at TP-3. The factory set values are recorded on the label inside the bottom cover. R26 controls the voltage to the CROSS feedback potentiometer and is used to "Balance" CROSS to LONG after the correct x-ray field size has been set. Refer to section 5, Steps 5.4 through 5.4.4 for adjustment procedure.

NOTE! Before setting these voltages to a value different from those on the inside cover, verify the calibration of Image Receptors (cassette trays). Refer to Section 4.5.

EQUIPMENT REQUIRED:

A. LINEAR collimator test pattern 70-09015 contained in this manual.
B. Measuring tape (ruler).
C. 14" x 17" x-ray film cassette.
D. Densitometer (or a 1.0 neutral density filter for density comparison).

4.1 LIGHT FIELD / X-RAY CONGRUENCE TEST

Place the x-ray source-to-table distance at 40" SID and lock in place.

4.1.1 Locate a cassette on the table top and accurately center the cassette to the light field. Mark the position of the cassette on the table top.

4.1.2 Manually reduce the size of the x-ray field to the next smaller film size.

4.1.3 Identify the light-field edges and carefully mark the edges by placing metal markers as illustrated below. See Figure 4.1.

4.1.4 Expose the film to a density of 1.0 and develop.

4.1.5 Carefully identify the x-ray field edges and measure the difference between the x-ray field edges and light field edges.

4.1.6 The sum of long axis difference (X1 + X2) shall not exceed 2% of the SID, and the sum of the cross axis difference shall not exceed 2% of the SID. See Figure 4.1.

4.1.7 If adjustment is required, refer to Section 5.0, 5.1 through 5.1.8.

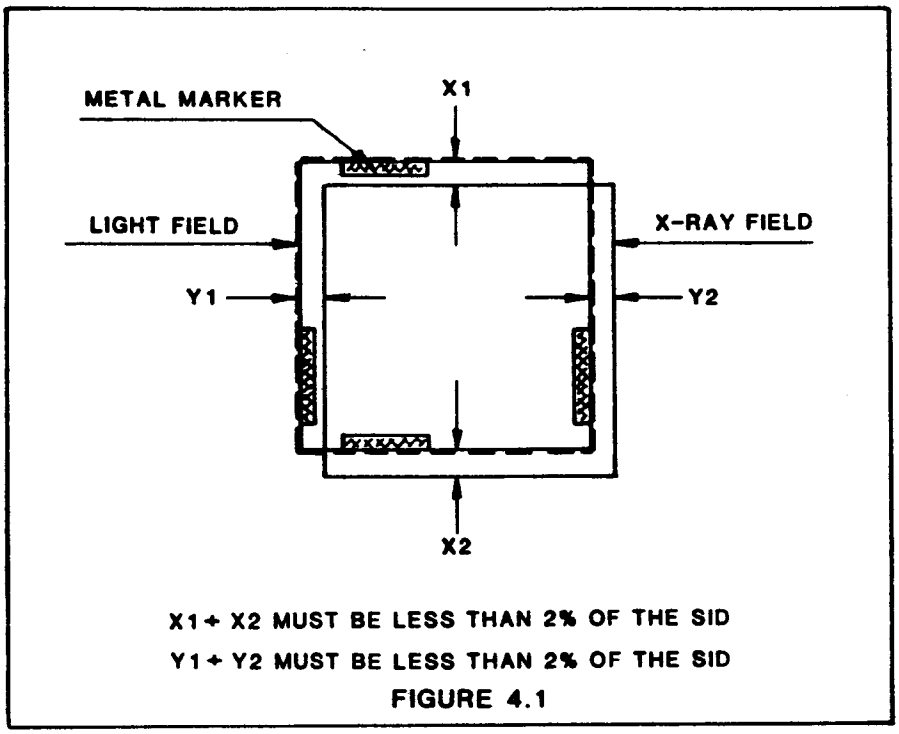


FIGURE 4.1

4.1.8 Angulate the collimator to 0° beam-down position and the table top to 0° horizontal. Remove the LINEAR collimator table-top TEST PATTERN 1 (70-09015) from this manual and position it on the table-top with the edges parallel to the table-top edges. Flatten the creases and tape it into position at the corners in a manner that will not damage it upon removal. (Figure 4.1)

4.1.9 Position the collimator at a focal spot distance of 40" ± 1/16" by measuring from the center of the exit window to the center of the light field on the table top; this distance should be 30 5/8" ± 1/16".

If necessary, remove the bottom collimator cover to gain access to the program switches on the Logic P.C.B. See COVER REMOVAL INSTRUCTIONS, Figure 3.0, Section 3.

4.2 40" SID ADJUSTMENT

Be certain there is no cassette in the table bucky! Set SW3-2 "ON" to simulate 40" HSID. (See Figure 4.1)

4.2.1 Set SW2-1 and SW2-3 "ON" to simulate a 14" x 14" cassette.

4.2.2 Set SW3-4 "ON" to simulate the insertion of the 14" x 14" cassette in the cassette tray.

4.2.3 The light field edges should now be inside the 14" x 14" at 40" SID tolerance marks on TEST PATTERN 70-09015.

4.2.4 If the light field edges are not within the 14" x 14" at 40" SID tolerance marks, adjust the 40" SID pot R23 a small amount (7.0 vdc nominal on TP-4, IC3, pin 1, Logic P.C.B. or TS3-4, Power Supply Chassis). Manually turn the collimator knobs to a larger size and release.

4.2.5 The shutters will become reset to the new size caused by adjusting R23.

4.2.6 Repeat steps 4.2.4 and 4.2.5 until the light field edges are within the 14" x 14" at 40" SID tolerance marks.

4.3 Collimator Feedback Linearity Test

The following tests will quickly confirm the correct factory settings of the shutter feedback potentiometers by simulating a 14" x 14" cassette, then simulating a 5" x 5" cassette. The "errors" of each of these field sizes must be the same.

EXAMPLE 1

Field size, Step 4.3.1 = 14.5" × 14.5" = +0.5" error

Field size, Step 4.3.5 = 5.5" × 5.5" = +0.5" error

CONCLUSION: Errors are consistent, collimator passes linearity test, proceed with Step 4.3.7.

EXAMPLE 2

Field size, Step 4.3.1 = 13.7" × 13.7" = −0.3" error

Field size, Step 4.3.5 = 5.4" × 5.4" = +0.4" error

CONCLUSION: Errors are inconsistent, collimator fails linearity test, skip to Section 5 and check VCPL and VCPC, Steps 5.4 through 5.4.4. If VCPL and VCPC are correct, replace the collimator head.

EXAMPLE 3

Field size, Step 4.3.1 = 13" x 14" = (Testing Stopped)

CONCLUSION: Errors in only one field size test inconsistent, resulting in a "rectangular" x-ray field size, collimator fails test. Skip to Section 5 and check VCPL and VCPC, Steps 5.4 through 5.4.4. If VCPL and VCPC are correct, replace the collimator head.

4.3.1 The light field should now be measured in the CROSS direction and the LONG direction and recorded. The CROSS size must match the LONG size within ±0.20".

4.3.2 Set SW3-4 "OFF" (Cassette removal).

4.3.3 Set SW2-1 and SW2-3 "OFF" then set SW2-2 and SW2-4 "ON" (exchanging 14" x 14" IR with a 5" x 5" IR).

4.3.4 Set SW3-4 "ON" to simulate the insertion of the 5" x 5" cassette in the cassette tray. Allow the system to readjust until both READY lights come on.

4.3.5 The light field should now be measured in the CROSS direction and the LONG direction and recorded. The CROSS size must match the LONG size within ±0.20".

4.3.6 If the measurement in Steps 4.3.1 and 4.3.5 are within ±0.20" skip to Step 4.3.7. If the measurements differ by more than ±0.20", skip to Section 5, Steps 5.4 through 5.4.4 and check VCPL and VCPC. If they are correct, replace the collimator head.

If the light field errors in Step 4.3.1 are more than 0.20" greater, or 0.20" less than the errors in Step 4.3.5, skip to Section 5, Steps 5.5 through 5.5.4 and check VCPL and VCPC. If they are correct, replace the collimator head.

4.3.7 Set SW3-4 "OFF" (removal of cassette).

4.3.8 Set SW-2-2 and SW-2-4 "OFF", then set SW2-1 and SW2-3 "ON" (exchanging 5" x 5" IR with 14" x 14" IR). Set SW3-4 "ON" (insertion of cassette).

4.4 72" SID Adjustment

Set SW3-2 "OFF" and set SW3-3 "ON" (exchanges 40" SID switch with 72" SID switch). Set SW3-4 "ON" to simulate the insertion of the 14" x 14" cassette in the cassette tray. Allow the system to readjust until both READY lights are ON.

4.4.1 The light field edges should now be inside the 14" x 14" at 72" SID tolerance marks on TEST PATTERN 70-09015.

4.4.2 If the light field edges are not within the 14" x 14" at 72" SID tolerance marks, adjust 72" SID pot R24 a small amount, (4.39 vdc nominal on TP-4, IC3, pin 1, Logic P.C.B. or TS3-4, Power Supply Chassis). Manually turn the collimator knobs to a larger size and release. Repeat the adjustment until the light field edges are within the 14" x 14" at 72" SID tolerance marks.

NOTE: At the end of this adjustment procedure re-set the test switches as follows:

SW2-1 – OFF	SW3-1 – OFF
SW2-2 – OFF	SW3-2 – OFF
SW2-3 – OFF	SW3-3 – OFF
SW2-4 – OFF	SW3-4 – OFF
SW2-5 – BEAM RIGHT (WALL BUCKY) ON FOR RIGHT OFF FOR LEFT	SW3-5 – BEAM LEFT (WALL BUCKY) OFF FOR RIGHT ON FOR LEFT

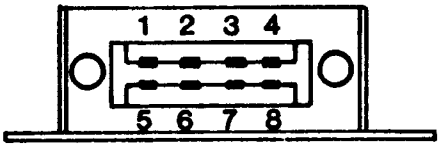
4.5 CASSETTE TRAY ADJUSTMENT

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

We have calibrated the collimator around a cassette tray that is calibrated at 500 ohms for an 11 inch (12⅛" outside) cassette. The 11" dimension represents exactly one-half of the 1K ohm cassette tray potentiometer. We strongly suggest that you check, and adjust if necessary, your cassette trays. Consult the tray manufacturer's manual for adjustment procedures.

Following is the size vs. ohms chart:

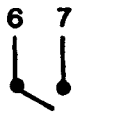
Cassette Size	Ohms Between Pins 1-5 and 4-8
5"	60 Ohms
7	207
8	280
10	427
11	500
12	573
14	720
17	940



Rear view of Tray Connector

Cross

Long

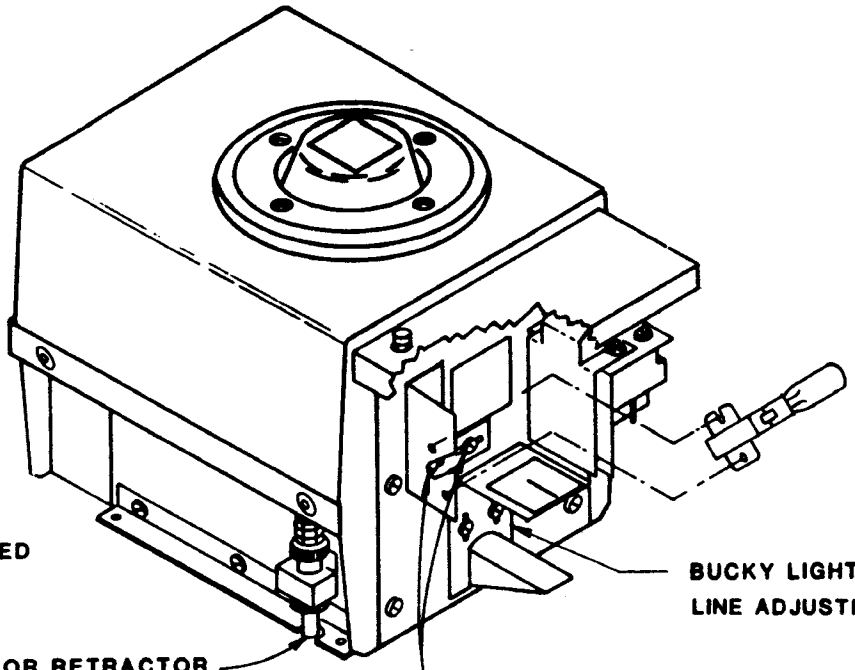


Cassette Present Switch

SECTION 5.0

ALIGNMENT PROCEDURES

LIGHT FIELD ADJUSTMENT



CROSS ALIGNMENT

1. LOOSEN LOWER KNURLED KNOB
2. ADJUST UPPER KNURLED KNOB FOR LIGHT FIELD ALIGNMENT, FRONT TO REAR.
3. TIGHTEN LOWER KNOB

LONGITUDINAL ALIGNMENT

1. SLIGHTLY LOOSEN THE TWO #6-32 SCREWS
2. POSITION LAMP BRACKET LATERALLY FOR LIGHT FIELD ALIGNMENT, LEFT TO RIGHT.
3. TIGHTEN THE TWO SCREWS.

WARNING: THE INTENSITY OF THE LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER DIRECTLY INTO YOUR EYES: MAINTAIN A POSITION IN WHICH YOU CAN NEITHER SEE THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

WARNING: THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS: DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

FIGURE 5.1

5.0 ALIGNMENT PROCEDURES

5.1 FIELD PROJECTION LAMP AND MIRROR ADJUSTMENT

These tests must be performed when the field projection lamp is altered from its original position or is replaced.

These tests must also be performed if the original mirror angle has been altered and if any edge of the developed x-ray image is outside of the tolerance marks as defined in Step 4.1.6.

5.1.1 Steps 4.1 through 4.1.6 should be carefully reviewed or repeated prior to a lamp or mirror adjustment attempt. This is particularly important if only a single testing indicates a failure to meet the requirements defined in Step 4.1.6.

5.1.2 The collimator position and the developed x-ray film must remain undisturbed from the position defined in Steps 4.1 through 4.1.9.

5.1.3 Remove the lamp housing cover and bottom collimator cover. See Figure 3.0 and Figure 5.1.

WARNING! THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS. DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

WARNING! THE INTENSITY OF LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER THE EYES DIRECTLY. MAINTAIN A POSITION IN WHICH YOU CAN SEE NEITHER THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

5.1.4 If the developed x-ray image (Step 4.1.6) is off-center in the longitudinal direction, loosen the two screws securing the lamp bracket. (Figure 5.1)

5.1.5 Use a pair of long-nose pliers to move the bracket slightly until the light-field has shifted to a position that is centered to the developed x-ray image (4.1.6) in the longitudinal direction. Tighten the two screws securing the lamp bracket.

5.1.6 If the developed x-ray image (Step 4.1.6) is in error in the cross-table direction, adjust the angle of the mirror (using the knurled knobs as shown in Figure 5.1) until the light-field has shifted to a position that is centered to the developed x-ray image (4.1.6).

5.1.7 Repeat Steps 4.1 through 4.1.8 to confirm the results of the above adjustments.

5.1.8 Tighten the lamp bracket screws and replace the lamp housing cover.

5.2 CROSS-HAIR WINDOW ADJUSTMENT

5.2.1 These procedures are to be performed if the cross hair shadows are not centered to the light-field.

5.2.2 Remove the cone-adaptor rails and the lower half of the collimator case (Figure 3.0).

5.2.3 Loosen the screws securing the plastic window.

5.2.4 Move the plastic window to align and center the cross hair pattern to the light-field (center lines on the test pattern).

5.2.5 Tighten the screws and reassemble the collimator cover.

5.3 BUCKY CENTERING LIGHT-LINE ADJUSTMENT

These procedures are to be performed if the centering light-line is not centered to the correctly adjusted light-field.

5.3.1 Remove the lamp housing cover.

WARNING! THE LAMP AND HEAT DEFLECTORS MAY BE HOT ENOUGH TO CAUSE SEVERE BURNS. DO NOT TOUCH ANY OBJECT IN THE LAMP AREA WITH BARE SKIN.

WARNING! THE INTENSITY OF LIGHT OUTPUT IS SUFFICIENT TO TEMPORARILY IMPAIR YOUR VISION IF ALLOWED TO ENTER THE EYES DIRECTLY. MAINTAIN A POSITION IN WHICH YOU CAN SEE NEITHER THE FILAMENT WHEN IT IS OFF, OR ALLOW LIGHT TO DIRECTLY ENTER YOUR FIELD OF VISION WHEN IT IS ON.

5.3.2 If the centering light-line is off-center to the correctly centered light-field or exhibits a rainbow of colors along one edge, loosen the two screws securing the prism/slit bracket (Figure 5.1.4).

5.3.3 Use a pair of long-nose pliers to move the bracket as required to center the light-line to the correctly adjusted light-field.

NOTE: In order to avoid a rainbow of color along the edges, or to eliminate these colors, maintain the prism in a position that is centered to the bright light-line observed on the bracket at the base of the prism while adjusting the bracket.

5.3.4 Tighten the screws and replace the lamp housing cover.

5.4 COLLIMATOR POTENTIOMETER VOLTAGE ADJUSTMENT (VCPL, VCPC)

NOTE: R25 is factory set and should not be altered in normal circumstances. This adjustment control controls the tracking, open to close, of the shutters.

5.4.1 Connect a DVM from logic ground to TP2 (VCPL).

5.4.2 Adjust R25 to produce the voltage reading that has been recorded on the label inside the lower plastic cover (Approximately 11.8 vdc).

5.4.3 With VCPL voltage correctly adjusted, connect the DVM from logic ground to TP3 (VCPC).

5.4.4 Adjust R26 to produce the voltage reading that has been recorded on the label inside the lower plastic cover (approximately 9.7 vdc).

SECTION 6.0

COMPLIANCE VERIFICATION

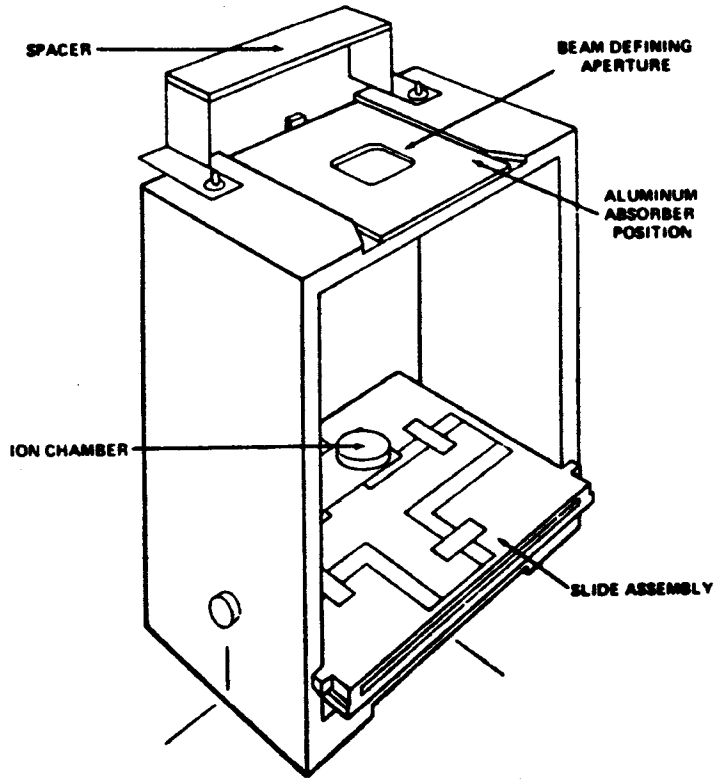
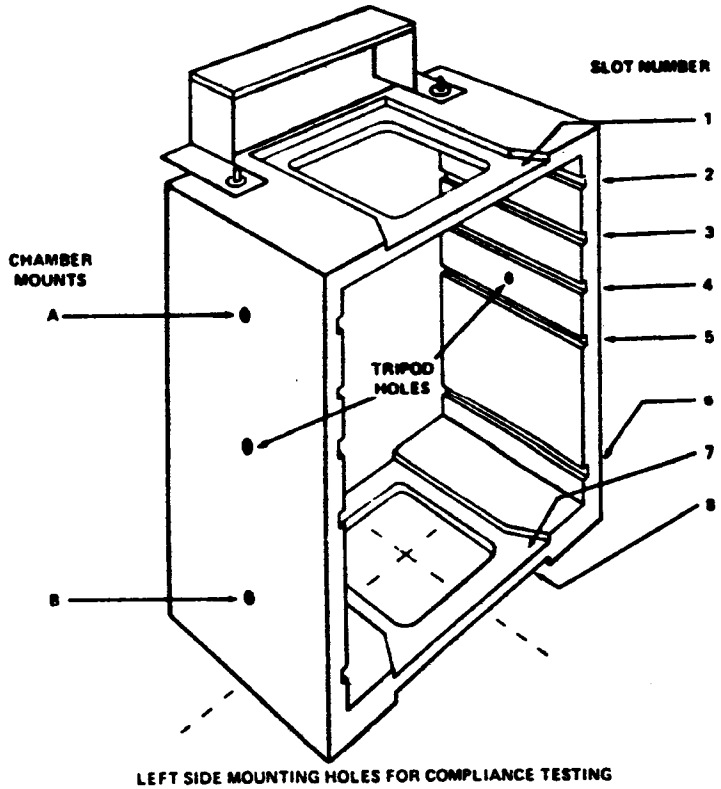


Figure 6.1



LEFT SIDE MOUNTING HOLES FOR COMPLIANCE TESTING

Figure 6.2

6.0 COMPLIANCE VERIFICATION

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, Performance Standards.

The following tests are from the NEMA Standards Publication, No. XR 8-1979 (Test Methods for Diagnostic X-ray Machines for use during initial installation).

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 special requirements of the Eureka Linear Collimator. Any reference to tolerances on compliance items are referenced directly from 21 CFR, Sub-Chapter J, Regulations. 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 and the compliance of the equipment is being determined.

6.1 VERIFICATION TESTS TO BE PERFORMED:

Test Procedure or Requirement	Applicable Paragraph
1. Visual Definition of X-ray Light-Field	XR8/2.14
2. Intensity of Light-Field Illumination	XR8/2.15
3. Minimum Field Size	XR8/2.16
4. X-ray Field/Receptor Center Alignment	XR8/2.17
5. Indication of Field Size	XR8/2.18
6. Positive Beam Limitation (PBL)	XR8/2.19
7. X-ray Field Limitation and Alignment	XR8/2.20
8. Return to PBL with Image Receptor Change	XR8/2.21
9. Keylock PBL Override	XR8/2.22
10. Beam Quality	XR8/2.09

RECORD THE RESULTS ON THE *RECORD SHEET* SUPPLIED AT THE END OF THIS SECTION.

RADIATION ☢ WARNING FOR DIAGNOSTIC X-RAY SYSTEMS

X-rays are dangerous to both operator and others in the vicinity unless established safe exposure procedures are strictly observed.

The useful and scattered beams can produce serious, genetic or potentially fatal bodily injuries to any persons in the surrounding area if used by an unskilled operator. Adequate precautions must always be taken to avoid exposure to the useful beam, as well as to leakage radiation from within the source housing or to scattered radiation resulting from the passage of radiation through matter.

Those authorized to operate, test, participate in or supervise the operation of the equipment must be thoroughly familiar and comply completely with the currently established safe exposure factors and procedures described in publications such as Sub-Chapter J of Title 21 of the Code of Federal Regulations, *"Diagnostic X-ray Systems and their Major Components"*, and the National Council on Radiation Protection (NCRP) No. 33, *"Medical X-ray and Gamma-ray Protection for Energies up to 10 MeV-Equipment Design and Use"*, as revised or replaced in the future.

Failure to observe these warnings may cause serious, genetic or potentially fatal bodily injuries to the operator or those in the area.

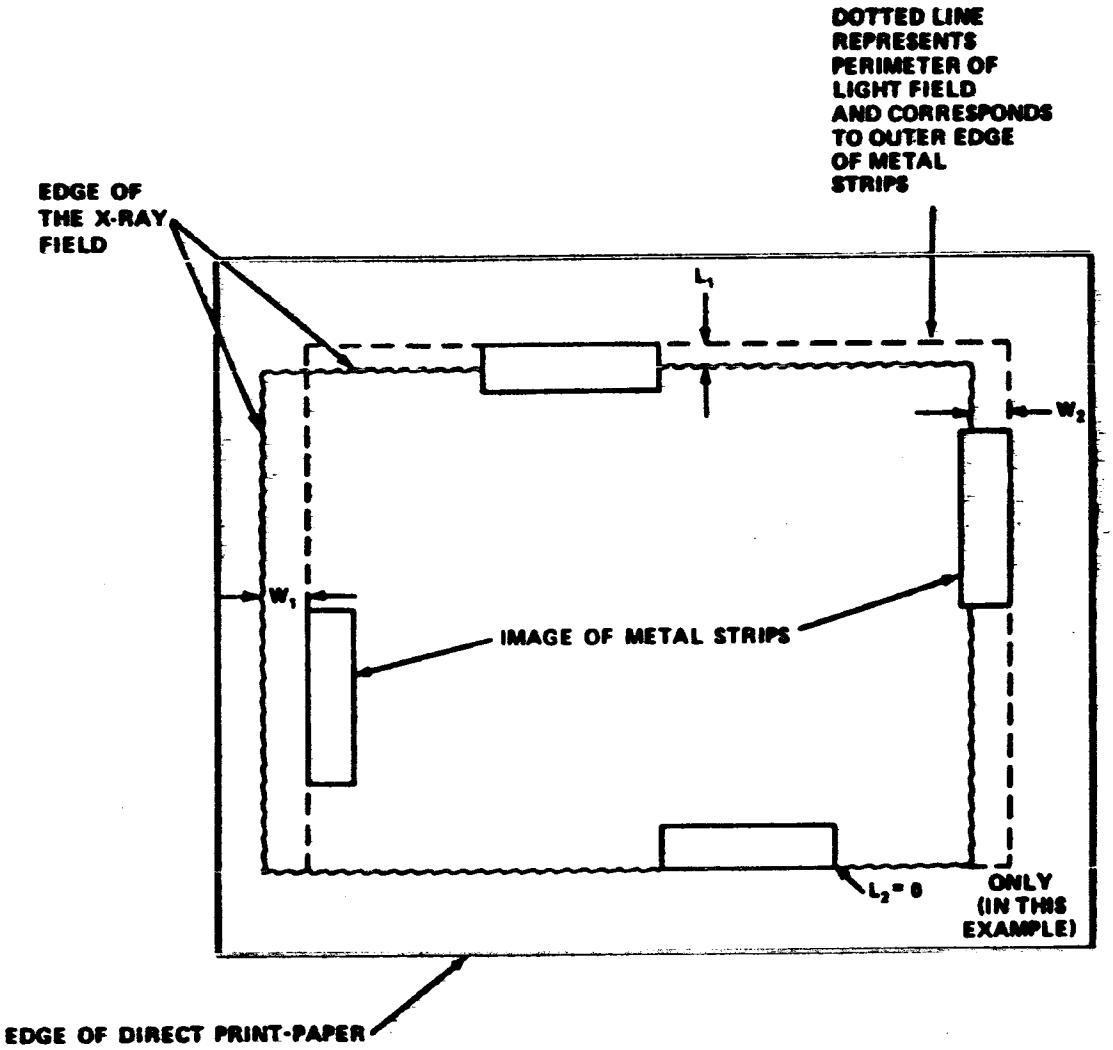

DOTTED LINE REPRESENTS PERIMETER OF LIGHT FIELD AND CORRESPONDS TO OUTER EDGE OF METAL STRIPS
EDGE OF THE X-RAY FIELD
L_1
W_2
W_1
IMAGE OF METAL STRIPS
$L_2 = 0$
ONLY (IN THIS EXAMPLE)
EDGE OF DIRECT PRINT-PAPER

Figure 6.3

XR 8-2.14 VISUAL DEFINITION (RADIOGRAPHIC) OF X-RAY LIGHT FIELD

REQUIREMENT – Means shall be provided for visually defining the perimeter of the X-ray field. 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. [See 21 CFR 1020.31(d)(2).]

.01 METHOD I — BRH/FDA COMPLIANCE TEST METHOD

A. EQUIPMENT REQUIRED

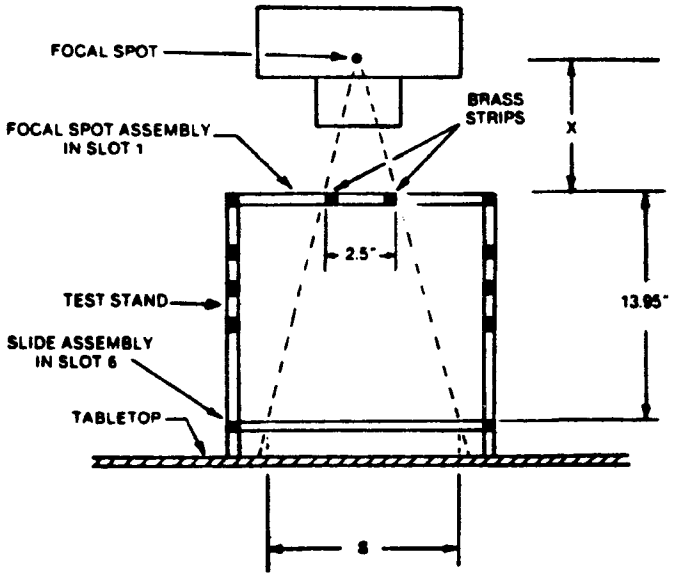
1. BRH/FDA compliance test stand (including slide assembly).
2. Four metal marker strips.
3. Plastic cassette, loaded with direct-print paper or film.

B. PROCEDURE

1. Attach the spacer, positioned out of the primary beam to the test stand. Center the stand on the table. Center the source over the stand, assure by the means provided that the axis of the X-ray beam is perpendicular to the plane of the image receptor, and bring the beam-limiting device down into firm contact with the spacer. Select the MANUAL mode of operation (there must not be a cassette in the cassette holder).
2. Insert the slide assembly, grid side up, into slot 6 of the test stand and the focal spot assembly into slot 1 (Fig. 6-2). Place a cassette loaded with direct-print paper or film into the slide assembly.
3. Adjust the collimator such that no part of the light-field intersects any portion of the top of the test stand. (Further collimation to a light-field of less than 15 by 20 centimeters [6 by 8 in] on the slide assembly grid may be desirable to assure that the X-ray field will be fully contained on the direct-print paper or film in the slide assembly).
4. Position the outer edge of each metal strip to correspond with each side of the light-field. One end of the metal strip shall extend to the center line of the respective grid arm.
5. Select proper technique factors and make an exposure (may require several exposures to obtain 1 R to the direct-print paper).
6. Develop the direct-print paper or film.

C. VERIFICATION OF COMPLIANCE

For determination of misalignment, compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal strips. On each side of the rectangular fields, measure the separation between the X-ray field and the outside edge of the image of the respective metal strip. Sum these measured separations for opposite sides of the X-ray field to yield a total misalignment in the length and in the width dimensions. Record the length misalignment and width misalignment, both without regard to sign (see Par. D below and Fig. 6-3).



DETERMINATION OF SID

Figure 6.4

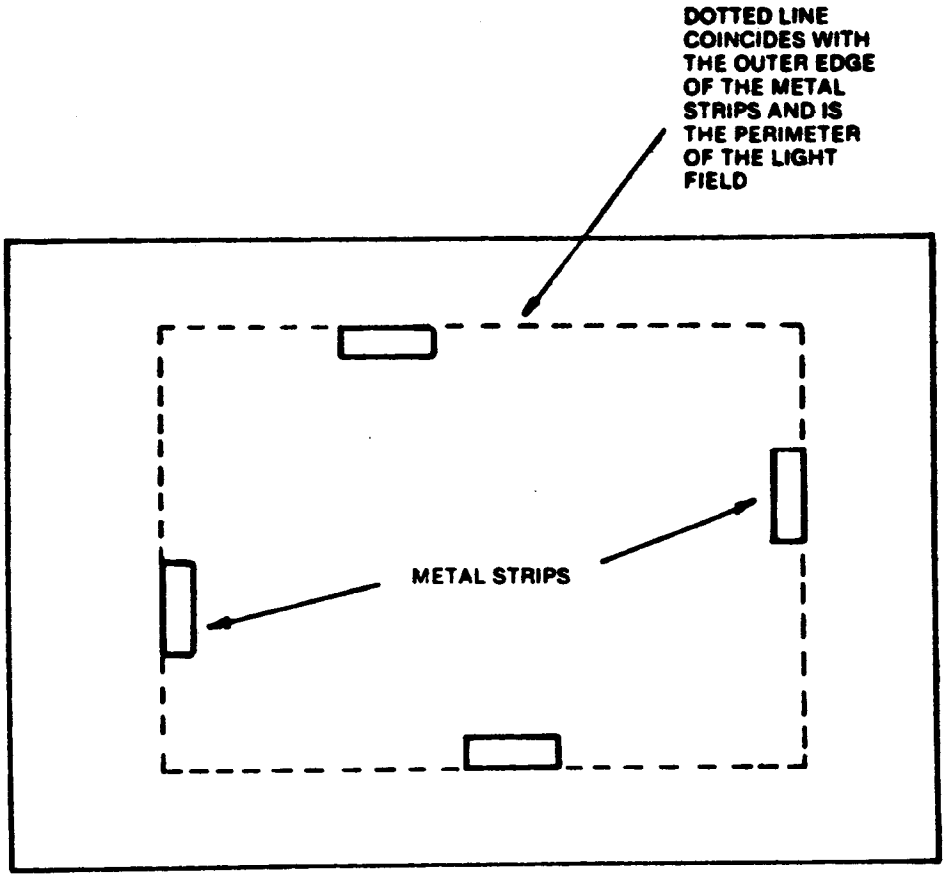


Figure 6.5

D. CALCULATIONS

Calculate the source-to-image distance (SID) per the following formula (to slot 6) as the indicated source-to-table top distance minus 4.7 centimeters (1.85 in) and record. Calculate 2 percent of this SID and record. Both the length and the width misalignment must be less than 2 percent of SID (to slot 6).

$$\frac{2.5}{S} = \frac{X}{X + 13.95}$$

$$2.5X + (2.5)\ 13.95 = XS$$

$$(2.5)\ 13.95 = XS - 2.5X$$

See Fig. 6-4.

$$34.875 = X\ (S - 2.5)$$

$$X = \frac{34.875}{S - 2.5}$$

The misalignments are calculated:

Length misalignment = $L_1 + L_2 \leqslant 2\%$ SID
Width misalignment = $W_1 + W_2 \leqslant 2\%$ SID

Calculate 2 percent of the measured SID. Each of the misalignments, length or width, must be less than or equal to 2 percent of the measured SID for compliance.

NEMA Standard 5-15-1979.

.02 **METHOD II — METAL MARKER METHOD**

A. GENERAL

The actual versus indicated source-to-image distance (SID) test must be performed prior to attempting this test.

B. EQUIPMENT

1. Plastic cassette with direct-print paper or film.
2. Radio-opaque markers.*

* Each marker is approximately 1/32 inch galvanized sheet metal having the dimensions of 1.5 by 1.5 inches.

C. PROCEDURE

1. Adjust the source assembly and the beam-limiting device so that they are approximately centered over the table and perpendicular to the table top. Then position the beam-limiting device to the SID previously determined and record the indicated value.
2. Insert the cassette and turn on the light field.** Adjust the beam-limiting device to the next size smaller than the cassette size being used.

** Make a note to record the field size indicated on the dial of the beam-limiting device for the SID being used.

3. Position the outer edge of each metal marker on the table top to correspond with each side of the light-field (Fig. 6-5).
4. Select the appropriate technique factors and make an exposure.
5. Develop film or direct-print paper.

D. VERIFICATION OF COMPLIANCE

For determination of misalignment, compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal strips. On each side of the rectangular fields, measure the separation between the X-ray field and the outside edge of the image of the respective metal strip. Sum these measured separations for opposide sides of the X-ray field to yield a total misalignment in the length and in the width dimensions. Record the length misalignment and width misalignment, both without regard to sign (See Par. E below and Fig. 6-3).

E. CALCULATIONS

Calculate the SID per the following formula (to slot 6) as the indicated source-to-tabletop distance minus 4.7 centimeters (1.85 in) and record. Calculate 2 percent of this SID and record. Both the length and the width misalignment must be less than 2 percent of SID (to slot 6).

$$\frac{2.5}{S} = \frac{X}{X + 13.95}$$

$$2.5X + (2.5)\ 13.95 = XS$$

$$(2.5)\ 13.95 = XS - 2.5X$$

See Fig. 6-4.

$$34.875 = X\ (S - 2.5)$$

$$X = \frac{34.875}{S - 2.5}$$

The misalignments are calculated:

Length misalignment = $L_1 + L_2 \leq 2\%$ SID
Width misalignment = $W_1 + W_2 \leq 2\%$ SID

Calculate 2 percent of the measured SID. Each of the misalignments, length or width, must be less than or equal to 2 percent of the measured SID for compliance.

NEMA Standard 5-15-1979.

.03 **METHOD III — ALTERNATE TEST STAND METHOD**

A. GENERAL

1. The image of the radiation field on the film must be of uniform density with sharply defined edges.
2. The graduated template is utilized to minimize the amount of error introduced into the measurement of the X-ray field size.
3. The actual versus indicated source-to-image distance (SID) must be determined prior to performing this test.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Cassettes and film.
3. Graduated template.

C. PROCEDURE

1. Align the tube unit and image receptor and set the SID with the normal operating aids (detents, scales, lights, etc.).
2. Load cassette and insert into image receptor.
3. Close shutters to a size smaller than that of the cassette placed into the image receptor.
4. Position the test stand in accordance with the manufacturer's instructions.
5. Energize the field light and record or define the position of the four light field edges as shown on the graduated template or position four metal markers such that the outer edge of each metal marker corresponds to an edge on each side of the light field or both.
6. Select proper technique factors, make an exposure, and develop film.

D. VERIFICATION OF COMPLIANCE

1. Calculate 2 percent of the actual SID and record.
2. Compare the edges of the X-ray field to the edges of the light-field as defined by the outer edges of the metal markers or by the graduated scale.
3. Measure the distance between the edges of the two fields for each side of the rectangular fields (See Fig. 6-3).
4. Arithmetically sum the misalignment of opposite sides, regardless of sign, of the rectangles, to yield misalignment in each of the two directions.

   Length misalignment = $L_1 + L_2 \leqslant 2\%$ SID
   Width misalignment = $W_1 + W_2 \leqslant 2\%$ SID

   Both the length and the width misalignment must be less than 2 percent SID as calculated in Step 1.

NEMA Standard 5-15-1979 1/3

XR 8-2.15 INTENSITY OF LIGHT FIELD ILLUMINATION

REQUIREMENT – When a light localizer is used to define the X-ray field, it shall provide an average illumination of not less than 160 lux (15 footcandles) at 100 centimeters or at the maximum source-to-image distance (SID), whichever is less. The average illumination shall be based on measurements in the approximate center of each quadrant of the light field. [See 21 CFR 1020.31(d)(2)(ii).]

.01 **METHOD I** — DIRECT TEST

A. GENERAL

1. Make certain that all surfaces in the light path are clean.
2. Reduce ambient light level as much as is feasible.

B. EQUIPMENT

Photometer capable of measuring 160 lux (15 footcandles).

C. PROCEDURE

1. Place the photometer on the tabletop and set the diagnostic source assembly such that the sensing area of the photometer is at 100 centimeters or the maximum SID, whichever is less.
2. Open the beam-limiting device to assure that each quadrant of the light field is larger than the sensing area of the photometer.
3. Refer to the manufacturer's instructions for proper use of the photometer.
4. Turn on the light localizer.
5. At or near the center of a light field quadrant, determine the illuminance by subtracting the ambient light level from the corresponding light level as measured when the light localizer is energized. Do not move the photometer between measurements.
6. Repeat the procedure for the remaining three quadrants.
7. Determine the average illuminance of the four light field quadrants.
8. Record the model number, serial number, and date of calibration of test instrument.

D. VERIFICATION OF COMPLIANCE

Verify that the average illumination is not less than 160 lux (15 footcandles).

NEMA Standard 5-15-1979.

.02 **METHOD II — INDIRECT TEST**

A. GENERAL

1. This indirect test is feasible after the correlation between light output and voltage is made; the manufacturer then specifies a voltage to be measured or adjusted, or both.
2. Make certain that all surfaces in the light path are clean and unobstructed.

B. EQUIPMENT

Digital Voltmeter.

C. PROCEDURE

1. Remove trim covers to gain access to the lamp socket.
2. Verify that the specified lamp is in the socket.
3. With the light-field energized, measure the voltage across the lamp socket terminals.
4. Record the voltage measured.
5. Record the model number, serial number and calibration date of the digital voltmeter.

D. VERIFICATION OF COMPLIANCE

The voltage recorded shall be within the tolerances specified by the manufacturer.
NEMA Standard 5-15-1979

NOTE: THE AC VOLTAGE AT THE LAMP SOCKET MUST NOT BE LESS THAN 19.5 VAC RMS.

XR 8-2.16 MINIMUM FIELD SIZE

REQUIREMENT – Minimum field size at 100 centimeters (radiographic) or the maximm source-to-image distance (SID) (fluoroscopic) shall be less than or equal to 5 by 5 centimeters [See 21 CFR 1020.31(d)(1), 1020.31 (e)(2), and 1020.32 (b)(2).]

.01 **METHOD I — FILM METHOD**

A. GENERAL

1. The following test is to be used for radiographic, fluoroscopic, and spot-film devices.
2. This procedure need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than 5 by 5 centimeters at the specified SID.

B. EQUIPMENT

1. Cassette.
2. X-ray film or direct-print paper.

C. PROCEDURE 1 — RADIOGRAPHIC AND SPOT-FILM DEVICES

1. Adjust the maximum SID obtainable (spot-film devices or 100-centimeter radiographic devices).
2. Adjust the beam-limiting device to the smallest field size obtainable.
3. Load cassette and set proper technique factors.
4. Make an exposure.
5. Process film.

D. PROCEDURE 2 — FLUOROSCOPIC ☢

1. Set fluoroscopic system for maximum SID and lock into position.
2. Remove all compression cones from the beam.
3. With the X-ray beam off, attach beam attenuator to the input surface of the image receptor.
4. Attach cassette to the bottom of the attenuator.
5. Close shutters as far as possible.
6. Set technique factors to assure proper exposure of the film.
7. Make exposure.
8. Process film.

E. VERIFICATION OF COMPLIANCE

Measure the X-ray field produced on film and verify that the field size is less than or equal to 5 by 5 centimeters.

NEMA Standard 5-15-1979.

.02 METHOD II — VISUAL METHOD

A. GENERAL

1. The following tests are to be used for radiographic, fluoroscopic, and spot-film devices.
2. These procedures need not be performed if it is apparent by visual means that the beam-limiting device can be adjusted to a size less than or equal to 5 by 5 centimeters at the specified source-to-image distance (SID).
3. These tests attempt to minimize radiation exposures as well as film processing by utilizing light field visual display, or image display, or visual mechanical movement.

B. EQUIPMENT

Beam attenuator.

C. PROCEDURE 1 — RADIOGRAPHIC

1. Set the tube unit at a distance of 100 centimetes from the image receptor.
2. Pull out the bucky tray and place an unloaded cassette into the tray. *Do not reinsert bucky tray.*
3. Position source assembly over film cassette in the extended bucky tray.
4. Actuate the light field and close shutters to minimum size. If the light is completely blocked from the image receptor no further test is required.
5. Measure the light field size on the cassette of the extended bucky tray.

D. VERIFICATION OF COMPLIANCE

Measured field size must be less than or equal to 5 by 5 centimeters.

E. PROCEDURE 2 — SPOT-FILM/FLUOROSCOPIC ☢

1. Set SID for maximum obtainable and lock in place.
2. Position beam attenuator to intercept entire X-ray beam.
3. Set appropriate technique factors (both spot-film and fluoroscopic).
4. Close shutters to smallest size obtainable and make an exposure.
5. Verify on viewing device that there is no visual indication of radiation. If any radiation field is discernible, Method I must be utilized to determine minimum field size.

F. VERIFICATION OF COMPLIANCE

Verify that no visual indication of the radiation field is discernible.

NEMA Standard 5-15-1979.

XR 8-2.17 X-RAY FIELD/RECEPTOR CENTER ALIGNMENT

REQUIREMENT – 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). (See 21 CFR 1020.31(e)(1).

A. GENERAL

1. All exposures taken during this test must have a uniform film density of approximately 1.0.
2. Actual versus indicated SID must be determined prior to performing this test.

B. EQUIPMENT

Radiographic cassette loaded with film (8 by 10 inches).

C. PROCEDURE

1. Load cassette with film and place into the bucky tray.
2. Assure that the X-ray beam is perpendicular to the image receptor and centered over the bucky tray.
3. Set the SID to the value determined in the actual versus indicated SID test.
4. Reduce the X-ray field to approximately 6 by 8 inches.
5. Make an exposure and develop film.
6. To determine as accurately as possible the corners of the image recorded on the film, locate two points on each of the four sides of the image. Through the two points on each side draw a straight line. These four lines when extended intersect making a rectangle which is a close approximation of the actual X-ray field. Draw a diagonal across the image to determine the center of the X-ray image.
7. To determine the center of the X-ray film draw diagonals across the film (the point where these two lines cross is the center of the film), or fold the film into quarters (the point where the two folds cross is the center of the film).
8. The distance from the film center mark to the image center mark is measured and recorded as the linear displacement or mis-alignment of the centers of the X-ray field and the image receptor.

D. VERIFICATION OF COMPLIANCE

Verify that this distance is less than or equal to 2 percent of the SID.

NEMA Standard 5-15-1979.

XR 8-2.18 INDICATION OF X-RAY FIELD SIZE

REQUIREMENT – 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). [See 21 CFR 1020.31(e)(1).]

A. GENERAL

The actual versus indicated SID test must be performed prior to beginning this test.

B. EQUIPMENT

A 24- by 30-centimeter or a 10 by 12 inch cassette with film.

C. PROCEDURE ☢

1. Set the SID to the value determined in the actual versus indicated SID test.
2. Center the film cassette in the cassette tray and insert into position.
3. Adjust the field size to 15 by 15 centimeters or 8 by 8 inches by means of the numerical indicators on the beam-limiting device.
4. Make an exposure and develop film.
5. Measure and record the length and width dimensions of the image.

D. VERIFICATION OF COMPLIANCE

The deviation of any of the recorded dimensions must not exceed 2 percent of the SID in Step 1.

NEMA Standard 5-15-1979.

XR 8-2.19 POSITIVE BEAM LIMITATION (PBL)

REQUIREMENT – Means shall be provided for positive-beam limitation (PBL) which will, at the source-to-image distance (SID) for which the device is designed, either cause automatic adjustment of the X-ray field in the plane of the image receptor to the image receptor size within five seconds after insertion of the image receptor or, if adjustment is accomplished automatically in a time interval greater then 5 seconds or is manual, will prevent production of X-rays until such adjustment is completed. At SID's at which the device is not intended to operate, the device shall prevent the production of X-rays. [See 21 CFR 1020.31(e)(2).]

A. GENERAL

The PBL requirement must be met if both the beam axis and table angulation are within plus or minus 10 degrees of the horizontal or vertical and the film is used in the cassette tray.

B. EQUIPMENT

Large size cassette.

C. PROCEDURE ☢

1. Set the source assembly to a SID where the PBL system is intended to operate.
2. Place the largest film cassette with which the system is intended to operate into the cassette tray; do not insert cassette tray at this time.
3. Turn on the light localizer and adjust the beam-limiting device to the smallest obtainable field size.
4. Insert the cassette tray and measure the time elapsed from the insertion of the cassette tray with the cassette inserted to the adjustment of the X-ray field to the image receptor size.
5. The adjustment must be accomplished within 5 seconds.
6. If the adjustment is not accomplished within 5 seconds or the beam-limiting device is of the manual type, select low-range values of tube potential and tube current and attempt to make an exposure. The production of X-rays must be prevented until the PBL adjustment is completed.
7. Move the source assembly to a SID where the PBL system is not intended to operate (see manufacturer's specifications) and attempt to make an exposure. Exposures must not be possible.

NEMA Standard 5-15-1979.

XR 8-2.20 X-RAY FIELD LIMITATION AND ALIGNMENT

REQUIREMENT – The X-ray field size in the plane of the image receptor, whether automatically or manually adjusted, 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. [See 21 CFR 1020.31(e)(2)(ii).]

.01 METHOD I — BRH/FDA TEST STAND METHOD

A. EQUIPMENT

1. BRH/FDA compliance test stand with accessories.
2. Slide assembly.
3. Plastic cassette containing a sheet of direct-print paper or X-ray film.
4. Ruler.
5. Cassette (preferably 8 by 10 inches or smaller).

B. PROCEDURE

1. Using the means provided, align the source assembly such that the beam axis is perpendicular to the image receptor.
2. Place the test stand on the table.
3. Position the spacer so as not to intersect the primary beam and secure with the pushbutton connectors.
4. Center the source assembly over the test stand using the means provided, e.g., the light-field used to define the X-ray field.
5. Bring the source assembly down into firm contact with the spacer.
6. Center the cassette tray with the source assembly using the means provided, e.g., bucky light.
7. Insert the plastic cassette into the slide assembly. Then insert the slide assembly into slot 5. (See Fig. 6-2.).
8. Center the film cassette in the cassette tray and insert into position. If the positive-beam limitation will not operate at this SID, raise the source assembly and lock in position at the first operable SID.
9. Make an exposure. Develop the image. Measure and record the length and width dimensions of the image.
10. Calculate the field size correction factor as the SID/A where:
    a. SID is the indicated source-to-image receptor distance, and;
    b. A is the indicated source-to-tabletop distance less 7.7 inches. Multiply each of the measured dimensions by the correction factor.

$$\text{X-ray field length at under-table image receptor} = \frac{\text{SID}}{\text{A}} \times (\text{X-ray field length at slot 5})$$

$$\text{X-ray field width at under-table image receptor} = \frac{\text{SID}}{\text{A}} \times (\text{X-ray field width at slot 5})$$

Determine the difference without regard to sign between the corrected length and width dimensions and the corresponding cassette film size dimensions (8 by 10, 5 by 7, etc.). Each of these differences must be less than 3 percent of the SID, and the sum of these differences must be less than 4 percent of the SID.

NEMA Standard 5-15-1979.

LINEAR I
LINEAR II
LINEAR III

.02 METHOD II — ALTERNATE TEST STAND METHOD

A. GENERAL

Prior to performing this test the magnification factor must be determined in accordance with the X-ray/Light Field Alignment Test – Method III.

B. EQUIPMENT

1. Manufacturer's recommended test stand.
2. Cassette with film.

C. PROCEDURE ☢

1. Align the tube unit and image receptor and set SID to the value determined in the actual versus indicated SID test.
2. Insert empty 8 by 10 inch cassette into bucky tray.
3. Position test stand in accordance with manufacturer's instructions.
4. Load a second cassette and place in the designated position.
5. Select the proper technique factors, make an exposure, and develop film.
6. Measure the length and width of the X-ray image on the film.
7. Multiply each measurement by the magnification factor previously determined.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979.

.03 METHOD III — CASSETTE METHOD

A. GENERAL

This procedure can be used only when a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

1. Large cassette with film.
2. Small cassette, empty.

C. PROCEDURE ☢

1. Insert empty smaller cassette into bucky tray.
2. Switch system to the override mode.
3. Remove the smaller cassette and insert the loaded large cassette.
4. Select the proper technique factors, make an exposure, and develop film.
5. Measure the length and width of the X-ray image on the film.

D. VERIFICATION OF COMPLIANCE

Verify that the X-ray field size in the plane of the image receptor does not differ from that of the image receptor (smaller cassette) by greater than 3 percent of the SID and that the sum of the length and width differences without regard to sign is not greater than 4 percent of the SID.

NEMA Standard 5-15-1979.

XR 8-2.21 RETURN TO POSITIVE-BEAM LIMITATION (PBL) WITH IMAGE RECEPTOR CHANGE

REQUIREMENT – Return to positive-beam limitation (PBL) shall occur with a change in image receptor size. [See 21 CFR 1020.31(e)(2)(iii).]

A. EQUIPMENT

Medium size cassette.

B. PROCEDURE

1. Select positive-beam limitation mode.
2. Insert the medium size cassette into the bucky tray and record the field size indication.
3. Collimate down to a field size smaller than the cassette.
4. Remove and reinsert the cassette.

C. VERIFICATION OF COMPLIANCE

Verify that the system has returned to positive-beam limitation. Record the field size indication and verify that it is equal to the previously recorded field size.

NEMA Standard 5-15-1979.

XR 8-2.22 KEY LOCK TO POSITIVE-BEAM LIMITATION OVERRIDE

REQUIREMENT – If a capability is provided to override positive-beam limitation, a key shall be required to override the positive mode, and the key shall be captive while the positive mode is overridden. [See 21 CFR 1020.31(e)(2)(v).]

A. GENERAL

This test can be performed only if a capability is provided for overriding positive-beam limitation.

B. EQUIPMENT

None.

C. PROCEDURE

1. Verify that a key is required in order to select the override mode.
2. Select the override mode using the key.
3. Verify that while in this mode the key is captive.

NEMA Standard 5-15-1979.

XR 8-2.09 BEAM QUALITY (HALF-VALUE LAYER [HVL])

REQUIREMENT – The minimum beam quality requirements listed in Table 6-1 shall be met. [See 21 CFR 1020.30(m).]

.01 METHOD I – VISUAL DETERMINATION OF HALF-VALUE LAYER (HVL)

A. GENERAL

The above HVL requirement will be considered to have been met if it can be demonstrated that the aluminum equivalent of the total filtration in the primary beam is not less than that shown in Table 6-2.

B. EQUIPMENT

None required.

TABLE 6-1 MINIMUM BEAM QUALITY REQUIREMENTS

KVp Range	Measured kVp	HVL (mmAl*)
Below 50	30	0.3
	40	0.4
	49	0.5
50 to 70	50	1.2
	60	1.3
	70	1.5
Above 70	71	2.1
	80	2.3
	90	2.5
	100	2.7
	110	3.0
	120	3.2
	130	3.5
	140	3.8
	150	4.1

*Type 1100 aluminum alloy as given in Aluminum Association Publication No. ASD-1, Aluminum Standards and Data.

TABLE 6-2 ALUMINUM EQUIVALENT OF PRIMARY BEAM TOTAL FILTRATION

Operating Voltage (kVp)	Total Filtration (mm Al Equivalent)
Below 50	0.5
50 – 70	1.5
Above 70	2.5

C. PROCEDURE

Visually inspect the system and determine the aluminum equivalence of the total filtration in the primary beam. This includes the inherent filtration of the X-ray tube, X-ray tube housing, beam-limiting device, and any additional filtration that may have been added in the useful beam (in fluoroscopic systems the tabletop is included as part of the added filtration).

D. VERIFICATION OF COMPLIANCE

The aluminum equivalence of the total filtration must be equal to or greater than the amount specified in Table 6-2.

NEMA Standard 5-15-1979.

.02 **METHOD II — STANDARD ABSORBER METHOD**

A. GENERAL

This test is to be used when the surveyor cannot remove or see the total filtration equivalence.

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 6-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 6-1.

B. EQUIPMENT

1. Radiation detector.
2. Standard absorber with equivalent filtration of 2.5 millimeters of aluminum.

C. PROCEDURE

1. With the detection device positioned horizontally, an exposure is made at a preselected technique factor of 80 kVp and appropriate mA and time. The reading of the radiation output is recorded.
2. Position a total of 2.5 millimeters of aluminum at the port of the beam-limiting device and repeat the exposure using the same technique factors. Record the radiation output.

   For X-ray units operating at low kVp (less than 50) and for mammography units, it will be necessary to use an aluminum absorber of 0.6 millimeters at 49 kVp.

D. VERIFICATION OF COMPLIANCE

Verify that the radiation output in step 2 is greater than or equal to 50 percent of the radiation output in step 1.

NEMA Standard 5-15-1979.

.03 **METHOD III — BRH/FDA COMPLIANCE TEST**

A. GENERAL

The HVL determinations obtained from the following procedures are to be compared with those illustrated in Table 6-1. The HVL in millimeters of aluminum of the system being tested must be greater than or equal to the values shown in Table 6-1.

B. EQUIPMENT

1. BRH/FDA compliance test stand with accessories (Fig. 6-1).
2. Survey meter adapted for use with stand with an ion chamber.
3. Several sheets of aluminum, each having a thickness of 0.5 or 1.0 millimeter.

C. PROCEDURE

1. Attach the spacer, positioned out of the primary beam, to the test stand. Center the stand on the table. Center the source over the stand and bring the beam-limiting device down into firm contact with the spacer. Select the MANUAL mode of operation (there must not be a cassette in the cassette tray). Insert the beam-defining assembly in slot 1 of the stand with the leaded side up (see Fig. 6-2). Adjust the beam-limiting device so that the X-ray field slightly exceeds the aperture of the beam-defining assembly. Mount the ion chamber at position B with the chamber facing upward. Connect the chamber and meter with the cable provided. Select a tube potential that is commonly used and is in the highest kVp range of the X-ray system.
2. With no added filtration in the beam, make an exposure and record the reading. For all diagnostic X-ray equipment, use Table 6-3 to detemine increments of filtration required to perform the half-value layer procedure. Make an exposure and record the reading for each total thickness.

TABLE 6-3 HIGHEST DESIGN OPERATING RANGE

Total Added Filtration, mm Al		
Below 50kVp	50 – 70 kVp	Above 70 kVp
0.5	1.0	1.5
1.0	1.5	2.5
1.5	2.5	3.5
2.0	3.5	4.5

The recorded data is plotted on semi-log graph paper (Examples A and B, Fig. 6-6) and the half-value layer is read directly from the graph.

D. VERIFICATION OF COMPLIANCE

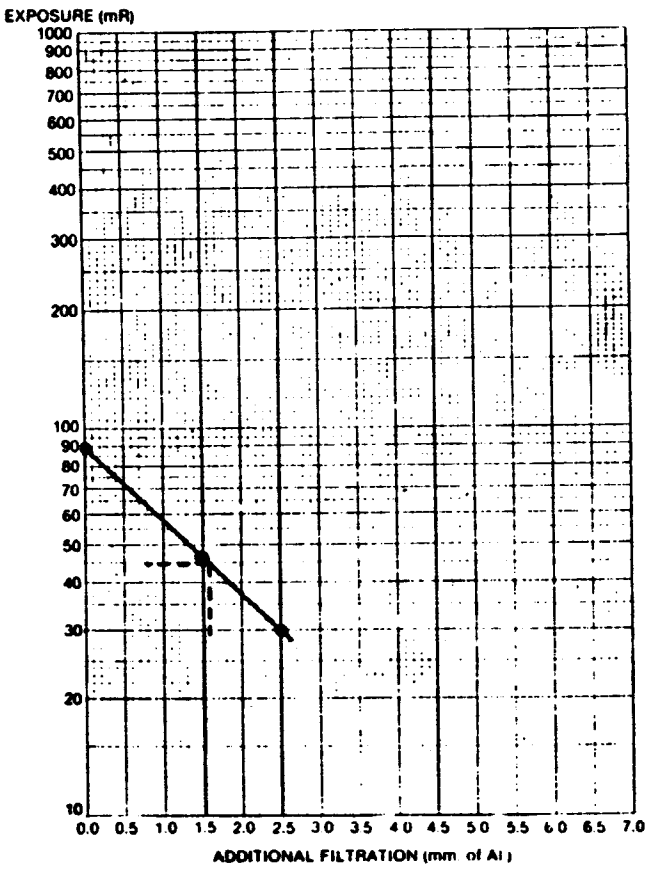
Verify that the half-value layer of the useful beam for a given X-ray tube potential is not less than the values shown in Table 6-1.

NEMA Standard 5-15-1979.

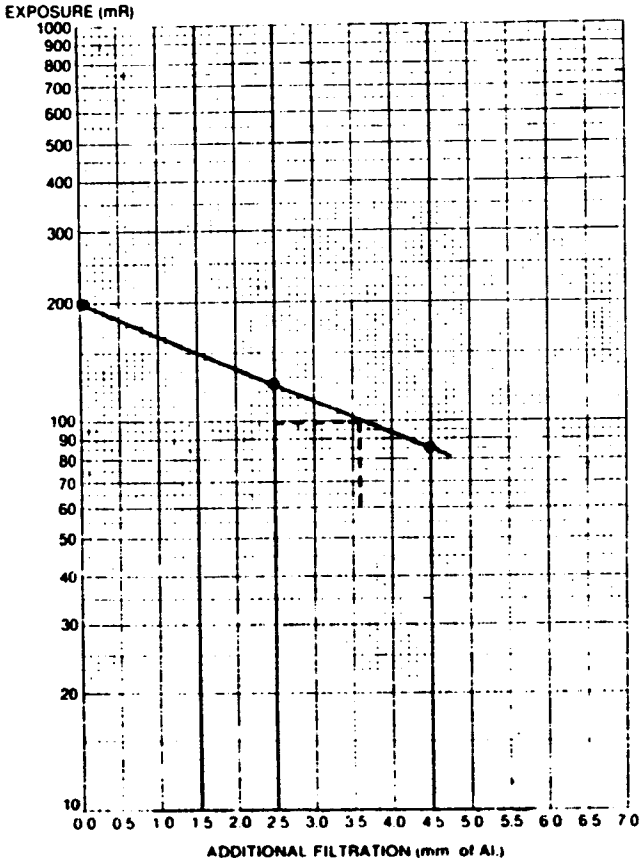
TABLE 6-4 HALF-VALUE LAYERS AS A FUNCTION OF FILTRATION AND TUBE POTENTIAL FOR DIAGNOSTIC UNITS*

Total Filtration mm Al	Peak Potential (kVp)									
	30	40	50	60	70	80	90	100	110	120
	Typical Half-Value Layers (mm Al)									
0.5	0.36†	0.47†	0.58	0.67	0.76	0.84	0.92	1.00	1.08	1.16
1.0	0.55	0.78	0.95	1.08	1.21	1.33	1.46	1.58	1.70	1.82
1.5	0.78	1.04	1.25†	1.42†	1.59†	1.75	1.90	2.08	2.25	2.42
2.0	0.92	1.22	1.49	1.70	1.90	2.10	2.28	2.48	2.70	2.90
2.5	1.02	1.38	1.69	1.95	2.16	2.37†‡	2.58†‡	2.82†‡	3.06†‡	3.30†‡
3.0	...	1.49	1.87	2.16	2.40	2.62	2.86	3.12	3.38	3.65
3.5	...	1.58	2.00	2.34	2.60	2.86	3.12	3.40	3.68	3.95

* For full-wave rectified potential.
† Recommended minimum HVL for radiographic units.
‡ Recommended minimum HVL for fluoroscopes.



EXAMPLE A



EXAMPLE B

Figure 6-6
HALF-VALUE LAYER DETERMINATION GRAPHS

RECORD SHEET

This sheet is to be used by the assembler to assure that all points of compliance are covered. It will also serve as a maintenance log.

HOSPITAL: _____ ROOM #: _____

DATE OF INSTALLATION: _____ ASSEMBLER: _____

Requirement	Applicable Paragraph	Installation Date	Date	Date	Date	Date
1. Visual Definition of x-ray light-field	XR 8/2.14					
2. Intensity of light-field	XR 8/2.15					
3. Min. Field Size	XR 8/2.16					
4. X-ray field/receptor center alignment	XR 8/2.17					
5. Indication of field size	XR 8/2.18					
6. Positive Beam limitation	XR 8/2.19					
7. X-ray field limitation & alignment	XR 8/2.20					
8. Return to PBL	XR 8/2.21					
9. Keylock PBL override	XR 8/2.22					
10. Half Value Layer	XR 8/2.09					
11. Cassette tray inspection/cleaning						
12. Electrical cable inspection						
13. SID Monitor inspection						
INITIALS:						
NOTES:						

NO TEXT

SECTION 7.0

RENEWAL PARTS LIST

NO TEXT

LINEAR™ II

RENEWAL PARTS LIST

EUREKA P/N	DESCRIPTION
	COLLIMATOR
70-10009	Swivel Mounting Ring – Tube Side
70-10008	Swivel Mounting Ring – Collimator Side
70-10036	Swivel Ring
70-10260	Thumb Screw
70-10127	Window – Cross Hair
70-10099	Knob – Front Panel
70-08040	Switch – Push Button – Light Field
70-04262	Lens for Push Button Switch
70-04263	Lamp for Push Button Switch
70-10091	*Cover – Bottom
70-10279	*Cover – Top
70-20100	Decorative Band – Linear II
70-04571	Lamp – Light Field – DZE 24 Vac, 150W
70-04572	Socket – Lamp
70-01901	Current Limit Resistor
70-03051	Triac, 15 Amp, Lamp Timer
70-10096	Prism, Centering Light-Line
70-10147	Mercury Tilt Switch
70-10065	Lamp Housing – Removable
70-10235	Lamp Housing – Top
70-20024	Mirror/Bracket Assembly
70-10066	Cone Track
70-10049	Spacer – 1/4"
70-10050	Spacer – 1/16"
70-10987	Spring – Comp., Mirror
70-10988	Spring – Ext., Mirror
70-10122	Tape Measure
70-08052	Linear II Lamp & Driver P.C.B. Assy.
70-08002	Linear II Logic P.C.B. Assy.
70-03354	Opto-Scr KA 110
70-04570	Lamp Indicator
70-10135	Motor, Shutter Drive – 24 VAC

*Specify Color: Lt. Gray, Dk. Gray, Allied Tan, White.

EUREKA P/N	DESCRIPTION
	POWER SUPPLY CHASSIS
70-06004	Transformer – Power 27/19 Vac
70-04621	Fuse Holder
70-04605	Fuse – 3 Amp SloBlo – Power
70-04607	Fuse – 8 Amp SloBlo – Lamp
70-04651	Strain Relief Bushing (SR-6N3-4)
70-04001	Relay – 24 VDC
70-08009	Master P.C.B. Assy. (Power Supply P.C.B.)
70-04602	Fuse – 1 Amp SloBlo (Master P.C.B.-Logic)

SECTION 8.0

APPENDIX

TABLE 1.

The following list is intended to help the installer determine mounting information only, and does not imply compatibility. See Section 1 for compatibility information.

MANUFACTURER	TUBE HOUSING	FOCAL SPOT TO PORT MOUNTING	DISTANCE TO COLLIMATOR MOUNTING FLANGE
Eureka	Emerald Series	2 1/16"	3/8" (.375)
	Diamond Series	2 1/16"	3/8" (.375)
	Sapphire Series	2 3/16"	1/4" (.250)
Eimac	B100	2 17/64"	11/64" (.171)
	B150	2 11/64"	17/64" (.265)
General Electric	Maxiray 100	2 5/16"	1/8" (.125)
	HRT, MX75	2 1/16"	3/8" (.375)
Picker/Dunlee	DU-140	2 1/16"	3/8" (.375)
	DU-200	2 1/16"	3/8" (.375)
	DU-300	2 9/32"	5/32" (.156)
	PX-400	2 5/16"	1/8" (.125)
Machlett	DX40 Series	2 1/16"	3/8" (.375)
	DX50 Series	2 3/16"	1/4" (.250)
	DX60 Series	2 5/16"	1/8" (.125)
	DX70 Series	2 5/16"	1/8" (.125)

DEFINITIONS

SID	**S**ource to **I**mage **D**istance.
VSID	**V**oltage representing **SID**.
VCSID	**V**oltage representing **C**ontinuous **SID**.
SID TRUE	Signal representing the Operating SID Range.
XF	**X**-ray **F**ield.
VXFC	**V**oltage at the Collimator Feedback Potentiometer Wiper representing the **X**-ray **F**ield in the **C**ross Dimension.
VXFL	**V**oltage at the Collimator Feedback Potentiometer Wiper representing the **X**-ray **F**ield in the **L**ong Dimension.
IR	**I**mage **R**eceptor (Cassette Tray).
VIRC	**V**oltage from the Cassette Sensing Element representing the **I**mage **R**eceptor size in the **C**ross Dimension.
VIRL	**V**oltage from the Cassette Sensing Element representing the **I**mage **R**eceptor size in the **L**ong Dimension.
IR TRUE	Voltage representing the Presence of a Cassette
VCPC	**V**oltage applied to the **C**ollimator **P**otentiometer in the **C**ross Position.
VCPL	**V**oltage applied to the **C**ollimator **P**otentiometer in the **L**ong position.

40 CONDUCTOR CABLE COLOR CROSS REFERENCE

OLD	NEW
Black	Black
Red	Red
White	White
Green	Green
Orange	Orange
Blue	Blue
Brown	Black/White
Yellow	Orange/Green
Violet	Blue/Red
Gray	Blue/Black
Pink	Orange/Red
Tan	Green/Black
Red/Green	Red/Green
Red/Yellow	Black/Red
Red/Black	Red/Black
White/Black	White/Black
White/Red	White/Red
White/Green	Green/White
White/Yellow	Orange/Black/Green
White/Blue	Blue/White
White/Brown	Blue/White/Orange
White/Orange	Orange/White/Blue
White/Gray	Orange/Black
White/Violet	Red/White
White/Black/Red	White/Black/Red
White/Black/Green	White/Black/Green
White/Black/Yellow	Black/Red/Green
White/Black/Blue	Blue/Black/White
White/Black/Brown	Green/Black/Orange
White/Black/Orange	Black/White/Orange
White/Black/Gray	Green/Black/White
White/Black/Violet	Orange/Black/White
White/Black/Black	Black/White/Red
White/Red/Black	Red/Black/White
White/Red/Red	White/Red/Orange
White/Red/Green	White/Red/Green
White/Red/Blue	White/Red/Blue
White/Red/Brown	Red/White/Green
White/Red/Violet	Red/Black/Green
White/Green/Black	Black/White/Green

(VIRC, IR, TRUE, VISID OUT, VSID IN and VIRL signals are analog and cannot be expressed in "Logic" terms)

SIGNALS (paragraph ref.)	3.2	3. 2.1	3. 2.2	3.3	3. 3.1	3. 3.2	3.4	3. 4.1	3. 4.2	3. 4.4	3. 4.6	3. 4.8	3.5	3. 5.2
VIRC (TS4-7), VIRL (TS4-5)														
$\overline{\text{STEREO/TOMO}}$ (TS4-11)	1	1	1	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{C = 0°, T = 0°}}$ (TS3-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0
$\overline{\text{C = +90°}}$ (TS3-6)	1	0	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°}}$ (TS3-7)	1	1	0	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{C = +90°, T = +90°}}$ (TS3-9)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{C = −90°, T = −90°}}$ (TS3-8)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
IR TRUE														
$\overline{\text{40" SID}}$ (TS4-14)	1	1	1	1	1	1	1	1	0	1	1	1	1	1
$\overline{\text{72" SID}}$ (TS4-9)	1	1	1	1	1	1	1	1	1	0	1	1	1	1
EXP. REL. RY (TS4-8)	0	0	0	0	0	0	0	1	0	0	0	0	0	1
$\overline{\text{TABLE LEFT SIDs}}$ (TS4-17)	1	1	1	1	0	1	1	1	1	1	1	1	1	1
$\overline{\text{TABLE RIGHT SIDs}}$ (TS4-15)	1	1	1	1	1	0	1	1	1	1	1	1	1	1
$\overline{\text{WALL L/R SIDs}}$ (TS4-19)	1	0	0	1	1	1	1	1	1	1	1	1	1	1
$\overline{\text{VERT SIDs}}$ (TS4-10)	0	1	1	0	1	1	0	0	0	0	0	0	0	0

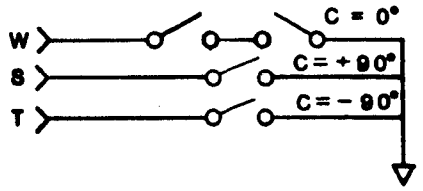
LINEAR II Logic Chart

"X" – Don't Care

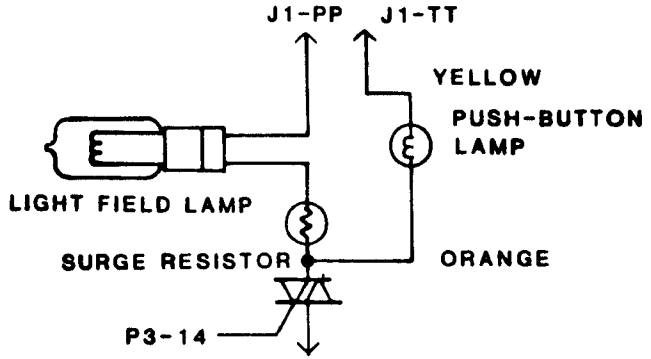
"1" – Logic High (+15 v)

"0" – Logic Low (0 v)

P2	Ribbon Color	P3	Function
1	Brn		N/C
2	Red		N/C
3	Orn		Long. Pot. #1 & Cross Pot. #3 – GND
4	Yel		Long. Pot. #2 – VXFL
5	Grn		Caross Pot. #1 – VCPC
6	Blue		Cross Pot. #2 – VXFC
7	Vio		Long. Pot. #3 – VCPL
8	Gry	1	VCC +15 VDC
9	Wht	2	Long. Open
10	Blk	3	72" SID IND.
11	Brn	4	N/C
12	Red	5	N/C
13	Orn	6	Long. READ IND.
14	Yel	7	40" SID IND.
15	Grn	8	MANUAL IND.
16	Blue	9	CROSS READY IND.
17	Vio	10	Long. Close
18	Gry	11	EXP. HOLD IND.
19	Wht	12	CROSS CLOSE
20	Blk	13	CROSS OPEN



P-1
ELCO CONNECTOR



P3	Ribbon Color	P2	PI	Function
1	Gry	8		
2	Wht	9		
3	Blk	10		
4	Brn	11		
5	Red	12		
6	Orn	13		
7	Yel	14		
8	Grn	15		
9	Blue	16		
10	Vio	17		
11	Gry	18		
12	Wht	19		
13	Blk	20		
14	Brn			TO TRIAC GATE
15	Red		JJ	+28 VDC
16	Orn			N/C
17	Yel			N/C
18	Grn		NN	OVAC
19	Blue		NN	OVAC
20	Vio			TO TIMER SWITCH
21	Gry			TO TIMER SWITCH
22	Wht			*MOTOR COM.
23	Blk			*LONG MOTOR – BLK
24	Brn			*LONG MOTOR – RED
25	Red			*CROSS MOTOR – RED
26	Orn			*CROSS MOTOR – BLK

*LINEAR II ONLY

LINEAR I & II
COLLIMATOR WIRING

SEE 40 CONDUCTOR CABLE COLOR CROSS REF.

Power Board T/S Number	40 Cond. Cable Color	ELCO CONN	Ribbon Color	PI Pin	Function
3-7	Wht/Grn	T	(1) Brown	1	C = −90°; Tilt Switch
3-9	Red/Grn.	N	Red	2	C = +90°, T = +90°
3-6	Wht/Red	S	(2) Orange	3	C = +90°
4-11	White	C	Yellow	4	Stereo/Tomo
4-9	Violet	J	Green	5	72" H SID
3-10	Wht/Red/Brn.	BB	Blue	6	C = 0°, T = 0°
4-18	Wht/Red/Red	AA	Violet	7	IR TRUE
4-5	Green	D	Gray	8	VIRL
4-4	Red/Yellow Red/Black	P	(3) White Black	9 10	PWR GRD PWR GRD
		N/C	Brown	11	N/C
		N/C	Red	12	N/C
4-17	Wht/Blue	V	Orange	13	Table Left SID
4-14	Wht/Blk/Blue	DD	Yellow	14	40" H SID
4-16	Wht/Yellow	U	Green	15	Vert. SID
4-15	Wht/Violet	z	Blue	16	Table Right SID
4-3	Brown Yellow	H	(4) Violet Gray	17 18	Logic GND Logic GND
4-20	Black	A	White Black	19 20	+15 VDC +15 VDC
4-8	Wht/Blk/Yellow	CC	Brown	21	Exposure Relay
3-8	Blue	F	Red	22	C = 90°, T = 90°
4-19	Wht/Blk/Brn.	EE	Orange	23	Wall L/R SID
			* Yellow	24	* Push Test
3-4	Wht/Blk/Orange	FF	Green	25	V SID Out
4-7	Tan	M	Blue	26	VIRC
3-5	Wht/Brown	W	Black		C – 0°, Tilt Switch
3-2	Wht/Blk/Violet	JJ	Red		to P3-15- (+28 VDC)

NOTES: (1) This wire crimped with Red lead from Tilt Switch.

(2) This wire crimped with White lead from Tilt Switch.

(3) These two wires crimped together with Brown lead form Tilt Switch.

(4) These two wires crimped together with Violet wire to Test Switch. Only for LINEAR II.

* LINEAR II ONLY

LINEAR I & II

WARRANTY

The EUREKA X-RAY TUBE COMPANY warrants its LINEAR™ SERIES COLLIMATORS to be free of defects in material and workmanship for a period of one year from the date of installation but not more than eighteen months from the date of shipment.

EUREKA's liability is limited to replacement or repair of any parts which prove to be defective.

All repairs (parts and labor) made by EUREKA under terms of this Warranty will be made at no charge to the Purchaser. All other repairs required will be invoiced.

All shipping charges from Warranty returns are the responsibility of the Purchaser. Only in the case of repairs effected under Warranty is EUREKA responsible for shipping charges.

This Warranty does not apply to equipment subjected to abuse, misuse or alteration, or to defects resulting from accidents.

The date of installation must be established by the return to EUREKA, within 15 days of the date of installation, of the fully completed Warranty Registration Card supplied with each Collimator.

EXCEPT AS SET FORTH HEREIN, EUREKA MAKES NO WARRANTIES EITHER EXPRESS OR IMPLIED INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EUREKA X-RAY TUBE CO.
3250 NORTH KILPATRICK AVENUE
CHICAGO, ILLINOIS 60641

00-02-968 11/82

SECTION 9.0

THEORY OF OPERATION

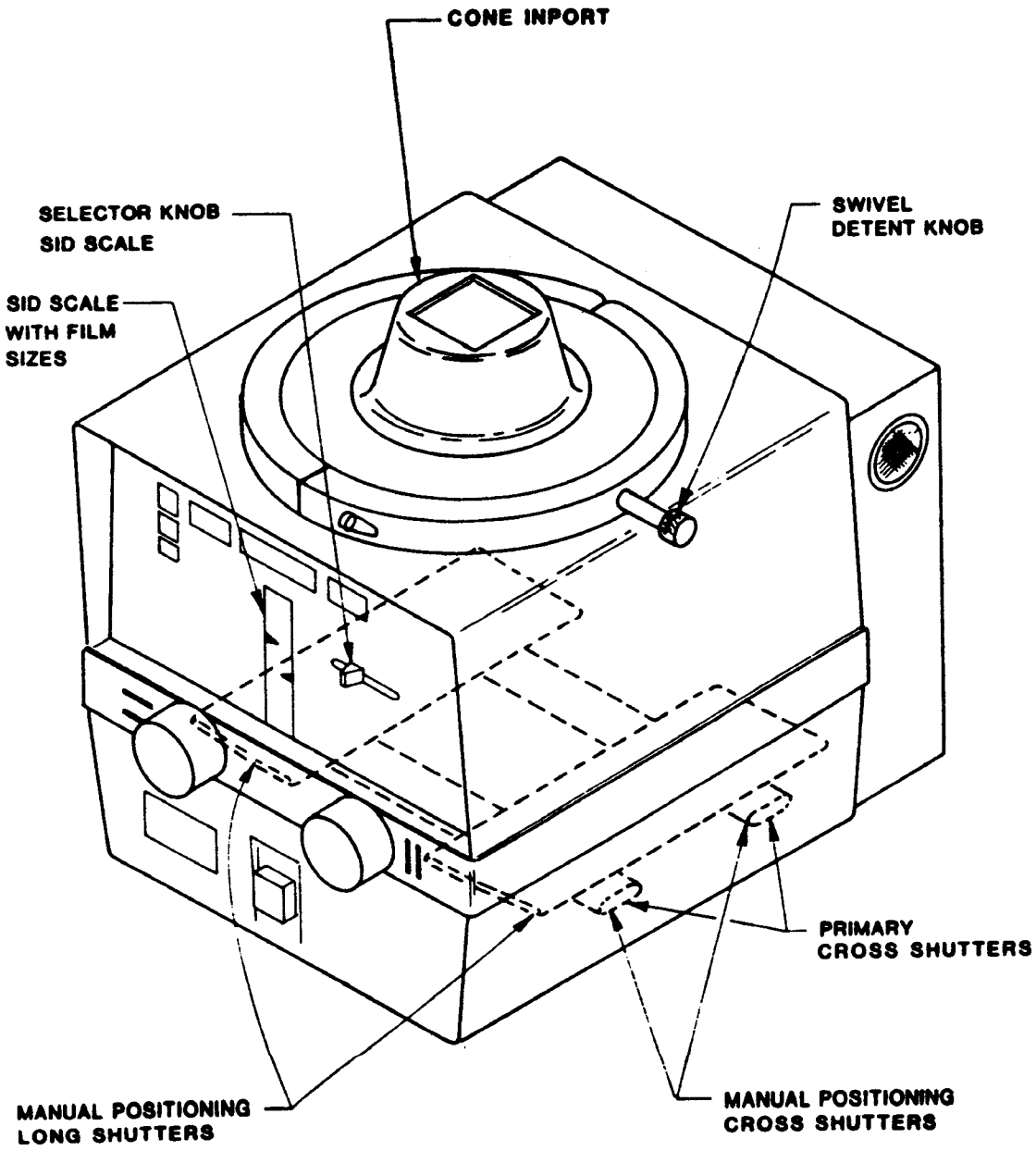

CONE INPORT
SELECTOR KNOB
SID SCALE
SID SCALE
WITH FILM
SIZES
SWIVEL
DETENT KNOB
PRIMARY
CROSS SHUTTERS
MANUAL POSITIONING
LONG SHUTTERS
MANUAL POSITIONING
CROSS SHUTTERS

FIG. 9.1

9.0 THEORY OF OPERATION

9.1 Mechanical Operation

The Eureka Linear II Series Collimator contains two major sets of shutters, long and cross, which define the absolute x-ray field size. There is also a fixed lead cone which protrudes into the port of the x-ray tube to help reduce the effects of off-focus radiation.

Both shutter mechanisms are geared with anti-backlash mechanisms and coupled with shafts to knobs on the front panel. The shutters may be positioned manually with these knobs. A field size indicator scale indicates all conventional film sizes, and the scale is selected depending on the SID in use. A knob on the front panel is used to select the appropriate scale (see Fig. 9.1).

All Eureka Linear Series Collimators have a swivel mount configuration. Detents are located at 90 degree increments. By unscrewing the detent knob (see Fig. 9.1), the collimator may be oriented to any position for achieving proper x-ray field to cassette alignment for table top or non-bucky operation.

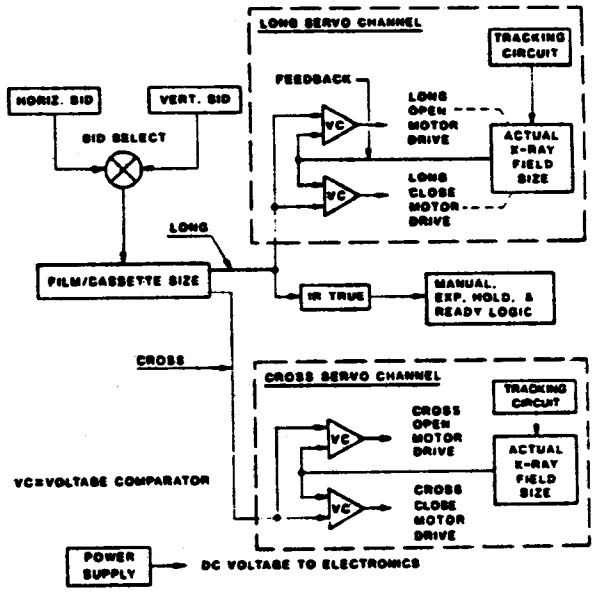
The shutter mechanism has been precisely aligned with respect to the mounting flange at the factory; therefore, the necessity for field alignment of central ray has been virtually eliminated.

9.2 Electronic Operation

The collimator electronics consists of the following systems and sub-systems:

- Long and Cross Servo Channels
- Vertical SID Voltage Range
- Exposure Hold and Ready Logic
- Manual Operation Logic
- Power Supply and Lamp Circuit

The operating system is represented by the following block diagram:



NOTE: Refer to section 8 for definitions.

9.2.1 Power Supplies – Schematic 70-08009

There are two power supplies for the collimator operation, a 27 volt A.C. supply protected by fuse F2 for the light field lamp and servo motors, and a low voltage, 15 volt D.C. regulated supply for the electronics.

The power transformer T1 is the source for both supplies with the 27 AC tap supplying the lamp and motors. The 19 VAC tap voltage is rectified by bridge B2 to an unregulated 28 VDC. This 28 VDC supplies the front panel lamps and VR1, a 3-terminal 15 volt 7815 IC voltage regulator. This supply is located on the master printed circuit board located in the power chassis (See Schematic 70-08009).

9.2.2 Light Field Lamp Circuit – Schematic 70-08032

The light-field lamp voltage is switched on and off by the 15 amp triac located on the lamp bracket. The gate signal is controlled by the output of IC4 (555 Timer) with an "ON" time of 25 seconds controlled by R18 and C7. The timer is triggered by the front panel "LAMP" push button switch. The output of IC4 drives the Opto-Isolator, IC8, which shorts bridge B1 to supply gate current to the triac. The surge resistor in series with the lamp filament offers high resistance at turn-on, reducing the in-rush current and greatly extending the lamp life.

9.2.3 Shutter Servo System – Schematic 70-08002

Both axis shutter systems are identical, so explanation will be limited to the cross axis circuitry.

A voltage is derived at the wiper of the cassette size sensing mechanism which contains two components:

(A) Cassette Size
(B) Source to Image Distance (SID)

This compound voltage (VIRC) is then applied to the two voltage comparators, IC16A & B. These two voltage comparators have their opposite inputs supplied with a voltage (VXFC) from the collimator feedback potentiometer. The logic chart follows:

Input Voltage – VIRC	<	=	>	Feedback Voltage – VXFC
	PIN 1			
IC16A, pin 2 (close)	1	0	0	IC16A, pin 3
	PIN 7			
IC16B, pin 5 (open)	0	0	1	IC16B, pin 6 Where 0 = 0 vdc and 1 = +15 vdc

NOTE: VIRC and VXFC are analog voltages and cannot be expressed in 1's or 0's.

IC9A, an R-S flip-flop, is positioned in line with the "close" drive signal from IC16A. Whenever the shutters are opened beyond allowable limits, SID is changed, table or collimator are tilted, or cassette is inserted, IC9A changes state which "sets" the Q output to a zero state. This zero is applied to the "AND" Gate, IC11B, pin 6, which inhibits the open drive signal from IC16B. This occurs only after the servo logic has been satisfied. It is reset by the action of IC16A output going low. This occurs on each servo cycle as the Logic must always be satisfied after a closing action of the blades.

Assuming all system logic is satisfied (IC11B, IC10B, IC12B and IC17F), the appropriate "open" or "close" signal is applied to either IC5A (OPEN) or IC5B (CLOSE) driver. These drive IC1 or IC3 on the Motor Drive P.C.B. (Schematic 70-08032) to supply 24 VAC to the reversible motor. IC2 on the motor drive P.C.B. couples the phase-shifting capacitor, C2, only during actual motor drive operation. The removal of this capacitor

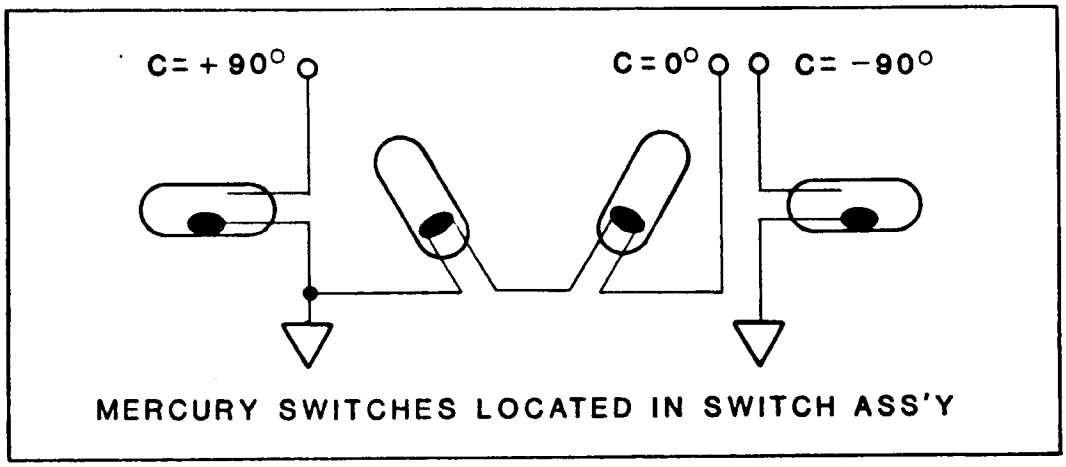
with no power applied reduces the effort required to position the shutters manually. After the system achieves balance a "1" is applied to IC5G turning on the CROSS READY INDICATOR lamp. A similar action applies to the Long logic circuitry. When both Cross and Long have been balanced, "1"'s from IC17F and IC17C drive NAND gate IC10A, AND gate IC11A and IC5E to extinguish the HOLD indicator lamp and energize the Exposure Release Relay, RLY1.

After this, the shutters may be manually closed without the servo logic producing an "EXPOSURE HOLD" condition. The "close" portion of the servo channel is always active. Therefore, if the shutters are manually positioned larger than the film size sensed, the servo system motors will drive the shutters closed until balance is re-achieved.

If STEREO/TOMO operation is selected, a "0" signal at IC7A, pin 1 causes the MANUAL indicator lamp to be lit via IC's 7D, 6D, 17D, and 5D, and through AND gate IC11A, places the system in MANUAL mode and inhibits the EXPOSURE HOLD function.

9.2.4 Tilt Monitors – Schematic 70-08009

The collimator has an angulation sensing switch assembly mounted on the inner front housing panel. There are four (4) mercury switches in the following configuration:



Where: C = +90° means collimator CW 90° from vertical (beam left)

C = −90° means collimator CCW 90° from vertical (beam right)

C = 0° means collimator in vertical position

The switches C = +90° and C = −90° actually activate 10° before the 90° positions. The two C = 0° switches activate at plus and minus 10° from the zero degree position.

It is these switch signals along with an identical table tilt monitor switch (if the collimator is installed with a tilting table) that selects the appropriate SID circuit to apply the voltage (VSID) to the cassette tray input (Image Receptor).

NOTE: If the collimator is positioned between +10° and +80°, or −10° and −80°, the collimator is placed into "Manual" operation. It is also this switch selects the appropriate Image Receptor, table or wall (RLY2), for cassette size sensing.

THE FOLLOWING TABLE SHOWS THE TILT MONITORS SID SELECTION MATRIX WHERE:

V = VERTICAL SID SELECTION
H(T) = HORIZONTAL SID, TABLE IMAGE RECEPTOR
H(W) = HORIZONTAL SID, WALL IMAGE RECEPTOR
M = MANUAL OPERATION

TILT TABLE ANGULATION	COLLIMATOR ANGULATION				
	C=-90° -90° TO -80°	-79° TO -11°	C=0° -10° 0° 10°	11° TO 79°	C=90° 80° TO 90°
T=-90° -90° TO -80°	H(T)	M	M	M	M
-79° TO -11°	M	M	M	M	M
T=0° -10° 0° 10°	H(W)	M	V	M	H(W)
+11° TO +79°	M	M	M	M	M
T=+90° +80° TO +90°	M	M	M	M	H(T)

*CAN BE H(W) WITH BEAM AT WALL

ONLY ONE RECEPTOR CAN BE SELECTED. THIS IS DETERMINED UPON INSTALLATION AND SWITCH SW2-5 (BUCKY RIGHT) or SW3-5 (BUCKY LEFT) IS SELECTED FOR THE APPROPRIATE INSTALLATION CONFIGURATION.

9.2.5 SID Voltages – Schematics 70-08002 & 70-08009

A voltage (VSID) representing the SID, either horizontal or vertical, is applied to the input of cassette size sensing potentiometers. The approximate values are as follows:

	HORIZONTAL				VERTICAL				
SID	36	40	48	72	36	40	48	64	72
VSID V.D.C.	7.57	7.02	5.92	4.36	7.57	7.02	5.75	4.71	4.36

The SID voltages are individually adjusted by the two potentiometers, R23 (40" SID) and R24 (72" SID). The wipers of the potentiometers are connected to the 4 section analog switch, SW1. The activation of the SID switches (external to collimator) are, by the nature of the installation, such that only one switch can be activated at a time. A typical selection would then be:

C = +90° (BEAM LEFT WALL)
T = 0°
SID = 40" HORIZONTAL

With the collimator at C = +90° the mercury tilt switch in the collimator head will supply a logic "0" (LED 1 "ON", Logic "0" = 0 VDC) to Inverter IC8B, pin 3 yielding a logic "1" (Logic "1" = +15VDC) on AND Gate IC6B, pin 6. The table vertical (T = 0) will supply a Logic "1" (LEDs 6 and 7 "OFF") to AND Gate 6C, pins 8 and 9, yielding a logic "1" input to AND Gate 6B, pin 5. The logic "1" output of 6B, pin 4, will yield a logic "0" output from Inverter 4A, pin 16 (WALL L/R SID SW). This causes, via P/J1-23 and TS4-19, pin 14 of the Buffered Inverter IC3 on the Master Board (Schematic 70-08009) to supply a logic "1", via TS1-22, to the external 40" horizontal SID switch. (The logic "0" on TS4-19, WALL L/R SID SW, also selects the wall bucky via RLY-2 on the Master Board (Schematic 70-08009). Closing the external 40" HORIZONTAL SID SWITCH puts a logic "1" on TS1-14 yielding a logic "0" output from the Inverter IC2, pin 14 on the Master Board. Via TS4-14 and P/J1-14 (40" SID) logic "0" will be applied to Inverter IC14A, pin 1.

Because the collimator is at +90° the mercury tilt switches, via P/J1-6 (C = 0°, T = 0°, LED 4 "OFF"), a logic "1" is applied to Inverter 14A, pin 1. The logic "1" output of 14A, pin 2 causes SW2 to select the 40" SID voltage, supplied by R23, to Buffer IC3A. The output of IC3A is supplied to the correct cassette tray input via P/J1-25, TS3-4 and TS3-14 (TABLE) or TS2-19 (WALL).

9.2.6 Exposure Hold and Manual Circuits – Schematic 70-08002

The collimator is placed into "MANUAL" operation upon the following conditions: (x-ray exposure is permitted)

A. When NO cassette is present
B. Collimator or table NOT at −90°, 0°, or +90°
C. An external signal for STEREO/TOMO operation is present

The collimator is placed into "EXPOSURE HOLD" when:

A. Cassette is present but servo system is NOT sized properly. This occurs during cycling of shutter blades.
B. If the collimator is NOT positioned at one of the permitted SIDs, i.e., 40" or 72" SID, and the cassette is present.

9.2.7 "Manual Operation" – Schematic 70-08002

The presence of a cassette is detected by current flow through the size sensing potentiometers upon activation of a series "cassette present" switch. The current flows from the cassette trays via TS3-15 or TS2-20, TS4-18 and P/J1-6 through VR1, a 1.22 volt zener diode. This VR1 voltage is compared to that of a forward-biased silicon diode, D2, by Voltage Comparator IC13A. The output of IC13A results in a level where "1" = NO CASSETTE PRESENT (LED-2 ON) and a "0" = CASSETTE PRESENT (LED-2 OFF) known as IR TRUE (Not Image Receptor True).

This condition, NO CASSETTE PRESENT, will cause the "MANUAL" indicator on the front panel to be illuminated through Logic IC6D, IC17D and IC5D. Through Logic IC11A, 11D and 5E the Exposure Release Relay, RLY-1, will be energized permitting an x-ray exposure.

Also, if either the collimator or table is angulated beyond the 10 degree angles of horizontal or vertical, the appropriate logic levels at P/J1 pins 22, 2, 3, 1 or 6 will be at Level "1" causing the logic of IC6A, 6C, 7A, 7B, 7D, 7C, 17D and 5D to again place the system into "Manual" operation. In addition, the exposure release relay will be energized permitting x-ray exposure.

The last condition for "Manual" operation occurs when an external signal is applied between TS1-1 (common) and one of the inputs, TS1-2, 3, 4 or 5 (Schematic 70-08009).

This is the "STEREO/TOMO" input and can be supplied with any of the following levels:

A. 5 volts AC or DC
B. 15 volts AC or DC
C. 24 volts AC or DC
D. 120 volts AC

The external voltage is applied through Bridge B1 to supply bias current to the photo-diode of Opto-isolator IC1. The photo transistor of IC1 then biases Inverter IC2 providing a "Low" to P/J1-4. The logic through IC7A, 7D, 6D, 17D, and 5D provides for an over-riding "Manual" operation.

9.2.8 "Exposure Hold" Operation

When a cassette is inserted, the servo electronics become unbalanced and may indicate EXPOSURE HOLD until the shutters are sized properly. Cassette insertion also triggers timer IC15, which is configured as a 0.5 second mono-stable multivibrator. The output (Pin 3) is applied through IC2C to IC10B, and 10C. These gates, through IC17F, 17C, 10A, 11A, 17D and 5E, place the system into EXPOSURE HOLD. The prime purpose is to assure that the cassette is fully and properly inserted before the electronic servo system begins to achieve balance.

At the end of the 0.5 second time delay, the servo motors will be driven until balance is achieved. During any operation of a motor, the EXPOSURE HOLD circuit is activated, preventing an x-ray exposure.

Another condition that results in an EXPOSURE HOLD condition is after the insertion of a cassette, the collimator is "NOT" at an authorized SID of 40" or 72" Horizontal or Vertical. The system is placed in EXPOSURE HOLD until an authorized SID is achieved.

9.2.9 Programming Switches

There are two switch packages, SW2 and 3, that provide either test input signals or collimator functional programming.

SW2-1, 2, 3, 4, & 5, and SW3-1, 2, 3, 4, & 5 can be switched ON to provide simulated input signals to aid in the initial alignment or for trouble-shooting. They function as follows:

SWITCH	INPUTS
SW2-1	14" Cross
SW2-2	5" Cross
SW2-3	14" Long
SW2-4	5" Long
SW2-5	Bucky Right
SW3-1	Unused
SW3-2	40" Horizontal SID
SW3-3	72" Horizontal SID
SW3-4	IR Select
SW3-5	Bucky Left

These switches must be in the OFF position for actual operation of the system.

SW2-5 and SW3-5 are programmed at the time of installation to provide the appropriate logic sensing for selection of the Wall Image Receptor (Bucky) inputs. SW3-5 is selected if the receptor is located at the left end of the x-ray table. Only one selection can be made for any given installation.

9.2.10 Tracking

The collimator must "track" the various input sizes as well as "track" a given input size versus SID.

This is the "STEREO/TOMO" input and can be supplied with any of the following levels:

A. 5 volts AC or DC
B. 15 volts AC or DC
C. 24 volts AC or DC
D. 120 volts AC

The external voltage is applied through Bridge B1 to supply bias current to the photo-diode of Opto-isolator IC1. The photo transistor of IC1 then biases Inverter IC2 providing a "Low" to P/J1-4. The logic through IC7A, 7D, 6D, 17D, and 5D provides for an over-riding "Manual" operation.

9.2.8 "Exposure Hold" Operation

When a cassette is inserted, the servo electronics become unbalanced and may indicate EXPOSURE HOLD until the shutters are sized properly. Cassette insertion also triggers timer IC15, which is configured as a 0.5 second mono-stable multivibrator. The output (Pin 3) is applied through IC2C to IC10B, and 10C. These gates, through IC17F, 17C, 10A, 11A, 17D and 5E, place the system into EXPOSURE HOLD. The prime purpose is to assure that the cassette is fully and properly inserted before the electronic servo system begins to achieve balance.

At the end of the 0.5 second time delay, the servo motors will be driven until balance is achieved. During any operation of a motor, the EXPOSURE HOLD circuit is activated, preventing an x-ray exposure.

Another condition that results in an EXPOSURE HOLD condition is after the insertion of a cassette, the collimator is "NOT" at an authorized SID of 40" or 72" Horizontal or Vertical. The system is placed in EXPOSURE HOLD until an authorized SID is achieved.

9.2.9 Programming Switches

There are two switch packages, SW2 and 3, that provide either test input signals or collimator functional programming.

SW2-1, 2, 3, 4, & 5, and SW3-1, 2, 3, 4, & 5 can be switched ON to provide simulated input signals to aid in the initial alignment or for trouble-shooting. They function as follows:

SWITCH	INPUTS
SW2-1	14" Cross
SW2-2	5" Cross
SW2-3	14" Long
SW2-4	5" Long
SW2-5	Bucky Right
SW3-1	Unused
SW3-2	40" Horizontal SID
SW3-3	72" Horizontal SID
SW3-4	IR Select
SW3-5	Bucky Left

These switches must be in the OFF position for actual operation of the system.

SW2-5 and SW3-5 are programmed at the time of installation to provide the appropriate logic sensing for selection of the Wall Image Receptor (Bucky) inputs. SW3-5 is selected if the receptor is located at the left end of the x-ray table. Only one selection can be made for any given installation.

9.2.10 Tracking

The collimator must "track" the various input sizes as well as "track" a given input size versus SID.

The tracking of input sizes is achieved by adjusting the collimator feedback potentiometer at the shutters closed position, and then adjusting the voltage to the collimator potentiometer (VCPL and VCPC). This is a factory adjustment procedure which provides the operating range of the feedback voltages (VXFL and VXFC).

Since the actual collimator shutters operate at two different distances from the x-ray tube focal spot, they require different voltage and resistance settings. The Long axis is the reference axis while the Cross axis is the secondary axis.

Therefore, only R26, VCPC, should be field adjusted. This is adjusted to achieve "balance" in the Long to Cross dimensions.

Tracking a given size for horizontal operation is easily and absolutely accomplished by the individual adjustments of R23 and 24.

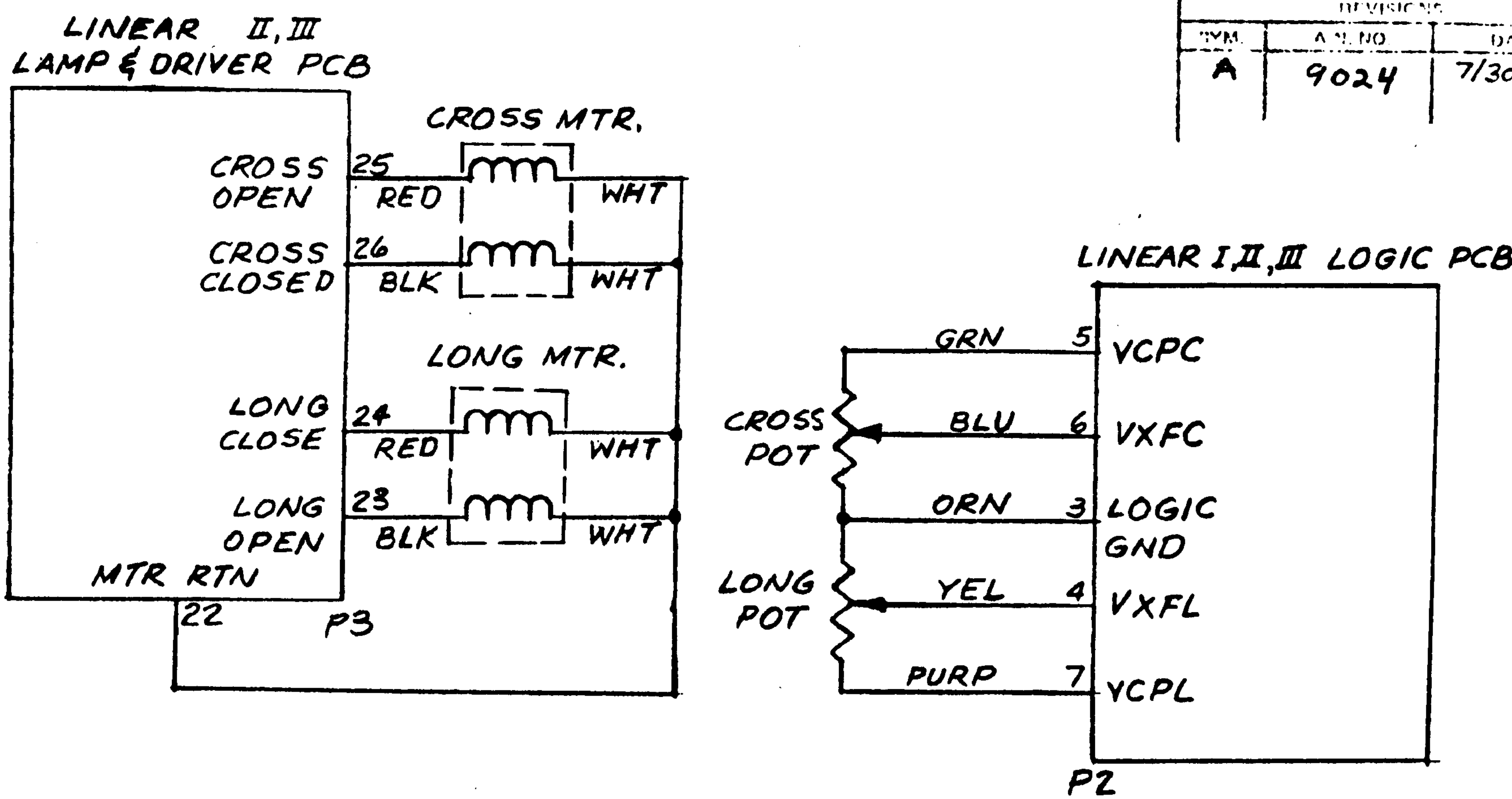
9.2.11 IR Selection

The electronics are configured to accept cassette size inputs from two different image receptors, normally, one in the x-ray table and one located on a wall within the x-ray room. Relay RLY-2 is energized when the collimator is tilted to the programmed direction (SW2-5, Bucky Right or SW3-5, Bucky Left) and the x-ray table is not not tilted, and the collimator is angulated toward the table, RLY-2 remains relaxed and the table receptor is selected just as the conditon of table at zero, collimator at zero.

It is also this "Tilt" logic that determines the SID voltage selection through IC3 on the master board located in the power chassis. This permits independent SID positons for the wall receptor, table vertical, and table trendelenburg.

NO TEXT

DWG. NO.	70-09038	
REVISIONS		
SYM.	A.N. NO.	DATE
A	9024	7/30/84



TITLE FEEDBACK POT & MOTOR WIRING DIAGRAM

SCALE ~

DRAWN M.L.

DATE 7-30-84

EUREKA X-RAY TUBE CO.

DWG. NO. 70-09038

EUREKA X-RAY TUBE CO.

PARTS LIST

TITLE: LINEAR I, II LOGIC PCB ASSY	APPLICATION		PARTS LIST NO.	
	NEXT ASSY	USED ON	70-08002	
			WRITTEN:	DATE:
			M. LACH	3-28-84
			APPROVED	DATE:
			D Wagner	6/5/84

REVISIONS

REV.	DESCRIPTION	DATE:	APPROVED
J	RELEASE TO PRODUCTION PER AN 8949	6/5/84	D Wagner
K	REV'D. PER ECN 411 DRA #3	10-1-85	D Wagner

EUREKA X-RAY TUBE CO.

PARTS LIST

PARTS LIST NO. 70-08002 REV. K

ITEM NO.	QTY	DWG SIZE	PART NO.	DWG TYPE	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
1	1		70-06251		LINEAR I,II LOGIC PCB		
2	3		70-03201		I.C., 16 PIN, TRANSISTOR ARRAY	ULN 2004A (XR 2204)	IC 1,4,5
3	1		70-03108		I.C, 14 PIN, TRIPLE 3 INPUT NOR	CD 4025	IC2
4	2		70-03351		I.C. 8 PIN, DUAL OP-AMP	LM258 (2904)	IC 3, 13
5	3		70-03112		I.C., 14 PIN, QUAD 2-INPUT AND	CD 4081	IC 6, 11, 12
6	1		70-03103		I.C., 14 PIN, QUAD 2 INPUT NAND	CD 4011	IC7
7	3		70-03109		I.C., 14 PIN, HEX-INVERTER	CD 4069	IC 8, 14, 17
8	1		70-03104		I.C. 14 PIN, DUAL D FLIP-FLOP	CD 4013	IC9
9	1		70-03107		I.C. 14 PIN, TRIPLE, 3 INPUT NAND	CD 4023	IC10
10	1		70-03353		I.C. 8 PIN TIMER	LM 555	IC15
11	2		70-03352		I.C. 8 PIN, DUAL VOLT. COMP	LM 393	IC 16, 18
12	1		70-03114		I.C. 14 PIN, QUAD BI-LAT. SWITCH	CD 4066	SW 1
13	1		70-02501		CAP, ELECT. 1 MF, 50V		C6
14	7		70-02506		CAP, TANT., 2.2 MF @ 25V ± 10%		C1-3, 18, 19, 21 22
15	1		70-02010		CAP, MONO, .1 uF @ 50V ± 10%		C24
16	8		70-02012		CAP, MONO, .01 µF @ 100V ± 10%		C4, 5, 7-10, 16, 20
17	10		70-02030		CAP, MONO, .001 uF @ 200V ± 10%		C11-15, 17, 23 25-27
18	2		70-03001		DIODE	IN914	D1, 2
19	1		70-03021		ZENER DIODE, 4.7 VZ, 1/4 W	IN750	VR2
20	10		70-03061		LED (RED)		LED 1, 2, 4-11
21	1		70-03062		LED (GREEN)		LED 3

EUREKA X-RAY TUBE CO.

PARTS LIST

PARTS LIST NO. 70-08002 REV. K

ITEM NO.	QTY	DWG SIZE	PART NO.	DWG TYPE	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
22	1		70-03301		REF. DIODE 1.22 VZ	LM 113	VR1
23	2		70-03402		TRANSISTOR	2N2222	Q1, 2
24	1		70-00045		RES. CARB. FILM, 1/4W, 1.5KΩ ±5%		R2
25	8		70-00064		" " " " 10KΩ "		R3,4,9,19,20 27-29
26	1		70-00058		" " " " 5.6KΩ "		R5
27	1		70-00079		" " " 51KΩ "		R1
28	1		70-00091		" " " " 200KΩ "		R10
29	1		70-00057		" " " " 5.1KΩ "		R11
30	1		70-00061		" " " " 7.5KΩ "		R21
31	2		70-00056		" " " " 4.7KΩ "		R13, R30
32	1		70-00051		" " " " 3.0KΩ "		R17
33	1		70-00067		" " " " 15KΩ "		R22
34	1		70-00301		RES. METAL FILM, 1/4W, 30.1Ω ±1%	RN55	R7
35	1		70-00302		" " " " 137Ω "	"	R12
36	1		70-00304		" " " " 154Ω "	"	R6
37	1		70-00307		" " " " 332Ω "	"	R8
38	2		70-00501		RES. PAK 8PIN SIP, 1/4W, 680Ω	81-681	RP1, 4
39	2		70-00504		" " 14PIN DIP, " , 10KΩ	141-103	RP2, 3
40	1		70-00603		RES. TRIMMER 4T, 500Ω	339P1-501	R26
41	1		70-00606		" " " 10KΩ	339P1-103	R25
42	3		70-04503		SOCKET, 16 PIN DIP	ICC16076	IC1, 4, 5

BILL OF MATERIAL

BILL OF MATERIAL NO.	REV.
70-0800Z	K

ITEM NO.	QTY	DWG SIZE	PART NO.	ITEM CLASS	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
43	11		70-04502		SOCKET, 14 PIN DIP	ICC14076	IC2, 6-12, SN1 14, 17, 19
44	5		70-04501		" , 8 PIN DIP	ICC08076	IC3, 13, 15, 16, 18
45	2		70-04202		SWITCH, SPST DIP 10 PIN	CTS 206-5	SW2, 3
46	5		70-0624		JUMPER, BUS BAR 24 GA		TP1-4, GND
47							
48	2		70-00604		RES TRIMMER 4T 1K		R23, 24
49	4		70-00116		RES CARB FILM 1/4W 6.8M 5%		R14-16, 18
	REF	D	70-0X002		LIN I, II SCHEMATIC & ASSY		

EUREKA X-RAY TUBE CO.

BILL OF MATERIAL

TITLE: ASSY, MASTER PCB	APPLICATION		BILL OF MATERIAL NO.	
	NEXT ASS'Y	USED ON	70-08009	
			WRITTEN:	DATE:
			M.LACH	11-5-85
			APPROVED:	DATE:
LINEAR I, II, III				

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
J	REVISED PER ECN 402 DRA	12/18-85	
J1	REVISED PER ECN 526	2/8/86	
K	ADDED R27-R30 RESISTORS ECN 1102 QRH.	7/6/87	

BILL OF MATERIAL

BILL OF MATERIAL NO.	REV.
70-08009	K

ITEM NO.	QTY	DWG SIZE	PART NO.	ITEM CLASS	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
1	1	D	70-06257	ID	MASTER PCB		
2	4	A	70-04521	HV	TERMINAL STRIP, 22 POS.		TS1-4
3	2	A	70-04003	HN	CLIP, RETAINING		
4	2	C	70-04001	NN	RELAY, 24V, 4 FORM C		K1,2
5	1	A	70-03041	HG	IC, 6 PIN DIP, OPTO COUPLER	MC2	IC1
6	2	A	70-03201	HJ	IC, 16 PIN DIP TRANSISTOR ARRAY	ULN 2004A	IC2,4
7	1	A	70-03202	HJ	IC, 16 PIN DIP TRANSISTOR ARRAY	NL 2032A	IC3
8	1	A	70-03304	HL	VOLTAGE REG. 15V	MC7815	VR1
9	2	A	70-03032	HF	BRIDGE RECTIFIER, 6A, KBPC 104	KBPC 104	B1,2
10	2	A	70-04002	HT	SOCKET, RELAY		K1,2
11	4	A	70-04503	HT	16 PIN IC SOCKET		J1, IC 2,3,4
12	1	A	70-02505	HB	CAPACITOR, ELECT. 2000μF, 35V		C1
13	1	A	70-02503	HB	CAPACITOR, ELECT. 100μF, 16V		C2
14	2	A	70-02506	HB	CAPACITOR, TANT. 2.2μF, 25V ±10%		C3,23
15	2	A	70-02508	HB	CAPACITOR, ELECT. 1000μF, 25V		C6
16	16	A	70-02010	HB	CAPACITOR, CERAM. .1μF, 50V		C4,5,7,10-22
17	3	A	70-03012	HC	DIODE, 1AMP, 100 VRRM	IN4002	D1,2,3
18	1	A	70-00401	HA	RESISTOR, 5W, 3.3KΩ		R1
19	1	C	70-00220	HA	RESISTOR, 1/2W, 390Ω, ±5%		R2

BILL OF MATERIAL

BILL OF MATERIAL NO.	REV.
70-08009	K

ITEM NO.	QTY	DWG SIZE	PART NO.	ITEM CLASS	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
20	2	C	70-00018	HA	RESISTOR, 1/4W, 100 Ω ±5%		R3,4
21	10	C	70-00064	HA	RESISTOR, 1/4W, 10KΩ ±5%		R5-9,14 23-26
22	8	C	70-00045	HA	RESISTOR, 1/4W, 1.5KΩ ±5%		R10-13,27-30
23	8	C	70-00034	HA	RESISTOR, 1/4W, 470Ω ±5%		R15-22
24	2	A	70-02011	HB	CAPACITOR, CERAM. .47μF, 50V		C8,9
25	1	A	70-10902	EF	SCREW, 6-32 x .25 SLTD PNH		
26	1	A	70-10815	EC	NUT, HEX 6-32		
27	000	A	70-10726	CG	THERMAL COMPOUND		
28	2	A	70-04635	HY	FUSE HOLDER		
29	1	A	70-04602	HY	FUSE, 1AMP		F1
30	1	A	70-04585	HX	HEAT SINK		
31	1	A	70-04506	HT	6 PIN IC SOCKET		IC1
32	.292	A	70-06602		SHRINK TUBING 3/32" DIA.		
	REF	D	70-08009	AE	ASSY DWG, SCHEMATIC		

EUREKA X-RAY TUBE CO.

PARTS LIST

TITLE:	APPLICATION		PARTS LIST NO.	
	NEXT ASSY	USED ON	70-08032	
LAMP & DRIVER PCB ASSY			WRITTEN:	DATE:
LINEAR II			M. LACH	12-13-83
			APPROVED	DATE:
			W. Wiegman	4-26-84

REVISIONS

REV.	DESCRIPTION	DATE:	APPROVED
A	RELEASED TO PRODUCTION	4-26-84	W. Wiegman

EUREKA X-RAY TUBE CO.

PARTS LIST

PARTS LIST NO. 70-08032 | REV.

ITEM NO.	QTY	DWG SIZE	PART NO.	DWG TYPE	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
1	1	C	70-06250		LAMP & DRIVER PCB		
2	7		70-04570		LAMP, INDICATOR 28 VDC	PEN-KEYSTONE 7561-W-28	L1,2,5-9
3	7		70-03354		I.C. 8 PIN, OPTO-SCR	KA110-1	IC1,2,3,5-8
4	1		70-03353		I.C. 8 PIN, TIMER	NE 555	IC4
5	1		70-03030		BRIDGE RECTIFIER 1 AMP	VM 28	B1
6	1		70-03304		VOLTAGE REGULATOR 15V	MC 7815	VR1
7	1		70-02507		CAP, ELECT. 10 MF, 25V ±10%		C7
8	2		70-02101		CAP. NON-POLAR. 10 MF, 50V $^{+50\%}_{-10\%}$		C2,3
9	1		70-02509		CAP. TANTAL. 2.2MF, 25V ±10%		C16
10	9		70-02009		CAP. CERAMIC, .01 MF, 50V ±20%		C5,6,9-15
11	2		70-02013		CAP. CERAMIC, .1 MF, 100V ±20%		C4,8
12	4		70-03012		DIODE, 1AMP, 100 VRRM,	IN 4002	D1-4
13	7		70-00010		RES. CARB. FILM, 1/4 W, 47 Ω ±5%		R1,2,5,6,14,20,21
14	1		70-00018		RES. CARB. FILM, 1/4 W, 100Ω ± 5%		R19
15	7		70-00034		RES. CARB. FILM, 1/4 W, 470 Ω ±5%		R3,4,7,9,13,15,16
16	1		70-00064		RES. CARB. FILM, 1/4 W, 10K Ω ±5%		R17
17	1		70-00110		RES. CARB. FILM, 1/4 W, 2.2 MΩ ±5%		R18
18	1	-	70-06524		JUMPER, BUS BAR, 24 AWG	BELDEN 8022	J1
19	8		70-04501		SOCKET, DIP, 8 PIN		
20	1		70-04506		SOCKET, DIP, 6 PIN		
21	REF	A	70-08032		LAMP & DRIVER PCB ASSY, LINEAR II		

EUREKA X-RAY TUBE CO.

BILL OF MATERIAL

TITLE: LINEAR II LAMP & DRIVER PCB ASSY.

APPLICATION		BILL OF MATERIAL NO.	
NEXT ASS'Y	USED ON	70-08052	
		WRITTEN:	DATE:
		M. LACH	3-25-86
		APPROVED:	DATE:
		D. Rhein	1/13/87

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	ORIGINATE PER ECN 1003 D. Rhein 1-12-87	1/12/87	D. Rhein
B	CHANGED ITEM 30-WAS 70-00010 PER ECN 1161	10/1/87	D. Rhein

BILL OF MATERIAL

BILL OF MATERIAL NO.	REV.
70-08052	B

ITEM NO.	QTY	DWG SIZE	PART NO.	ITEM CLASS	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
1	1	C	70-06269	ID	LINEAR I, II, III, LAMP & DRIVER PCB		
2	1	A	70-03065	HI	LED LIGHT BAR, 16 PIN DIP, H.E. RED	HLMP-2685D	LB6
3	3	A	70-03066	HI	LED LIGHT BAR, 8 PIN DIP, YELLOW	HLMP-2755E	LB 1,2,5
4	2	A	70-03067	HI	LED LIGHT BAR, 16 PIN DIP, GREEN	HLMP-2885E	LB 7,8
5	1	A	70-03063	HI	LED LIGHT BAR, 16 PIN DIP, YELLOW	HLMP-2785	LB9
6	7	A	70-03043	HG	OPTO COUPLER/ISOLATOR, 6 PIN DIP	MOC 3011	IC1-6,8
7	1	A	70-03353	HJ	I.C. 8 PIN DIP, TIMER 555		IC7
8	1	A	70-03030	HF	BRIDGE RECTIFIER 1 AMP	VM28	B1
9	6	A	70-03052	HH	TRIAC	MAC 97A5	Q1-6
10	5	A	70-03012	HC	DIODE, 1 AMP, 100 VRRM	IN4002	C1-5
11	2	A	70-00508	HA	RESISTOR ARRAY, 16 PIN DIP, 47Ω		RP1, 2
12	5	A	70-04597	HT	SOCKET, 16 PIN DIP, WIRE WRAP		LB1&5, 6-9
13	1	A	70-04598	HT	SOCKET, 8 PIN DIP, WIRE WRAP		LB2
14	1	A	70-02511	HB	CAPACITOR, TANT. 10 MF, 35V		C17
15	2	A	70-02509	HB	CAPACITOR, TANT. 2.2 MF, 35V		C15,16
16	2	A	70-02101	HB	CAPACITOR, NON-POL, 10 MF, 50V		C1,11
17	1	A	70-03304	HL	VOLT. REGULATOR	MC7815	VR1
18	1	A	70-02010	HB	CAPACITOR, CER. .1MF, 50 VDC		C19
19	8	A	70-02012	HB	CAPACITOR, CER. .01 MF, 100 VDC		C3,4,6,8,10,13 18,21

BILL OF MATERIAL

BILL OF MATERIAL NO.	REV.
70-08052	B

ITEM NO.	QTY	DWG SIZE	PART NO.	ITEM CLASS	DESCRIPTION	VENDOR PART NO.	REF. DESIGN
20	1	A	70-02030	HB	CAPACITOR, CER. .001 MF 200 VDC		C20
21	6	A	70-02021	HB	CAPACITOR, CER. .22 MF, 50 VDC		C2,5,7,9,12,14
22	7	C	70-00042	HA	RESISTOR, CARB. FILM, 1/4 W, 1 KΩ ±5%		R20, 22-27
23	1	C	70-00018	HA	RESISTOR, CARB. FILM, 1/4 W, 100 Ω ±5%		R21
24	1	C	70-00110	HA	RESISTOR, CARB. FILM, 1/4 W, 2.2 MΩ ±5%		R19
25	1	C	70-00112	HA	RESISTOR, CARB. FILM, 1/4 W, 3.3 MΩ ±5%		R18
26	9	C	70-00225	HA	RESISTOR, CARB. FILM, 1/2 W, 1 KΩ ±5%		R3,5,7,10-15
27	2	C	70-00229	HA	RESISTOR, CARB. FILM, 1/2 W, 2.2 KΩ ±5%		R8,9
28	8	A	70-04506	HT	SOCKET, 6 PIN DIP		IC1-6,8,B1
29	1	A	70-04501	HT	SOCKET, 8 PIN DIP		IC7
30	.125	A	70-06524	CC	JUMPER-BUS BAR 24 AWG	BELDEN 8022	R28
31	2	A	70-00064	HA	RESISTOR, CARB. FILM, 1/4 W, 10 KΩ ±5%		R16, R17
32	24	A	70-04674	HZ	SPACER (.5" LONG)		
	REF.	C	70-08052-1	AE	SCHEMATIC		
	REF	C	70-08052-2	AE	ASSY DWG.		